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Dedicated to the 150th Anniversary and
The 1st Congress of World Engineers and
Riga Polytechnical Institute / RTU Alumni

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RIGA TECHNICAL UNIVERSITY
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Table of contents

Computer Science 3
- Boundary Field Problems and Computer Simulation 3
- Technologies of Computer Control 20
- Applied Computer Systems 41
- Information Technology and Management Science 66

Power and Electrical Engineering 98
- Power Engineering 98
- Electrical Machines and Drives, Robotics 107
- Power Electronic Converters and Applications 118
- Process Control 131
- Environmental and Climate Technologies 137

Materials Science and Applied Chemistry 183
- Materials Science 183
- Chemistry and Chemical Technology 217
- Textile and Clothing Technology 278

Humanities and Social Sciences 304

Architecture and Urban Planning 331

Construction Science 359
- Construction Science 359
- Heat, Gas and Water Technology 407
- Geomatics 436

National Economy and Entrepreneurship 451
- Scientific Problems of Technogenic Environment Safety 451
- International Business, Logistics, Customs and Taxes 463
- National and Regional Economics 478
- Production Economics, Finance and Marketing 514
- Quality Technologies and Management 569

Technology Transfer and Innovation 577

Engineering, Mechanics and Mechanical Engineering 581
- Production Engineering 581
- Heat Power and Thermal Physics 597

Transport 606
- Road Transport 606
- Railway Transport 609
- Aeronautics and Transport Systems 619

International Symposium on Biomedical Engineering and Medical Physics 639

Real Estate Economics and Construction Entrepreneurship 740

Computer Science

Boundary Field Problems and Computer Simulation

Regional Hydrogeological Model of Latvia as a Tool for Estimating Interaction between Groundwater and Surface Water

Aivars Spalvins, Janis Slangens, Inta Lace, Kaspars Krauklis, Olgerts Aleksans, Natalja Levina and Viesturs Skibelis
(*Riga Technical University*)

Keywords **– hydrogeological models, software tools for modeling groundwater flows, recharge and discharge of groundwater, hydrological cycle, Latvia**

The countries of the world and of European Union are developing hydrogeological models (HM) where by means of computer modeling, the information necessary for groundwater management is obtained. In 2012, the Riga Technical University (RTU) has finished establishing of HM that covers the whole territory of Latvia and border areas of neighbouring countries [1]. HM includes 25 geological layers of the active groundwater zone (till the Narva D2nr regional aquitard) that is being used as a source for providing drinking water. The 3D-body of HM is represented by 951×601×25 finite difference grid where the approximation step is 500 meters. To ensure compatibility with models of other countries, the commercial program Groundwater Vistas (GV) is used for running HM. GV contains software tools applied for groundwater modeling worldwide.

HM is a part of the Latvian Shared Environmental Information System. It is supported by the Latvian Environment, Geology and Meteorology centre. HM comprises geological and hydrogeological information provided by the centre.

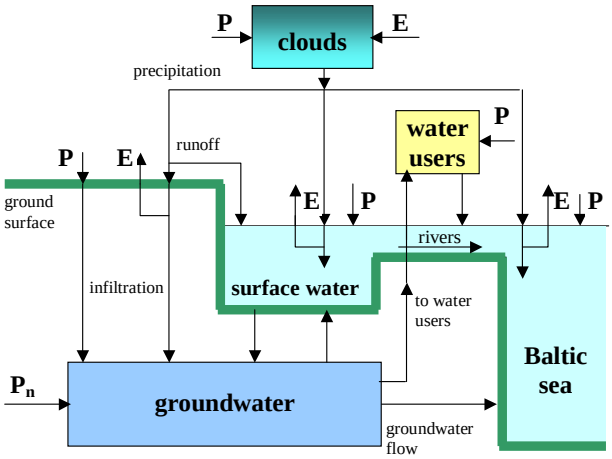

Fig. 1. Sheme of hydrologic cycle and its pollution sources for Baltic region; E – evaporation; P, Pn –anthropological and natural pollution

Presently, HM provides data regarding geometry and permeability of geological layers, 3D distributions of groundwater heads and flows. These parameters include full information necessary for making decisions on sustainable management of groundwater bodies. In the scheme of Fig.1, HM describes processes within the module *groundwater* that is an important part of the hydrologic cycle for the Baltic region.

The next stage of HM development will convert the model into a tool that provides information describing interaction between groundwater and surface water sources. As it follows from Fig.1, the sources include elements of hydrographical network (rivers, lakes, Baltic Sea) and precipitation (rain, snowfalls). Without knowledge about this interaction, it is not possible to integrate surface water and groundwater into the joined system that includes elements that are taking part in the closed hydrologic cycle (atmosphere, groundwater, surface water, and atmosphere).

Due to the fact that HM applies the ground surface elevation map (digital relief) and the hydrographical network, as the boundary conditions, HM can compute amount of water passing between groundwater and surface water bodies [2]. However, it is necessary to feed into HM extra information regarding measurements of water flow for rivers. In HM, this information will be used for adjusting values of elements that join groundwater and surface water bodies.

The expected HM further development turns the model into the tool that enables to join groundwater and surface water sources into the connected system (see Fig.1.). Due to this achievement, the quality of water management for Latvia will increase considerably.

This publication is a part of the Project (agreement Nr.2010/0220/2DP/2.1.1.1.0/10/APIA/VIAA/011) entitled *Creating of hydrogeological model of Latvia to be used for management of groundwater resources and for evaluation of their recovery measures*. The Project is being co-financed by the European Regional Development Fund.

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Methods of Obtaining Distributions of Piezometric Boundary Conditions and of Infiltration Flow for Regional Hydrogeological Model of Latvia

Aivars Spalvins, Janis Slangens, Inta Lace and Kaspars Krauklis (*Riga Technical University*)

***Keywords* – hydrogeological models, boundary conditions, infiltration flow, calibration of models, Latvia.**

In 2012, the regional hydrogeological model (HM) of Latvia has been completed by Riga Technical University. HM covers 475km×300km area (Fig. 1.). It includes the territory of Latvia, the Gulf of Riga (active zone) and border areas of neighbouring countries (passive zone). The both zones are separated by the 4km vide border. Steady state HM simulates the active groundwater zone that contains drinking groundwater resources for Latvia. HM includes 25 geological layers. The plane approximation step of HM is 500 metres [1].

The HM body is enveloped by its top and bottom surfaces, but HM outer vertical sides are constituted by the shell. On all HM outer surfaces, piezometric boundary conditions are fixed. On the HM top and bottom surfaces, accordingly, the relief (ground surface elevations) and the Pernava aquifer *D2pr* head distribution maps are used, as boundary conditions. The relief map also represents the geometrical top surface of HM.

Initially, the HM shell surface acts as an impermeable barrier for a groundwater trans-boundary flow, because, outside the HM body, the area of HM inactive zone is located. To overcome this drawback, the distribution of boundary conditions for the HM shell must be found. The distributions are set on the middle line of the HM border-zone where the real values of trans-boundary flows for aquifers must be recovered (Fig.1.).

The unknown head distribution for the HM shell has been found by enlarging (100-1000) fold hydraulic conductivity of the shell. Then the shell acts like the 3D- interpolation device that provides the needed boundary condition, as a result found by HM itself. When the result is fixed, as the boundary condition, conductivity of the shell must be restored to the normal one.

The infiltration flow passing through the HM top surface is the most important model parameter that fully controls results provided by HM. The task of obtaining the right infiltration flow is the extremely difficult one, if customary methods of modeling are used. For the regional model of Latvia that covers large area, intensively and direction of the infiltration flow are changing drastically. To overcome this difficulty, an original method has been applied for HM of Latvia, where the map of relief elevation controls infiltration flow and the aeration zone acts as a formal aquitard. In this case, HM itself provides the infiltration flow distribution (Fig. 2.) that can be adjusted by calibrating permeability of the aeration zone [2].

The methods of calibrating the infiltration flow are explained and results of their application are described for the regional HM of Latvia. The relief also regulates head distributions within the HM body and, due to this phenomenon, HM provides trustworthy results even after its first run.

In this digest, two original methods used for establishing boundary conditions for HM are described. They have enabled to create the regional HM of Latvia during a rather short time (24 months).

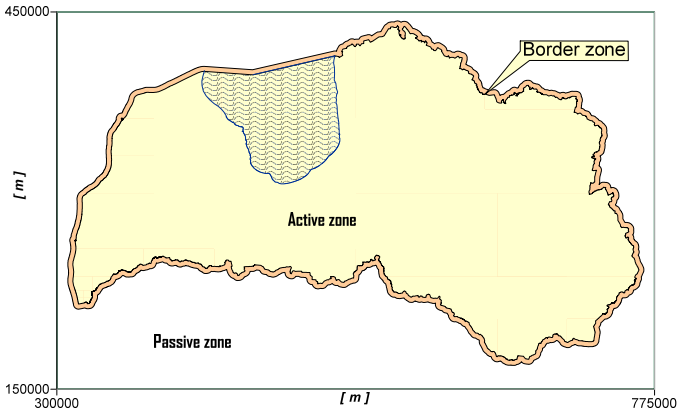

Fig. 1. Location of regional HM active and passive zones

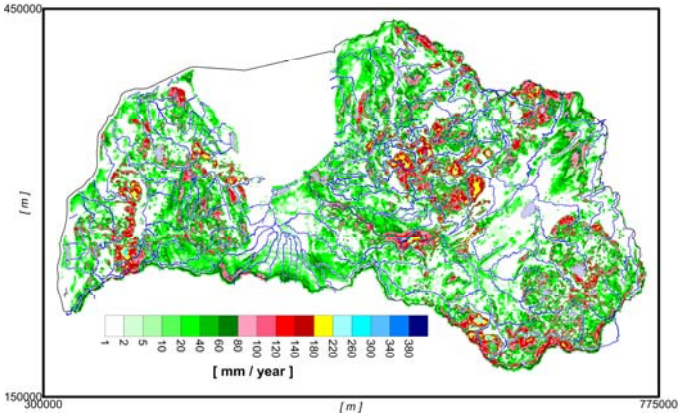

Fig. 2. Distribution of infiltration flow created by HM

This publication is a part of the Project (agreement Nr.2010/0220/2DP/2.1.1.1.0/10/APIA/VIAA/011) entitled *Creating of hydrogeological model of Latvia to be used for management of groundwater resources and for evaluation of their recovery measures*. The Project is being co-financed by the European Regional Development Fund.

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Methods and Software Tools Used to Designate Geometry for Regional Hydrogeological Model of Latvia

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(*Riga Technical University*)

Keywords **– hydrogeological models, computer based modelling, geometry of model, interpolation tools, Latvia.**

In 2012, the hydrogeological model (HM) of Latvia was established, by scientists of Riga Technical University. HM comprises the active groundwater zone that provides drinking water. The 3D-body of HM is approximated by the 951×601×25 size finite difference grid. Its plane approximation step is 500 metres and HM accounts for 25 geological layers [1].

The commercial software Groundwater Vistas (GV) is used, to run HM. The GV system contains tools used worldwide for hydrogeological modeling.

The most time consuming and troublesome part of establishing HM is to designate its geometry that is represented by thicknesses of geological layers composing the HM body. For HM of Latvia, most of these layers are outcropping. They are not continuous and, for this reason, they are not present everywhere on the area of HM. This phenomenon is demonstrated by Fig. 1 where the map of geological borderlines for primary strata is shown. It is clear from the vertical geological section of Fig. 2 that after emerging at the surface, such layers have the zero thickness. No thicknesses m=0 are allowed by the GV system and, m=0.02 metres is applied, to represent them, in HM.

Thicknesses of layers are not used by GV, as initial data. A modeller must prepare the set of z-maps that presents elevation surfaces of the layers. The GV system uses the z-maps for obtaining thicknesses of layers.

To prepare the z-maps three steps of data interpolation have been performed:

- selecting and checking borehole data that describe stratigraphy of the geological environment; the trustworthy data are located on the lines forming vertical cross sections that help to check and rectify borehole data; the EXCEL system is applied, to carry out this step. These lines later are used as information carriers;
- by using the graphical system SURFER, the preliminarily set of the z-maps is prepared; the verified borehole data and information carried by geological borderlines are applied by SURFER, as the pointwise information sources;
- the final version of the z-maps has been obtained by the Geological Data Interpolation (GDI) system [2]. GDI uses lines as data carriers for creating the layer surfaces. The linewise information is obtained by interpolating the borehole data located along the lines.

It was rather difficult to create the z-maps for the four Quaternary layers, because borehole information describing their geometry is waste and contradictory. For this reason, mainly pointwise data and a few lines were applied as sources for obtaining the z-maps of the Quarternary system.

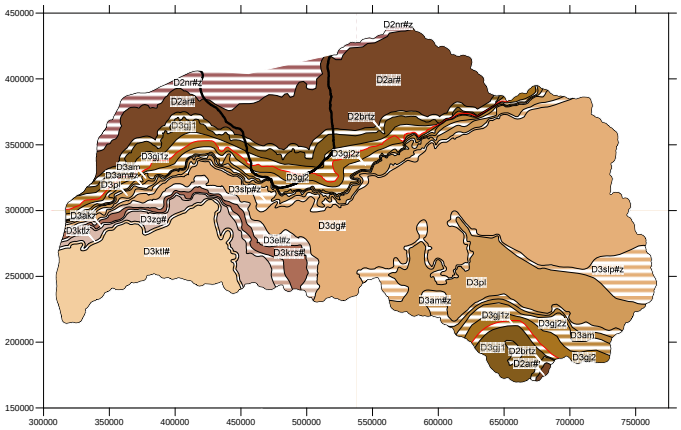

Fig. 1. Geological borderline map for primary strate

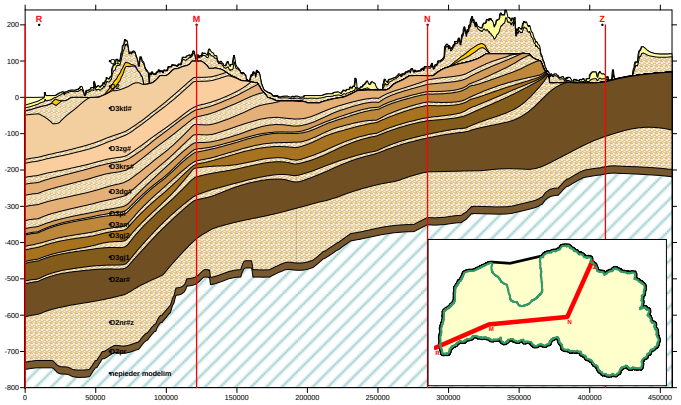

Fig. 2. Vertical geological cross section

This publication is a part of the Project (agreement Nr.2010/0220/2DP/2.1.1.1.0/10/APIA/VIAA/011) entitled *Creating of hydrogeological model of Latvia to be used for management of groundwater resources and for evaluation of their recovery measures*. The Project is being co-financed by the European Regional Development Fund.

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Computer based methods for including hydrographical network in regional hydrogeological model of Latvia

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***Keywords* – hydrogeological models, hydrographical network, computer based modelling, Latvia.**

In 2012, the hydrogeological model (HM) of Latvia has been established, by the Environment Modelling Centre team of Riga Technical University, as an element of the Latvian shared environmental information system [1]. The 3D –body of the geological environment to be modeled is represented by 951×601×25 finite difference grid which plane approximation step is 500 meters. HM is established in the framework of the commercial program Groundwater Vistas (GV) which includes the worldwide used MODFLOW system for running the model. As initial information for creating the model serves a set of digital maps (elevations of geological layer surfaces, permeability of layers, boundary conditions, etc.). Elements of hydrographical network (rivers, lakes, Baltic Sea) and the digital relief map serve as boundary conditions. The map is applied on the HM top surface. The digital relief controls infiltration flow through the aeration zone and also accounts for embedding in HM lakes and areas of Baltic Sea [2]. Although, rivers and lakes (see Fig.1.) are included in the relief, rivers are also joined with HM layers, as universal boundary conditions of the GV system. This kind of boundary conditions includes not only river water levels but also river bed conductivity elements. The elements account for "strength" of HM contact with a river. Because most of geological layers of Latvia are outcropping, a river, on its run, can be joined with different layers. For example, the river Gauja runs through the Quaternary, the lower and upper Devonian layers (Fig. 2.). Hence, about 200 larger rivers of Latvia are included in HM (Fig. 1.); no modeler is able to join them properly with a model. For this reason, it was necessary to develop a special software tool for accomplishing this task. This program performs two steps:

- find aquifers with which a river must be joined;
- if a river runs through a valley that contains aquitards located above the river, their permeability is considerably increased; in this way, the stage of river is opened for a water flowing into the river from above.

To carry out the first step, elevations of a river long line profile are compared with surfaces of geological layers. If a river stage lies within an aquifer, the stage must be joined with the aquifer. When the right aquifer is found, for the current river stage, the program performs the second step by founding set of aquitards which permeability must be increased.

The program prepares data files that are used for entering data of rivers into HM. Due to this special software tool, reliability of the HM contacts with a set of rivers has been improved considerably.

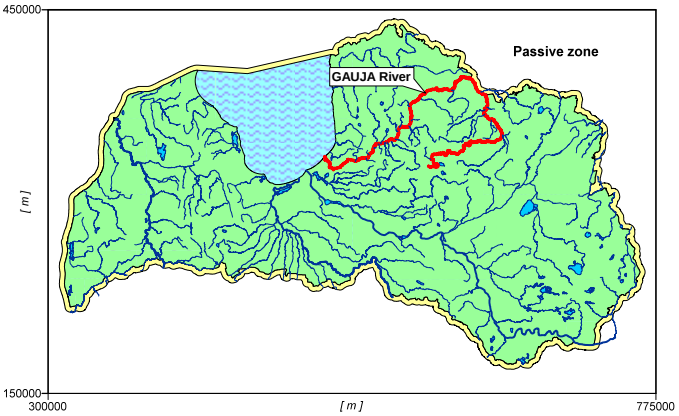

Fig. 1. Set of rivers and lakes included in HM

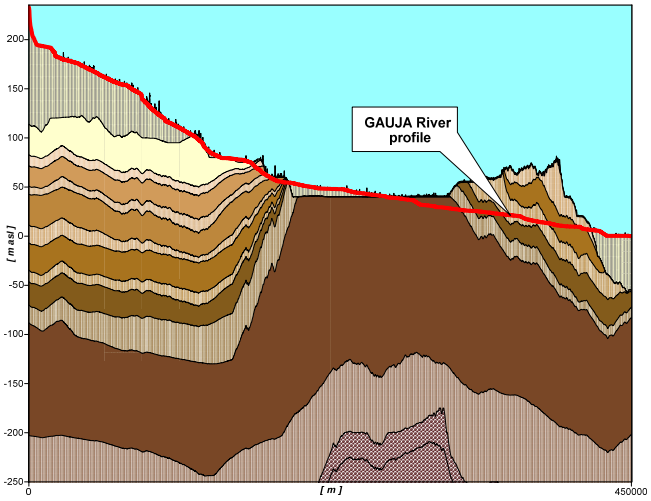

Fig. 2. Vertical cross section along the Gauja river

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Characterization of Wind Loading of the Large Radio Telescope

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***Keywords* – Computational Fluid Dynamic, Large-Eddy Simulation, large radio telescope, turbulence models, wind-load.**

I. Introduction

This paper describes numerical simulations of wind-loads on the large parabolic reflector antenna RT-32 with a diameter of 32 m. The wind flow leads to a compressive load on the dish and thus to a deformation of the reflector. These deformations can cause a performance degradation of the input signal, or even loss the observed or controlled object.

Studies have been carried out at the Ventspils International Radio Astronomy Center to investigate the wind-loading effects on the radio telescope RT-32 structure. The wind loads are calculated with the help of an open sourced Computational Fluid Dynamic (CFD) toolkit OpenFOAM.

II. Solution Strategy

A. Computational domain and mesh generation

The computational domain covers *10D* (*D* is the width of the tower building) in streamwise (*X*) direction, *5D* in lateral (*Y*) direction and *4H* in vertical (*Z*) direction for the Reynolds Averaged Navier-Stokes (RANS) approach. The computational domain of the Large-Eddy Simulations (LES) is 204 x 136 x 118 m^3 (length x width x height).

The RT-32 Finite Volume (FV) model contains main reflector, tower building, frame and some of bigger beams. Beams and the tower construction surface mesh are created with the open source tool Gmsh and then they are exported to triangulated surface format which is used as input file of the OpenFOAM's *snappyHexMesh* utility.

B. Turbulence models and numerical methods

In this study, the characteristic velocity is about 3.5 m/s therefore the flow could be treated as incompressible flow.

Two RANS turbulence models are used in the present study: the standard k-epsilon model [2] and RNG k-epsilon model [3], where *k* is the turbulence kinetic energy and *epsilon* its rate of dissipation.

A numerical study simulating the time-dependant flow field structures is carried out using a Large Eddy Simulation model [4], which incorporates the one-equation sub-grid scales (SGS) turbulence model.

C. Boundary conditions

Table 2 summarizes boundary conditions with their corresponding entry specifications used for RANS turbulence models.

TABLE II

Boundary conditions specifications of the RANS

	inlet	outlet	walls	other
U	const	$\partial U/\partial n = (0\ 0\ 0)$	(0 0 0)	$\partial U_t/\partial n = (0\ 0\ 0)$ $U_n = 0$
p	$\partial p/\partial n = 0$	0	$\partial p/\partial n = 0$	$\partial p/\partial n = 0$
k	const	$\partial k/\partial n = 0$	$\partial k/\partial n = 0$	$\partial k/\partial n = 0$
epsilon	const	$\partial \varepsilon/\partial n = 0$	$\partial \varepsilon/\partial n = 0$	$\partial \varepsilon/\partial n = 0$

At the inflow and outflow boundaries in the LES models, all variables are set to a cyclic condition: enables two boundaries to be treated as if they are physically connected.

For the initial velocity values at the walls fixed values of 0 were used. The other boundaries are defined as symmetry planes (f.v.).

III. Results and Discussion

A. Parametric study

First, CFD simulations were performed in a three-dimensional, empty (without reflector, tower building, frame and beams) computational domain. The main objectives for these simulations are:

1) explore the effect of vertical mesh sensitivity;
2) extract the most convenient model constants for flow around telescopes.

B. Comparison among different elevation angles and wind directions

The CFD calculations of the RANS were made at four different elevation angles of the main reflector: $\alpha = 90^0$ (zenith), 60^0, 30^0, 0^0 and at five wind directions: $\beta = 0^0$, 45^0, 90^0, 135^0 and 180^0. The inlet velocity (wind) is oriented in the *x*-direction.

The maximum pressure difference on the main reflector surface is when the wind direction is 45^0 (see Fig. 9).

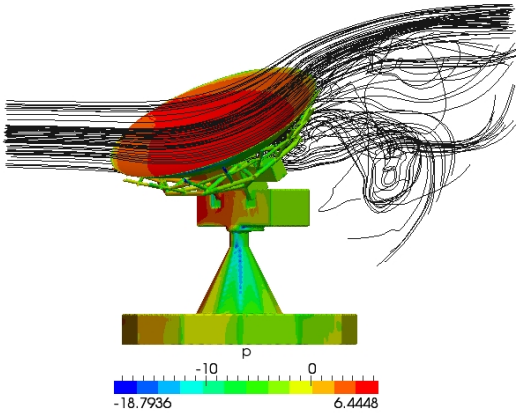

Fig. 9. The flow around the radio telescope; the wind direction is 45^0, the elevation angle is 30^0.

Acknowledgements

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Formation of the Ice Casting Pattern Structure and Methods of Its Modeling

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Volodymyr Kravchenko (*Physico-Technological Institute of Metals and Alloys, Kyiv*),
Olena Mul (*Ternopil National Ivan Puluj Technical University*)

Keywords **– Ice casting patterns, aqueous composition, dendrites, clusters, fractals.**

I. Introduction

Development of new cryo-technology types for foundry allows increasing its environmental cleanliness with the help of replacement of the traditional polymer pattern moulding materials by frozen water. Casting for ice patterns (CIP) allows noticing some crystallization phenomena laws, which are important for creation of qualitative casting patterns with a variety of technological properties. Ice transparency is long used to facilitate visual observation of dendrites structure formation for physical modeling of crystallization processes for metals, polymers, etc. This paper subject is peculiarities of ice crystallization during cooling water to the temperatures of -15…-20°C, modern variants of its modeling and the use of research results for production of ice casting patterns [1].

II. Analysis of the Latest Investigations

Analysis of the latest investigations did not reveal investigations of the structure of industrial constructions from ice. However, similar phenomena are considered in structural cryology [2] and permafrostology [3], where ice crystals are studied mainly as the material basis of our planet's cryosphere. In [3], considered as a classic paper in this area, there are presented experiments on the freezing for water-saturated samples of typical types of soils, in particular, of sand and of bentonite. For foundry cryotechnologies there is an analogy here: freezing of the sand sample is comparable with processes of frozen sand mold obtaining, and freezing of the water-saturated clay sample – with ice pattern obtaining on freezing an aqueous composition in the mold.

III. Results and Their Discussion

To study the process of aqueous composition freezing under conditions typical for an experimental production of casting patterns, we measured the temperature during cooling of samples in the air inside the freezer at the temperatures -15…-17°C. Most often single-use patterns after placing them into the mold sand are exposed to melting with the removal of fluid excess from the mold cavity. Therefore, the temperatures -15...-20°C are sufficient for cooling. In a cylindrical vessel from flexible thin-walled plastic with a diameter of 100 mm there were frozen three types of samples weighing 1 kg each: one from tap water and two aqueous composition with binders, 25% solution of liquid sodium glass (the density of 1.08 g/cm^3) and 25% solution of dextrin (the density of 0.98 g/cm^3) respectively. The temperature was measured in the sample center; the initial temperature was +3°C. The obtained results showed that the composition with the addition of liquid glass was crystallized in 30-32 min., faster than two others, which solidified approximately in the same time (40-45 min.).

The mechanism of growth of ice crystals in water is most adequately reflected in the cluster model of H. Frank and V. Wan [2]. According to this model, water is a conglomerate of large associates of molecules H_2O (clusters), appearing and then dissociating. X-ray and IR investigations of water showed that molecules arrangement inside the clusters was similar to their arrangement in the crystal lattice of ice. A decrease in temperature leads to an increase in the number of molecules in the cluster. Thus, even before the formation of the first stable ice crystals, there are ice-like formations in water. The growth of ice crystals occurs not constantly as a result of deposition of separate molecules on the edges, but by jumps due to addition of separate blocks of approximately 10^{-7}-10^{-3} cm.

In recent works on modeling clusters are described as fractals [4, 5] and clustering is considered as one of the ways of fractals appearance in irreversible processes. Here we should mention the Sander model with limited diffusion of aggregation (LDA). Unordered, chaotic growth of the crystal, identified with LDA, brought to a finite limit, is a consequence of motion of randomly wandering particles to the cluster that generates fractal structures. The similarity between the constructions of ice dendrites and LDA forms is explained by the fact that both processes are described by the Laplace equation from potential theory where the potential gradient corresponds to the field of diffusion in LDA and the cluster surface of LDA corresponds to the equipotential surface.

IV. Conclusions

In this paper there was considered a range of issues related to the mechanism and kinetics of ice solidification during obtaining a single-use casting pattern as well as distribution of impurities in ice. On the example it was shown the application of advanced mathematical methods of crystallization visual modeling in view of theory of clusters and fractals. Examples of casting patterns and their structures are given. The physical component of the modeling allows to describe the growth of ice formations during the pattern forming. The mathematical component makes it possible to build and study the numerical model, giving an idea about mechanisms and causes of crystals growth. For the technological use of the results, aspects of their adequate interpretation in terms of the physical model are important, as well as some obtained numerical characteristics and proposed research areas to bring the CIP technology to the experimental and industrial applications.

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Mathematical over XML family of technologies

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***Keywords* – Hierarchical XML structure, XML conceptual model, Monadic second order logic (MSO), First order logic (FOL).**

I. Introduction

The proposed analysis presents the theoretical ground and some simple applications of here analyzed mathematical tools, applied to XML-based technologies. The specification of W3C about XML definitions presents the parser as an essential idea and combines lexical and syntax analyzers, interpretation of DTD-parameters, the links to WEB etc. The parser has to convert internal encoding (ASCII or UTF) to Unicode, verify well-formed XML document and optionally validate against an XML Schema or DTD. In Section 2 are described the existing two approaches for XML API object-based interface (DOM) and event-based interface (SAX). In Section 3 are shown the main characteristics of several widely used XML tree structures. The access to the information stored in XML hierarchy is presented in Section 4. Finally, in Section 5, the general issues, conclusions, the further researches and some open problems are discussed.

II. Object-Based Interface Vs. Event-Based Interface

In this paper, are explored the existing two basic ways to interface a parser with an application: using object-based interfaces (DOM) or by means of event-based interfaces (SAX). Actually, according to object-based interface, the parser explicitly builds a tree of objects that contains all the elements in the XML document. This is probably the most natural interface for the application because it is handed a tree in the memory that exactly matches with the hierarchical file definition. With an event-based interface the parser does not explicitly build a tree of objects. Instead, it reads the file and generates events as it finds elements, attributes or text in the file. There are events for element starts, element ends, attributes, text content, entities, and so on. Object-based interfaces are ideal for applications that manipulate XML documents such as browsers, editors, XSL processors etc. Event-based interfaces are geared toward applications that maintain their own data structure.

III. XML Document as a Tree Structure

The paper studies XML hierarchical constructions as structures of unranked trees, which lead to modern logical formalisms for querying and navigation over XML documents. The modern theory of trees proves the following assertion: each unranked tree can be presented by reciprocal and simple way through balanced binary trees. In other words, regularity preserving translations from unranked trees to binary trees exists. If we divide unbalanced tree into two sub trees and try to navigate with two parsing procedures both parsers handle the nodes (root, children and leaves) with different times for running. In the parsing process both parsers execute handling of appropriate XML documents with time difference ΔT . This difference in times ΔT we are named with the term "dead hug". The so-called dead hug as time period depends on the number of nodes in both trees, the lengths of names of elements etc.

IV. Algebraic Search and Access to the Information Stored in XML Hierarchy

As result of this theoretical model here is given the unique determination of the physical address of the object O_k^r (XML node r from level *k)* in common structure, i.e. the number p_k^r by the following way:

$$p_k^r = \sum_{i=1}^{k-1} \alpha_i + \alpha_k^I = \alpha_1 + \alpha_2 + ... + \alpha_{k-1} + \alpha_k^I = \\ = \alpha_1 \sum_{i=1}^{k-1} \Phi(h_i) + \alpha_k^I \quad (1)$$

where:

$$\Phi(h_1) = c_0 = 1; \ \Phi(h_2) = c_0 \cdot c_1 = c_1; \ ...;$$

$$\Phi(h_k) = c_0 \cdot c_1 \cdot c_2 \cdot ... \cdot c_{k-1} = c_1 \cdot c_2 \cdot ... \cdot c_{k-1}$$

are the transforming characteristic elements from the XML tree hierarchy. Definitely, according to suggested formal algebraic description each of the physical addresses p_k^r of objects in a real XML hierarchical data structure can be simply calculated by means of formula 1. Here a_k^I is the code value a_k in the hierarchical level *k*. The calculations in this formula are based on the formal description of the sets of code values of XML nodes components.

V. Conclusions

On the base of the described XML tree structures, in this article is proposed an approach, inspired by the presented theoretical formalisms, which directly addresses XML hierarchical components. Meanwhile, some practical works about two-parser architecture using algebraic methods are underway. The initial results give hopeful prospects about these new parsing technologies. The presented approach makes obvious the possibilities for reaching linear time functions in XML tree hierarchy handling, which could accelerate this critical process.

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Determination of Heat Exchange Law, by Using Average Isotherm

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***Keywords* – Inverse problem, heat exchange, temperature field, isotherm.**

I. Introduction

Determination of heat exchange law between a solid and environment is one of the major inverse problems of thermal conductivity. There is an average isotherm method among those for solution of this problem [1], [2], which enables determination of heat exchange coefficient, by using a temperature measurement at one point of a solid. Such heat exchange process must be provided for application of this method that results in stationary temperature distribution when time inclines to infinity.

A mathematical model of such process includes so called regular part, *id est*, a heat exchange process in a solid is described qualitatively enough by the first addend of its mathematic model that is a series. We offer to solve the same problem, by using input information on changes of temperature at one point of the solid during entire course of non-stationery heat transfer process. In such a case existence of regular mode is not required for solution of the problem.

II. Formulation of Problem

Inverse thermal conductivity problems are solved following temperature measurements in an environment where a mathematic model of thermal conductivity is as simple as possible. We shall consider a case when heat exchange with an environment takes place convectively.

$$\frac{\partial t}{\partial \tau} = a\left(\frac{\partial^2 t}{\partial x^2} + \frac{k-1}{k}\frac{\partial t}{\partial x}\right) \tag{1}$$

$$t(x,0) = const$$

$$\lambda \frac{\partial t(b,\tau)}{\partial x} = \alpha\left(t_e(\tau) - t(b,\tau)\right), \tag{2}$$

k=1 is a plate, $x \in [-b;b]$; k=2 is a cylinder, k=3 is a sphere, $x \in [0;b]$.

Having reduced the problem (1), (2) to non-dimensional form, we obtain

$$\frac{\partial T}{\partial F} = \frac{\partial^2 T}{\partial N^2} + \frac{k-1}{N}\frac{\partial T}{\partial N} \tag{3}$$

$$T(N,0) = 0$$

$$\frac{\partial T(1,F)}{\partial N} = B\left(T_e(F) - T(1,F)\right), \tag{4}$$

where $T = \dfrac{t-t_0}{t_1-t_0}$, $N = \dfrac{x}{b}$, $F = \dfrac{a\tau}{b^2}$, $B = \dfrac{ab}{\lambda}$.

The average temperature may be calculated according to a formula at every moment of time:

$$T_V(F) = k\int_0^1 T(N,F)N^{k-1}dN\,. \tag{5}$$

As showed in [1] and [2], this temperature does not depend on time F practically under a regular mode and weakly dependent on non-dimensional heat exchange coefficient B. Non-dimensional coordinate $N=N_V$ where temperature is equal to the average temperature is called an average isotherm $T(N_V,F)=T_V(F)$. Knowing changes of temperature at point $N=N_1$, determination of temperature field for all $N \in [0;1]$ is possible as it is showed in paper [1] and [3], thus $T_V(F)$ is calculable pursuant to experiment data. Temperature field must be written as follows [1]:

$$T(N,F) = \sum_{n=0}^{\infty} T_e^{(n)}(F)P_n(N,k), \tag{6}$$

where $P_n(N,k)$ are known functions. Taking a final number of addends into a series, the average isotherm can be determined by solving equation $T(N,F)= T_V(F)$.

On the other hand, solution of problem (3), (4) is [1]

$$T_V(F,B) = \sum_{n=0}^{\infty} T_e^{(n)}(F)Q_n(N_V,B,k), \tag{7}$$

where $Q_n(N_v,B,k)$ are known functions. Having solved equation $T_V(F,B)= T_V(F)$, non-dimensional heat exchange coefficient B can be determined, that, in its turn, enables determination of heat exchange coefficient α..

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On Stability of a Cylindrical Couette Flow with Suction/Injection in Radial and Azymuthal Magnetic Fields

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Keywords **– stability, Couette flow, magnetic field, magnetohydrodynamics.**

I. Introduction

The present paper is dedicated to an investigation of stability of the flow of conducting fluid between two infinite rotating cylinders. The same fluid is pushed through the walls, and also radial and azymuthal magnetic fields are applied to the system. In this case the flow could become unstable and turbulent, so it is necessary to know conditions of instability and possibilities to control the flow.

II. Formulation of the Problem

The scheme of the flow is shown on the Fig. 1.

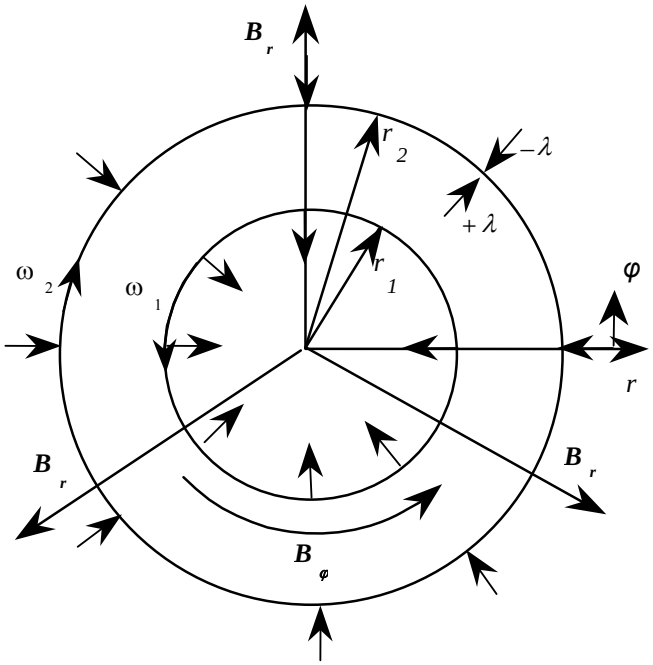

Fig. 1.Scheme of the flow.

Here ω_1, ω_2 are angular velocities and r_1, r_2 – radii of the inner and outer cylinders respectively, λ corresponds to intensity of suction/injection, B_r and B_φ are respectively the intensity of radial and azymuthal magnetic fields.

This problem has the exact self-similar solution, shown in [1].

III. Stability Problem

To investigate the stability of this flow the linear stability theory was used. In this case all velocity components are considered as a sum of the velocity component of a non-perturbed flow and small perturbation. Additionally, in spite of the fact that the exact solution which has no axial velocity, we need to take it into account. So, the components of flow velocity are taken in the form:

$$V_r = \frac{C}{r_2}\frac{1}{\bar{r}} + D_1\Phi(\bar{r})e^{-st+in\varphi+ikz}$$

$$V_\varphi = -\frac{K}{r_2}R'(\bar{r}) + D_2 f(\bar{r})e^{-st+in\varphi+ikz} \qquad (1)$$

$$V_z = D_3 N(\bar{r})e^{-st+in\varphi+ikz}$$

and pressure

$$p(\bar{r},\varphi,\bar{z}) = p_1(\bar{r}) + p_2(\bar{z}) + Gq(\bar{r})e^{-st+in\varphi+ikz},$$

here all variables with line above represents non-dimensional co-ordinates, wave numbers n and k are natural, but parameter s is complex. Perturbation functions Φ, f and q also are complex.

Using standard linearization procedure the system of ordinary differential equations with respect to variable $\bar{r}$ is obtained.

All boundary conditions for perturbations are trivial.

A flow is stable if the real part of parameter s is positive: $\mathrm{Re}\, s \geq 0$, and is convectively unstable if $\mathrm{Re}\, s < 0$. So, the problem is to find such combination of flow parameters that makes the flow stable, and also to find the border between these two regimes.

To solve this problem the collocation method is used. In this case all perturbation functions are represented as finite sum of Chebyshev polynomials. Putting these expressions into the system of differential equations, we obtain system of algebraic equations that could be represented in matrix form and forms a general eigenvalue problem:

$$A\vec{v} = sB\vec{v} \qquad (2)$$

Solving this eigenvalue problem, we need to find a combination of flow parameters such as suction/injection intensity, magnetic field intensity and angular velocities of cylinders for which real parts of all eigenvalues are non-negative.

Thus task is very complicated, so in this work we try to find stability only for axisymmetric case: $n = 0$.

Obtained results will be presented in the full paper.

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Pantograph-Catenary Control System Based on Parametric Identification

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Keywords **– Pantograph-catenary system, mechanical multibody system, parametric identification, controller, adaptive pantograph.**

I. Introduction

The main purpose of the research is to use computer of high-speed train to optimize pantograph and catenary (contact network) system by reducing power consumption where basic parameters are changing in time randomly.

Linear model of pantograph-catenary system is considered where the upper and lower blocks of pantograph and catenary are modelled using lumped masses, springs and shock absorbers.

Input and output system signals are measured when the train moves. These signals are processed by parametric identification algorithms to determine current values of system matrices. State matrices are used in Riccati equation to calculate controller coefficients. Adaptive controller provides dynamic stability of the system when its parameters are changing in time and random external perturbations**.**

II. Models

Catenary mathematical model is usually represented by the 2nd order differential equation with time-varying parameters [1-3] .

$$M_i(t)\ddot{z}_i(t) + C_i(t)\dot{z}_i(t) + K_i(t)z_i(t) = Q_i(t) \ , \qquad (1.1)$$

where

$z_i(t)$ – amplitude of *i*-th modal component,
$M_i(t)$ – mass of *i*-th modal component,
$C_i(t)$ – damping coefficient of *i*-th modal component,
$K_i(t)$ – stiffness coefficient of *i*-th modal component,
$Q_i(t)$ – forcing function of *i*-th modal component.

Taking the frequency of oscillations for the *i*-th component of the model by $\omega_i(t)$:

$$\omega_i(t) = \sqrt{\frac{K_i(t)}{M_i(t)}} \ ,$$

and the damping factor with respect to other model parameters by $\varepsilon_i(t)$, equation (1.1) takes the form [1]:

$$M_i(t)\ddot{z}_i(t) + 2M_i(t)\varepsilon_i(t)\dot{z}_i(t) + M_i(t)\omega_i^2(t)z_i(t) = Q_i(t) \ , \quad (1.2)$$

For a given shape and vibration frequency of catenary signals time response for every component is defined by (1.2), and the output signal of the entire catenary model is equal to the sum of all $M_i(t)$ components.

A. System Pantograph-Catenary Model with Variable Parameters

System software MATLAB/Simulink allows simulating dynamic systems with time-varying parameters. We illustrate this by example of catenary dynamic characteristics with time-varying parameters modeling by (1.2).

This simulation includes the following steps:

a) representation the system model with time-varying parameters to the model with constant parameters;

b) formation the transfer function for the system with given (nominal) values of the coefficients (*M, C, K, Q*) in (1.1);

c) to form of the corresponding S-function in MATLAB / Simulink based on the original transfer function, which provides changing of the coefficients in time in the desired range of frequencies and amplitudes;

d) to add necessary subfunctions of random variations in amplitudes of the simulated output signal to the S-function ;

e) to study of the dynamic system under external disturbances at different time intervals of operation.

f) to create the combined pantograph-catenary system with time-varying parameters.

The research block-scheme of the catenary dynamic model with time-varying parameters is shown in Fig. 1.

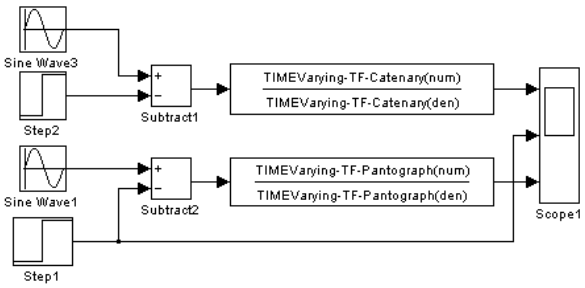

Fig. 1. Schemes of the pantograph and catenary models

III. Summary

Mathematical models of pantograph-catenary adaptive system with time-varying parameters which is affected by external shock disturbance led to the following conclusions:

a) the model adequately reflects dynamic characteristics of real pantograph-catenary autonomous systems used in modern electric trains moving at high speeds (200 km/h and more);

b) based on system parameters estimation (obtained by solving the parametric identification problem) optimal values of controller coefficients are calculated using Riccati equation;

c) adaptive controller provides the necessary dynamic and accuracy characteristics of the system with random changes in system parameters and external shock impacts during the operation;

d) elaborated programs implement basic algorithms of measurement data, parametric identification and adaptive corrector and do not impose special requirements for pantograph computer in train.

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Determination of Complex Eigenvalues in Eddy Current Testing Problems

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Keywords **– Eddy currents, TREE method, complex eigenvalues, Cauchy theorem.**

I. Introduction

The TREE method is one of semi-analytical methods for the solution of eddy current testing problems [1]. It can be used, in particular, in the case where a conducting medium has finite dimensions. Examples include the following applications: (a) a coil with alternating current located above a coaxial conducting cylinder of finite radius and height and (b) a coil above a conducting region with a flaw in the form of a cylinder of finite size coaxial with the coil. The use of boundary conditions at the interface between regions with different conductivities leads to an eigenvalue problem (see, for example, [2]) where the eigenvalues, in general, can be complex.

II. Analysis

From a mathematical point of view one needs to find complex roots of the equation

Error! Objects cannot be created from editing field codes. (1)

inside a closed contour C ,where $f(z)$ is analytic inside C . The algorithm for the computation of the roots of (1) is described in [3]. It is based on the Cauchy theorem. First, the number of zeros n_c of (1) inside C is given by the line integral

$$n_c = \frac{1}{2\pi i}\oint_C \frac{f'(z)}{f(z)}dz \qquad (2)$$

Second, if $n_c = k(k \geq 1)$, then one can construct a polynomial of degree k whose roots are exactly the same as the roots of (1). Note that the corresponding polynomial, in general, cannot be considered as an approximation to $f(z)$. We can only conclude that the roots of $f(z)$ are the same as the roots of the corresponding polynomial.

In the present paper we describe the computer program for automatic calculation of zeros of (1) inside a rectangular contour C . The rectangular domain where the roots of (1) are sought is divided into rectangular sub-domains C_i which is bounded by the lines $x = x_i$, $x = x_i + \Delta x$, $y = y_j$, $y = y_j + \Delta y$, where Δx and Δy are fixed constants. Line integral (2) is then calculated along each contour C_i . If there are no roots of (1) inside C_i ($n_c = 0$) we select another rectangle in the domain. However, if $n_c = k(k \geq 1)$ then the next step of the procedure depends on the value of k . If $k = 1$ then the only root of (1) inside C_i is given by the formula (see [3]):

$$z_s = \frac{1}{2\pi i}\oint_C z\frac{f'(z)}{f(z)}dz \qquad (3)$$

If $k > 1$ then rectangle C_i is divided into two smaller rectangles where the height of each rectangle is equal to the half of the height of rectangle C_i . The number of zeros of (1) is then calculated inside smaller rectangles by means of formula (2). The procedure is repeated until there is only one root inside a small rectangle. The value of the root is then computed by means of formula (3). The code is written in Mathematica.

Our algorithm is based on the assumption that there is only one root of (1) inside C_i . In general, it is not necessary and one can consider more than one zero inside C_i . If there are k zeros inside C_i then one can construct a polynomial of degree k using the formulas given in [3]. The coefficients of the polynomial are expressed in terms of line integrals along C_i . Next, we can use built-in Mathematica routine **Roots** in order to find all the roots of the corresponding polynomial inside C_i (these roots are exactly the same as the zeros of $f(z)$ inside C_i). The number k should not be too large (in practice, k should not be larger than 5) since calculation of roots of higher order polynomials is an ill-posed problem.

Several cases are used in order to test the program. Numerical values of the roots are in very good agreement with the values reported in the literature. The program developed in the paper can be used in order to compute complex eigenvalues for the solution of eddy current testing problems by means of the TREE method.

III. Acknowledgement

The work has been supported by the European Social Fund within the project “Support for the implementation of doctoral studies at Riga Technical University”.

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Numerical Solution of Spatial Stability Problems for Slightly Curved Shallow Mixing Layers

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***Keywords* – spatial stability problems, slightly curved shallow mixing layers, numerical solution**

I. Introduction

Classical method for stability analysis of two-dimensional fluid flows is based on the method of normal modes where a perturbation is assumed to be of the form

$$\psi(x,y,t) = \varphi(y)e^{i(\alpha x-\beta t)} \tag{1}$$

Here $\psi(x,y,t)$ is the stream function of the flow (see, for example, [1]). Both parameters α and β can be complex. There are two special cases of (1) which are widely used in practice: (a) temporal stability problem where α is real and $\beta = \beta_r + i\beta_i$ is complex and (b) spatial stability problem where $\alpha = \alpha_r + i\alpha_i$ is complex and β is real. Both cases lead to the same result (see Gaster's transformation [2]) if one is interested in marginal stability curve. However, Gaster's transformation should not be used away from the marginal stability curve since spatial growth rates are not the same as temporal growth rates.

In the present paper spatial stability problem for the case of slightly curved shallow mixing layers is solved numerically by collocation method based on Chebyshev polynomials.

II. Analysis

Two-dimensional shallow water equations for slightly curved shallow mixing layers are

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0, \tag{2}$$

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+\frac{\partial p}{\partial x}+\frac{c_f}{2h}u\sqrt{u^2+v^2}=0, \tag{3}$$

$$\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+\frac{\partial p}{\partial y}+\frac{c_f}{2h}v\sqrt{u^2+v^2}+\frac{1}{R}u^2=0, \tag{4}$$

where u and v are depth-averaged velocity components in the x and y directions, respectively, p is the pressure, h is water depth, c_f is the friction coefficient and R is the radius of curvature (we assume that $1/R << 1$). Introducing the stream function, eliminating the pressure, linearizing (2)-(4) in the neighborhood of the base flow and using the method of normal modes of the form (1) we obtain the eigenvalue problem (see [3]):

$$L\varphi_1 = 0, \tag{5}$$

$$\varphi_1(\pm\infty) = 0, \tag{6}$$

where

$$L\varphi \equiv \varphi''[u_0 - c - iSu_0/k) + \varphi'(2u_0/R - iSu_{0y}/k) + \varphi(k^2c - k^2u_0 - u_{0yy} + ikSu_0/2).$$

and $c = \beta/\alpha$.

We denote by (*Temp*) and (*Spa*) the solutions to (5), (6) corresponding to temporal and spatial problems, respectively (see [3]). It is shown in [3] that the following relationships hold for temporal and spatial stability problems:

$$\alpha_r(Temp) = \alpha_r(Spa);\ \beta_r(Temp) = \beta_r(Spa); \tag{7}$$

$$\alpha_i(Spa) = -\beta_i(Temp)/c(Temp), \tag{8}$$

where the subscripts r and i correspond to the real and imaginary parts of the corresponding complex numbers, respectively. It follows from (7) and (8) that for the calculation of the marginal stability curve (where the growth rate is zero) it does not matter which method is used: temporal stability analysis or spatial stability analysis. However, Gaster's transformation can be used only in a small neighborhood of the marginal curve.

Spatial stability analysis should be used in regions away from the marginal stability curve. Since problem (5), (6) is linear in c and nonlinear in α, from a numerical point of view spatial stability analysis is more difficult to perform than temporal stability analysis. However, using the transformations $\varphi_1 = \alpha\varphi$ and $\varphi_2 = \alpha\varphi_1$, we transform (5), (6) to linear generalized eigenvalue problem which can be solved by collocation method based on Chebyshev polynomials.

Results of numerical calculations are presented. The accuracy of the Gaster's transformation away from the marginal curve is analyzed.

III. Acknowledgement

The work has been supported by the European Social Fund within the project "Support for the implementation of doctoral studies at Riga Technical University".

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Principles of Creation of Software for Processing Flight Information at the Flight Test Stage of Aerospace Systems

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Keywords **– Identification, model, parameter, information, aircraft.**

I. Introduction

The method for description of computing algorithms as symbolical combinatory models (SC-models) has been developed. They can be used for optimization of algorithms and development of formalized mathematical methods for creation of software for aircraft onboard computers, allowing realizing parallel modes of processing of results of measurements of signals in conditions of deficiency of their dynamism.

II. Problem Statement

The offered method is based on representation of algorithm in a symbolical form which actually is an image of its analytical description of algorithm. Representation of algorithm in a parallel form simultaneously is also a method of regularization of the initial problem. Application of SC-models of computing algorithms of identification of industrial objects allows representing them in a parallel form that allows to increase the performance of information processing in aircraft onboard computers. Symbolical descriptions of algorithms are convenient means for creation and implementation of computer software.

Imitating SC-models of computing algorithms can serve as basis of innovative methodology of formation of software for control and diagnosis systems of technical objects in their modes of normal functioning. On their basis analytical descriptions of characteristics of identification of dynamic objects and processes can be received. Efficiency of practical application of SC-models has been proved in [4]: the inverse matrix for almost singular 20th order Hilbert matrixes has been found with 100% accuracy, although it was considered that over 10th order it is impossible.

In algorithms of identification it is necessary to take measures for maintenance of their numerical stability. The method of algorithm parallelization allows to solve this problem. Architecture of the parallel algorithm can be adjusted by changing the arguments of the combinatorial operators that form the symbolical combinatory model (SC-model) of the algorithm which increases the possibilities of creating software for identification of industrial objects. They are offered to be formed on the basis of ordered numerical sequences in the space of positive integer numbers. Using such models there is a possibility to perform optimization of software.

The system of equations is described in form:

Error! Objects cannot be created from editing field codes. (3)

Solving (3) gives an estimate of vector $\overline{\beta}$ of coefficients of characteristic polynomial $B(z)$ (4):

Error! Objects cannot be created from editing field codes. (5)

Matrices Y are Toeplitz matrices that worsen their conditionality even more. Therefore instead of traditional algorithms for finding the inverse of ill-conditioned matrices it is appropriate to apply alternative algorithm in which singular situations related to division of results obtained in separate stages by small values that are close to the level of noise do not arise, as it happens in Gaussian method. According to it, the elements of the inverse matrix are found as minors that are calculated using the known formula:

$$\det H = \sum_{P} (-1)^{\chi} \cdot (a_{1\alpha_1} \cdot a_{2\alpha_2} \cdot, \ldots \cdot a_{n\alpha_n}) \tag{10}$$

Here, the sum is distributed over all possible permutations P = (α1, α2, …, αn) of elements of Y: 1, 2, …, n. The elements of Y^{-1} (5) are found as minors of Y from which the matrix H is formed:

$$\left[Y^{-1}\right]_{ij} = \frac{H_{ji}}{\Delta H} \tag{11}$$

Elements of H are found using the formula (10) in which permutations are formed with the help of deterministic symbolical combinatory (SC) model that has the form of graph as a branching tree.

Therefore for its practical realization a special symbolical combinatory (SC) model for definition of minors (11) of initial matrix has been developed:

$$\begin{aligned} &\varphi Gr^*(n,\overline{\nu}) \Rightarrow \left[\varphi KC(\nu_1)^*(\overline{1.n})\right] \times \circ \left[\varphi KC(\nu_1)^*(\overline{1.n})/\tilde{a}_1\right] \times \circ \\ &\quad \times \circ \left[\varphi KC(\nu_1)^*(\overline{1.n})/\tilde{a}_{12}\right] \ldots \times \circ \left[\varphi KC(\nu_1)^*(\overline{1.n})/\tilde{a}_{12\ldots.n-1}\right] \\ &\overline{\nu}^T = [\nu_1 \nu_2 \ldots \nu_k]; \quad \sum_{i=1}^{k} \nu_i = n \end{aligned} \tag{13}$$

For increasing its accuracy in operations of multiplication of numbers in branches of the graph, a SC-model has also been used which is free from rounding mistakes.

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Imitation Modelling of Computing Algorithms of Identification of Technical Objects

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***Keywords* – identification, imitation model, algorithm, equation system, minor, determinant**

I. Introduction

During operation of technical objects, it is necessary to solve problems of continuous current control and diagnosis of their condition. Acquisition of reliable estimations of their parameters is possible under condition of computer management of control and diagnostic system. This needs development of efficient software which can be created under the condition that in model of identification of object's parameters, noise-tolerant computing algorithms for solution of systems of difference equations will be used.

II. Problem Statement

Traditional algorithms do not satisfy this requirement as in the majority of their variations recurrent procedures based on the method of elimination are used. They can lead to occurrence of singular situations at any stage of calculations when sensitivity of algorithms to noise suddenly increases in an unpredictable way and the results obtained at the previous stages become invalid. Especially strongly this drawback shows at processing the aircraft flight information as the transients in it and in its onboard control systems are damped by special devices because of conditions of flight safety and observance of flight restrictions. Therefore processing of such smoothed analogue signals in models of identification usually leads to increase in their sensitivity to noise and systematic errors of signal discretization. For this reason, on the basis of traditional computing methods, it is impossible to create reliable on-board and ground computer control and diagnostic systems. Therefore the urgency of simulation modelling of algorithms and software with the purpose of testing their usability before their practical application on aircraft becomes obvious. However building simulation models on the basis of use of any mathematical relations generated in literal form is difficult and inefficient as they do not allow using formalized methods for their optimization.

In given paper, the problem of creation simulation models of computing algorithms in a formalized mathematical form is considered on the basis of symbolical combinatorial (SC) models of computing algorithms. They are offered to be formed on the basis of ordered numerical sequences in the space of positive integer numbers. The property of order guarantees determined and unambiguous character of simulation SC models despite of their combinatorial structure as it is not necessary to use unproductive enumeration methods of enumerative combinatorics. The advantage of symbolical simulation models is that they allow to practically automate the process of creation of software and use adaptive principles for its tuning. Toeplitz matrix of system of difference equation with elements:

$$[Y]_{r,L} = \sum_{k=1}^{m} C_k \cdot q_k{}^{r+L} \tag{3}$$

in practice usually are ill-conditioned. It is offered to use algorithm in which elements Y^{-1} are found through minors of Y:

$$\tilde{Y}_{ji} = \sum_{P} (-1)^m \cdot (Y_{1\alpha_1} \cdot Y_{2\alpha_2} \cdot, \ldots \cdot Y_{n\alpha_n}) \tag{4}$$

$$Y^{-1} = \begin{bmatrix} \tilde{Y}_{11} & \tilde{Y}_{21} & \ldots & \tilde{Y}_{n1} \\ \tilde{Y}_{12} & \tilde{Y}_{22} & \ldots & \tilde{Y}_{n2} \\ \ldots & \ldots & \ldots & \ldots \\ \tilde{Y}_{1n} & \tilde{Y}_{2n} & \ldots & \tilde{Y}_{nn} \end{bmatrix} \cdot \frac{1}{\det Y} \tag{5}$$

The basis of SC model is graph structure:

$$\begin{aligned} &\varphi GrD(\bar{\nu}) * (\overline{1.n}) \Rightarrow \left[\varphi Det * \left\{\varphi KC(\nu_1) * (\overline{1.n})\right\}\right] \times \circ \\ &\times \circ \left[\varphi Det * \left\{\varphi KC(\nu_1) * (\overline{1.n}) / \tilde{a}_1\right\}\right] \times \circ \\ &\times \circ \left[\varphi Det * \left[\varphi KC(\nu_1) * (\overline{1.n}) / \tilde{a}_{12}\right]\right] \ldots \\ &\times \circ \left[\varphi Det * \left[\varphi KC(\nu_1) * (\overline{1.n}) / \tilde{a}_{12\ldots.n-1}\right]\right] \end{aligned} \tag{10}$$

Model (10) is a generalization of Laplace theorem when the matrix is split not into two but into arbitrary number of strips. For example, for the matrix of 5th element (5), they can be found through minors of 3rd and 2nd orders in strips with rows (r_1, r_2, r_3) and (r_4, r_5). $ims_j = (\tilde{r}_j; \tilde{L}_j)$ for sub-matrices in sections of graph (10) are determined as components of numerical sequences (8):

$$\bar{a}_1 = (123, 124, \ldots, 345);\ \bar{a}_2 = (45, 35 \ldots, 12) \tag{11}$$

that form:

$$\overline{ims}_1 \Rightarrow (r_1, r_2, r_3) \otimes \circ (123,124,\ldots,345)$$

$$\overline{ims}_2 \Rightarrow (r_4, r_5) \otimes \circ (45,35,\ldots,12).$$

For sections (10) we find:

$$\bar{\psi}_1 \Rightarrow \varphi Det * \overline{ims}_1 ; \bar{\psi}_2 \Rightarrow \varphi Det * \overline{ims}_2 \tag{12}$$

$$\overline{\det} \Rightarrow \bar{\psi}_1 \otimes \bar{\psi}_2 \otimes \bar{zn} \tag{13}$$

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Humanistic approach to teaching the course of mathematics

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Keywords **– humanization of the study process, humanistic approach to teaching mathematics**

I. Introduction

There is a disparity in Latvia between the demand for qualified employees from the employers and the resources of the educational system. Currently there is a reorientation in economics from production to the development of the services. Studies attest that in Latvia workforce expenses gradually increase, and an available economically active workforce for the country decreases in the labor market. Currently individual spheres face the lack of workforce (building, sale, health care), then, in future, this problem can affect wide economical segment. According to the projections of the Bank of Latvia, until the year 2015, 200000 economically active citizens will gradually leave the country, thus, decreasing workforce supply in Latvia even more.

The lack of qualified workforce is an urgent problem in the whole world. The only way to ensure the prosperity and compete in the labor market is to create new study programs with wider specialization opportunities and with more side courses to the basic profession.

II. Attitude to Mathematics

Acquisition of mathematics in school is a long, continuous process that starts in form 1 and goes on in the higher educational institutions. During this time, teachers and motivation of acquisition of mathematics change. When working with students at university, their different knowledge levels and attitude towards mathematics that has been developed during the studies at school must be taken into consideration that is why the aim of the study was to follow students' experiences in the acquisition of mathematics and find out the causes of the change of the study motivation.

Object of the study were learners from two different educational institutions: Ozolnieku Secondary school of the district of Jelgava (OSS), and 1st course students of Riga Technical University (RTU) (see table 1).

TABLE I

Enjoyment or dislike towards Mathematics

	RTU	OSS
Like	28%	26%
Dislike	17%	12%
Cannot tell	55%	62%

III. The Role of Teachers in Learning Mathematics

Diverse attitude towards mathematics must be taken into consideration when working with these learners, and an attempt to change it should take place to reach good results. Examining the attitude change towards mathematics at primary school, a conclusion can be drawn that the main affecting factors are teacher's personality and professional proficiency. Students in forms 1– 4 almost everyone have positive attitude towards mathematics, except the cases when teacher raises the voice on students. Difficulties and the change of attitude usually derive in the period of forms 7-9, when study motivation drops, harder tasks require greater intellectual effort. Psychological peculiarities of this age also should be taken into consideration, which require greater tolerance, thoughtfulness and ability to raise interest in students. Some student writes: „If understood, would like".

If lessons are interesting, teacher is smiling and well-disposed, mistakes are explained tolerantly, students gain satisfaction and joy for the time spent for mathematics that creates a positive motivation for the acquisition of mathematics. A lot of students admit that by improving the attitude towards the teacher of mathematics, by trusting him or her, also the progress and emotional attitude towards mathematics has changed.

If students from secondary school blame teacher more for the difficulties in the acquisition of mathematics, then, students from Riga Technical University blame themselves for not having made an enough effort to acquire the material of the secondary school. Students spend more time to solve one task (100-120 min), whereas, pupils ~10-60 min.

As a motivation to acquire mathematics, secondary school students mention the fact that it will be useful at university, as well as, when working it helps to do different calculations, which means, they understand and feel the practical use of mathematics in real life.

Summarizing the results of the questionnaire, it is visible, what a great role teacher's personality plays in the acquisition of mathematics, not to destroy the existing curiosity in the children during the first school years, to keep this interest and joy of cognition during primary school, secondary school and also during university. Teacher must think about the emotional contact with the student, and that there is a willingness to achieve the result and correct the mistakes, must respect each student as an individual with own abilities and psychological peculiarities.

IV. Conclusions

Universities must provide an opportunity to individually revise the school program of mathematics.

Teachers and lecturers must acquire a humanistic approach to teaching mathematics by introducing interactive teaching methods and preparing study tools for students' individual work.

To ensure the continuity in the study process of mathematics, cooperation between secondary school teachers and university lecturers must be encouraged, by sharing experiences, looking for new working methods and creating new study materials during joint meeting.

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Observation of Age Peculiarities Teaching Mathematics to Part – Time Students

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***Keywords* – mathematics, the study of mathematics, the style of learning, adult education, educational processes**

I. Introduction

Studies of mathematics in Riga Technical university of Latvia are managed for full-time and part-time studies.

The main difference between the part-time studies and the full-time studies is that students with different age, studying break and learning conditions study in the same group.

II. General Regulations

In the researches of R. J. Havighurst [1] about the relationship of life's cycles with educational needs, following sight show up: in the age from 18 to 30 years education is connected with the perspectives in career; in the age from 30 to 40 years education is an additional field of self-realization and self-updating; in the age from 40 to 50 years person demonstrates his or her own firmness and conviction; after the age of 50 persons choose such educational courses, which promote analyzing, meditation and apprising**.**

Four methods are used in the educational process of mathematics: work in groups on projects to get an independent information in the processes of reference, understanding and exchanging; frontal work – to lay out prepared information in classes; cooperative (of pairs, partners, groups); individual work – for training abilities and skills, for mutual assessment and self-assessment.

III. . Problems of Teaching Part-Time Students

To motivate adults to study, some essential regularities of adult education should be taken into account:

1. students' self-realization are ensured in the studying process and experiences to think and read independently are created;
2. critical reflection is pointed out, and it is based on the following processes:
   - on the used methods;
   - on the direct, alternative, presupposed ideas, activities and opinions;

Necessity of lifelong education changes emphases of educational processes in schools, and that highlights self-dependent education more and more.

Part-time student receives education together with the care for the family and work responsibilities. Such students is not always psychologically ready to start again an intense study work, there is a steady concept in his or her cognition about the abilities and knowledge they have that not always accord with realities. Pedagogues first task is – convince he students in his or her positive opportunities and give the necessary knowledge about the study work in general.

Pedagogue must create eligible syllabus and teaching methods for each specific group, where stress is put on cooperation, positive motivation and perspective. Adult's personality and chosen aims must be taken into consideration in the communication.

Study materials more often must contain wider revision choice of themes than it is necessary for full-time basic studies. Study materials are advisable to visualize to the utmost, giving a chance to see the material both in general, and in details. Together with an example of solving the tasks, theoretical grounds and explanations must be given.

Adult psychology requires precisely worked out evaluation system that does not allow subjectivity. The rules of evaluation must be discussed in advance and tolerantly complied.

Student, who starts studies in the part-time studies immediately after the secondary school and can attend all classes, wants to work in the usual regime – with explanation from the lecturer, with lasting teaching period, when all students are involved, when during classes enough time is spent for solving the tasks on the board and at the end of each class there are tasks given to solve individually at home, when the acquisition of he material is checked for smaller themes and also these evaluations influence the semester results. In such study process, every new theme of the material is based on the elements of previously acquired knowledge and skills, and a part of the lecture is enough for introduction of the topic.

Student, who starts again the studies after a break, wants a longer revision course in general and also before every new theme, because „new theme" in his or her understanding is rarely connected with known or acquired previously, the break in studies has left its influence not only on real knowledge, but also on student's concept about them, skills of intellectual work are forgotten too, that is why part of the study time is spent on assuring that every work can be done, if you do.

Student, who combines studies with work and is only able to attend part of the available classes, wants to get short and specific information, his or her attitude towards the tasks done at home is negative, but he or she wants to receive materials that are suitable for an individual work – concise, understandable, with ready examples to solve the tasks. In his or her understanding, lecturer must work as a consultant, taking into account individual needs of every student. Tests should not be too regular and matching the time of student's work regime.

IV. Conclusions:

1. Pedagogue during the work with adults must be ready to change roles and teaching methods.
2. For a qualitative learning process, suitable study materials for adult working skills and psychological preparedness are necessary.

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Computer Science

Technologies of Computer Control

An approach of 3D model smoothing based on interpolation surface subdivision

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***Keywords* – Interpolation, polygon, surface subdivision.**

I. Introduction

The problem of free – form objects in 3D visualization is an actual task in computer graphics and solving it is important for practical use. This paper describes a new approach to free-form object reconstruction, based on initial 3D model smoothing using surface subdivision. There are many approaches to surface subdivision based on surface approximation [1]. In this paper the proposed approach is based on interpolation surface subdivision.

II. Proposed approach

Initial data is a polygonal model of an object (polyhedron), which is based on a set of vertexes P_i and a set of normal vectors $\vec{n}_i$ set. The model uses two types of polygons – triangular (described as $P_iP_jP_k$) and quadrangle (described as $P_iP_jP_kP_l$). The Fig.1.a and Fig.2.a illustrated this case.

The proposed approach is based on the creation of the interpolated polygonal surfaces. This approach can be described by the following three steps.

Step 1. The calculation of tangent vectors. The tangent vector m_{ij} from point P_i to point P_j must fulfill the following condition:

- tangent vector m_{ij} must be perpendicular to the normal vector n_i;
- tangent vector m_{ij} must belong to the plane, created by n_i and the vector between point P_i and P_j.

From these conditions the tangent vector can be calculated by a cross product of two vectors as follows:

$$\vec{m}_{ij} = h \cdot \left(\vec{n}_i \times \left(P_j - P_i\right)\right) \times \vec{n}_i . \quad (1)$$

where: h – is the length coefficient.

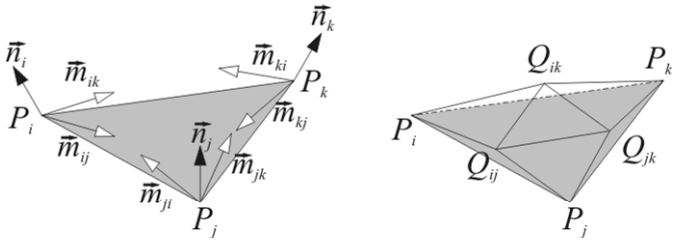

Fig. 1. a) Initial triangle polygon and b) result polygonal mesh.

Step 2. The computation of middle point on the polygon edges. Let polygon edge between vertexes P_i and P_j is interpolated by parametric curve. This curve is an edge of the parametric triangle surface, which interpolates the initial triangle polygon. In this case the middle point can be calculated as follows:

$$Q_{ij} = \frac{1}{2} \cdot \left(P_i + P_j\right) + \frac{1}{8} \cdot \left(\vec{m}_{ij} + \vec{m}_{ji}\right). \quad (2)$$

In the case of a triangle polygon equation (2) can be used for each edge. The result of subdivision is a new polygonal mesh, created by 4 triangle polygons: $P_iQ_{ij}Q_{ik}$, $P_jQ_{jk}Q_{ij}$, $P_kQ_{ik}Q_{jk}$ and $Q_{ij}Q_{ik}Q_{ik}$. The Fig.1.b. shows this case.

In the case of quadrangle polygon it is necessary to calculate an additional vertex using Step 3.

Step 3. The computation of central point on the quadrangle polygon. Let quadrangle polygon $P_iP_jP_kP_l$ be interpolated by parametric surface. In this case the middle point can be calculated as follows:

$$Q_c = \frac{1}{4} \cdot \left(P_i + P_j + P_k + P_l\right) + \frac{1}{64} \cdot \left(\vec{n}_i - \vec{n}_j + \vec{n}_k - \vec{n}_l\right) + \\ + \frac{1}{16} \cdot \left(\vec{m}_{ij} + \vec{m}_{ji} + \vec{m}_{jk} + \vec{m}_{kj} + \vec{m}_{kl} + \vec{m}_{lk} + \vec{m}_{li} + \vec{m}_{il}\right) . \quad (3)$$

In the case of a quadrangle polygon the result of subdivision is a new polygonal mesh, created by 4 quadrangle polygons: $P_iQ_{ij}Q_cQ_{il}$, $P_jQ_{jk}Q_cQ_{ij}$, $P_kQ_{kl}Q_cQ_{jk}$ and $P_lQ_{il}Q_cQ_{kl}$. The Fig.2.b. shows this case.

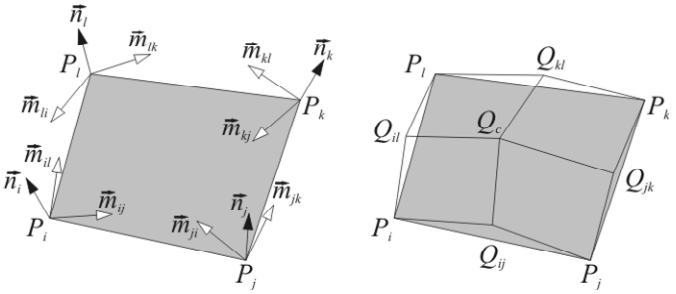

Fig. 2. a) Initial quadrangle polygon and b) result polygonal mesh.

The proposed approach is a recursive function. It means that the result of previous smoothing iteration is the initial data for next smooth iteration. In this case the polygon count ratio can be described as follows:

$$S_{fin} = S_0 \cdot 4^R . \quad (4)$$

where: S_{fin} – is the count of polygons in final model;
S_0 – is the count of polygons in initial model;
R – is the depth of recursion.

The polygonal computer graphics is the most popular technique for real-time visualization. The proposed approach makes it possible to create a smooth polygonal mesh without calculating an analytical surface. The proposed approach was tested on a medical object [3] example.

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Medical image analysis to determine the effectiveness of treating osteoporosis

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***Keywords* – Medical image, segmentation, osteoporosis, trabecular bone, cortical bone.**

I. Introduction

Osteoporosis is a bone disease that leads to an increased risk of fracture. In osteoporosis the bone mineral density is reduced and bone micro architecture deteriorates. The effect that osteoporosis has on a bone is displayed on figure 1. The areas of the bone architecture that are most affected by osteoporosis are the trabecular(spongy) bone and the cortical(compact) bone, where trabecular bone is the sponge-like bone in the ends of long bones and vertebrae, and the cortical bone is the hard outer shell of bones. Osteoporosis causes the thinning of the cortical bone and deterioration of trabecular bone structure.

The diagnosis of osteoporosis can be made using conventional radiography and by measuring the bone mineral density (BMD). The most popular method of measuring BMD is dual energy x-ray absorptiometry (DXA or DEXA)[1]. In addition the diagnosis of osteoporosis requires investigations into potentially modifiable underlying causes; this may be done with blood tests.

An important part of treating osteoporosis is lifestyle changes (Aerobics, weight bearing and other exercises) and there are several medications used to treat osteoporosis, depending on gender. Now finding whether treatment is effective is another matter, because it has been shown that just knowing bone mineral density, is not enough to determine the risk of a fracture [2]. So to determine the effectiveness of treatment it is also necessary to analyze the changes in bone structure during treatment. Although there are methods that do this, they use sophisticated imaging equipment like High-resolution peripheral quantitative computed tomography (HR-pQCT) or high-resolution magnetic resonance imaging (MRI) [3], but so far these machines are very rare.

This paper proposes a method to determine the effectiveness of treating osteoporosis by analyzing medical images which were acquired using conventional computed tomography machines, which can be found in most hospitals.

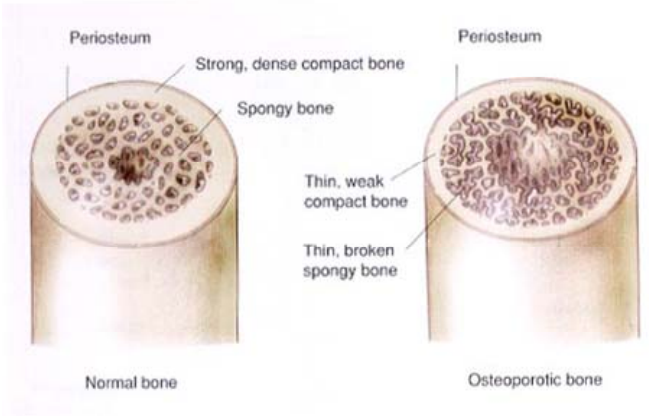

Fig. 1. Bone structure deterioration from osteoporosis.

II. Proposed method

The areas of the bone that are most affected by osteoporosis and are visible on medical images are the trabecular and the cortical bones, so the proposed method focuses on these areas and consists of two steps.

The first step in analyzing the bone structure is to segment the medical image to find which parts belong to the trabecular and cortical bones. This is done by analyzing the radiodensity of pixels in the image. The radiodensity of a cortical bone is more than 1000 on a Hounsfield scale. Using these values we segment the image to find an area that belongs to the cortical bone and then we segment the area that is located inside the cortical bone to find which parts of bone belong to the trabecular bone.

The second step is to compare the medical images that were taken at the beginning of treatment and after a certain time period (3 or 6 months), to see whether treatment is working. To do this we need to compare the amount of pixels that belongs to the trabecular and cortical bones. If after the time period this amount has increased then treatment is working, if the amount did not change or even decreased then treatment is not effective.

III. Experiments

The proposed method was tested using medical images that were acquired with conventional computed tomography.

Analysis of these medical images allowed to evaluate the changes in bone structure and therefore the effectiveness of medical treatment plan.

IV. Conclusions

The method proposed in this paper should help doctors treating osteoporosis to determine whether their treatment plan is working so that they could adjust it and choose a better treatment plan.

The advantage of this method is that it does not require sophisticated imaging equipment and can be implemented using conventional computed tomography.

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Robotic Exploration and Recognition Algorithms for Research of an Object in Unknown Environment

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Robotics, Exploration, Image Recognition, Video Camera, Unknown Environment.

I. Introduction

This work covers the modeling of a real-world robot, whose task is to locate an object in an unknown environment and to come close to it by defined distance. In work [1] the given task was to find an object by its color and without environmental obstacles. This time, the target object is characterized not only by its color, but also by a given shape. The robot has to find its goal in an unknown environment, overcoming obstacles on its way. The placement of these obstacles, as well as the position of the objective, is initially unknown and random. All information about the surrounding space is obtained through video cameras and sensors on the robot.

II. Areas of research

To identify the target object satisfying the required pre-defined characteristics, a recognition algorithm is used. Decision making rules are implemented to define the behavior of the robot based on data collected on the environment and on object detection.

Two distinct areas need to be addressed. First, a recognition algorithm [2], capable of recognizing with efficiency the target object. This algorithm processes robot sensor inputs in real time, providing a response that can be acted upon. The primary qualities of this algorithm are speed and reliability. Object detection includes the following factors: object color, shape and size.

Second, the decision logic for the robot is a combination of exploration and obstacle avoidance algorithms (for instance bug following algorithm [3] or any other combination), and appropriate reaction based on input from the recognition algorithm. The robot logic seeks to minimize the exploration time and the travel distance for reaching the set goal.

III. Simulation

Prior to the implementation of a real-life robot, a simulation environment is built. The simulation enables rapid and cost effective prototyping of possible solutions. Through simulation, it is possible to setup and compare different hardware and/or software solutions, and to compare the efficiency of different algorithms.

The simulation environment must match the real environment as closely as possible, in the definition of the robotic platform and in the information returned by virtual sensors.

For this purpose, we are leveraging Microsoft Robotics Developer Studio, which provides a common programming framework that can be applied to support a wide variety of robots, including simulated ones. This framework supports the implementation of an orchestration service that will work with partner services, to coordinate sensor inputs and actuator controls, providing functionality that can be abstracted from specific hardware or components – and allow the replacement of individual components such as the robot, sensors or partner services such as image recognition.

Figure 1 is a representation of a simulated scene, as captured through a simulated sensor. Such input is key to the object recognition algorithm.

Fig. 1. Simulated Camera view

Figure 2 is a representation of additional input that can be provided through another simulated sensor, such as a depth camera, which can increase efficiency or accuracy.

Fig. 2. Depth Camera View

Through experimentation, results of the simulation will support the validation of proposed algorithms for the given problem, i.e. detection of an object by its given features, in an environment with multiple objects and obstacles.

IV. Real world implementation

After best candidate approaches have been identified and validated through simulation, the solution can be deployed to a hardware platform. This step allows the validation of the selected strategy and the real-world efficiency of the solution.

The same algorithms as in simulation are used for the real world robot, without much difference. Changes or optimizations are however required when dealing with real world robots and sensor, to take in account image noise and corrections that need to be applied to sensor inputs and motor drive.

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On Resource Distribution in Mobile Telemedicine Screening Complex

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Keywords **– Telemedicine, health care, mobile, screening, diagnostics, e-health, resource distribution.**

I. Introduction

Public health is one of key priorities of any European Union country, including Latvia. This means not only high quality and high levels of treatment of diseases, but also the timely diagnosis and prevention. An important role here is regular preventive examinations that can be taken by the family doctor, if he is provided with the necessary medical technologies. Currently investigations and analysis are usually carried out by several health care institutions, because only in rare cases, family doctor has the set of diagnostic equipment and skills to evaluate the information obtained in the investigations. Usually the tests are carried out at different times and in institutions, possibly located at considerable distance from the residence of the person under investigation. Thus additional time and resources of the patient and the employer's is being spent time on the way to examination centers and waiting for the results as well as for re-appointment with the doctor's for collection and assessment.

II. The Aim of the Project

The solution of above defined problem is development of new mobile telemedicine screening complex with analysis and advice center, which will eliminate the existing system deficiencies and will be more advanced. At the same time as research work is considered as "industrial" and is supported by EC ERDF, agreement Nr: 2011/0007/ 2DP/2.1.1.1.0/10/APIA/ VIAA/008, with the same it must be commercially interesting for potential investors and business companies, to realize its results in future. It may be achieved by optimal function and resource distribution, considered mainly software, between components of complex.

System overall schematic and information flow is shown below in Fig.1.

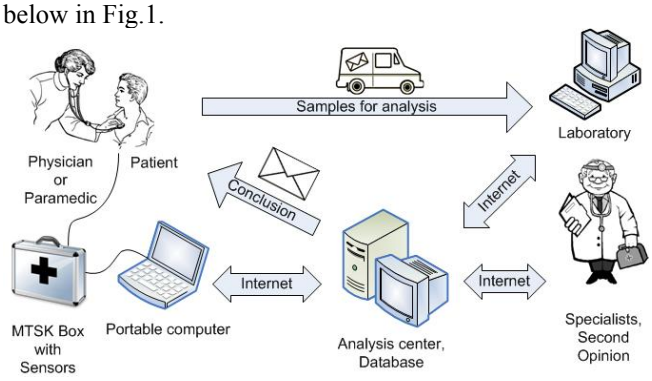

Fig.1 Information Flow in MTSK and Overall Schematic.

III. Research to be Carried Out in the Project

Development of mobile telemedicine screening complex includes principles of division of tasks between hardware (performed by individual module electronics and embedded software in MTSK Box, Fig.1.) and software located in Portable Computer, and, Analysis Center. Division of functionality should be acceptable from business point of view (it must give some profit for company, when realized). Additionally according EC legislation, complex must confirm EC Directive 93/42 "Medical Devices", and be prepared to undergo conformity assessment for mandatory CE mark.

As planned, basic module should provide registration of at least 10-14 parameters, where some 8-10 are hardware provided (by use of sensors and embedded software), and rest by software on PC.

As planned, final analysis and evaluation of achieved data should be done by certified specialists in evaluation centre, as it confirms EC regulations. Possibly it may gain potential investor interest.

Industrial research of MTSK modules is based on team previous experience in local and international projects [2, 6].

In addition to mentioned above extended research needs to be done to include new features in MTSK:

IV. Results

MTSK Module research and development and experimental design are generally finished and include modular design of devices, including embedded software, and their role in complex. Resource distribution between complex parts is evaluated. This research includes also wireless data transmission options, achieved quality and methods to provide data integrity and safety. Business/investor considerations to project are also included.

It is proved, that this business concept is available for future development.

Research work is not finished and the presented are only preliminary results up to day. The results of research when finished and system pilot sample will be used to develop industrial model of MTSK. It is proved, that distributed Analysis system is more effective than "stand alone", or "local robotic", as all systems (EC, USA legislation) require Legal specialist confirmed Interpretation, not robotic, as a result. Quality of services will possibly improve because the study of MTSK development plans not only to increase the number of recorded parameters, but also increase the quality of use. This result in additional new research and new innovative solutions including information obtained in the analysis and interpretation of the project.

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Synthesis of an optimal recovery strategy by using multi-objective genetic algorithms

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***Keywords* – mathematical modeling, topological model, multi-objective optimization, genetic algorithms.**

I. Introduction

Various methods based on mathematical modeling for the analysis of a functioning system or processes are widely used. Mathematical models has been created and used to perform a full spectrum analysis, investigate the performance under fault conditions and predict further status of the system. Also these models could be used to select or generate a recovery strategy. A correct recovery strategy can stabilize the operation of the system and improve the overall performance conditions. In this article a method for the synthesis of an optimal recovery strategy based on multi-objective genetic algorithms has been proposed. As an implementation of the proposed method an example from medicine is described.

II. Topological modeling of a functioning process

Mathematical modeling and heuristic approaches are widely used to analyze various functioning systems and processes [1]. A mathematical model represents an abstract, simplified mathematical construction that reflects reality and is created for defined research purposes. Such a model is described by a group of characteristics and logical regularities Topological modeling [2] is and effective method for the constructing of a mathematical model for a heterogeneous system when available information is insufficient.

Miscellaneous topological models for differential diagnostic, diagnostic parameter selection, prediction of a diseases' state and therapy selection has been created. To perform all these tasks one common type of a topological model is used and slightly adjusted to the each subtask [3]. A common model for arterial hypertension, atherosclerosis and diabetes mellitus has been created [4]. Model includes a set of external influences (recovery strategies), which in this medical case are defined as therapies. By adding these therapies it is possible to model drug influence to the organism, predict final state of the patients' health and evaluate the therapy by defined efficiency criteria.

III. Optimality criteria of a recovery strategy

The results of each therapy are evaluated by the following performance criteria:

1. The efficiency rate of the therapy influence shows how each therapy changes the health state of the patient. The rate is found by modelling the performing therapy, which mathematically is a result of recalculating all functional levels of the topological model nodes and summarising the changes in one value;
2. A complex influence rate to an essential part of the process. The final importance level of the therapy is calculated by summing up the importance levels of all covered nodes;
3. The recovery coverage level is used to describe an influence spectrum of the therapy. The criterion indicates how the therapy covers a periphery and hardly reachable nodes of the model;
4. Provoked side effects criterion is the first negative parameter to be minimised. The parameter is calculated by summing up the functioning levels of the provoked side effects of the therapy;
5. A recovery complex cost is the second criteria with negative manner. The criterion is calculated by using expert group inquiry methods.

Proposed criteria are used to evaluate the efficiency of a therapy and to give the opportunity to compare it by other therpies. In the case of pathogenesis topological model [4], eight external influences are used. By using combinatory laws it is possible to estimate the possible amount of all available therapy combinations. It is necessary to select a therapy combination because in most cases a mono therapy cannot fully eliminate a disease and turn the patients' health state in normal condition.

IV. Multi-objective algorithms for the selection of an optimal recovery selection

If the set of all possible combinations of recovery strategies (therapies) is small and conceivable then brute- force search methods can be used. For this task domain combinatory multi-objective optimization could be used. But if the set of solutions is large and even infinite then full search methods are useless. In this case multi- objective genetic algorithms are suitable. For the synthesis of an optimal recovery strategy three genetic algorithms are selected:

1. Weighted sum genetic algorithm is based on widely used weighted sum optimization. The fitness function is created by transforming all criteria in one common criterion. Then the final solution set is estimated by iterative generation of optimal Pareto set;
2. Vector evaluated genetic algorithm divides the population of solutions in n groups, where n is the amount of criteria. Then within the group solutions by one criterion are optimized. Final solutions are estimated by minimal rank;
3. Multi-objective genetic algorithm is based on the Pareto ranking scheme and by iterations generate a true Pareto set.

V. Results

Selected multi-objective genetic algorithms are adjusted and implemented in medicine computer system. Examples from historical clinical data has been tested. All methods provide comparative results and in observable scale can generate solutions which are provided by brute- search methods.

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Decision Making Method for Therapy Selection

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***Keywords* – expert system, knowledge base, knowledge representation, production laws, decision making.**

I. INTRODUCTION

In this paper is described development of an expert system for decision making in medicine. System is designed for determination of drug groups and its combination in arterial hypertension (AH) treatment process. Most attention is devoted to the representation of knowledge and formalizing those in the knowledge base. First of all the knowledge was represented using decision trees and then formalized by production laws. The developed knowledge base has an implementation in a computer system.

II. DOMAIN DEFINITION

Around the world research of effective AH therapy is made. One of this kind of research is European hypertension and the European Society of Cardiology hypertension evaluation and treatment guidelines [1]. Guidelines provide knowledge about recent findings in treatment strategy selection, groups of drugs, indications, contraindications and mutual compatibility of drugs. Authors solve the problem, how to formalize the amount of knowledge founded in guidelines into knowledge base and to develop an expert system that could make a decision about recommended groups of drugs for an individual patient. This is one of solutions how to facilitate the daily work of doctors [3, 4].

Overall, the designed expert system consists of two subsystems: 1) subsystem for a treatment strategy selection; 2) subsystem for drug and its combination selection. In this paper authors has focused on the second subsystem development.

III. DECISION TREES FOR DRUG GROUP SELECTION

The guidelines [1] contains knowledge about 9 hypertensive drug groups for AH patients. From example shown in Table 1 is seen groups of drugs (diuretics, Beta - blockers, etc.), indications (the list of conditions and diseases, when drugs are recommended for use), absolute and relative contraindications.

TABLE 1

INDICATIONS AND CONTRAINDICATIONS FOR THE MAJOR GROUPS OF ANTIHYPERTENSIVE DRUGS (FRAGMENT)

Drug group	Drug use indications	Contraindications	
		Absolute	Relative
Beta-blockers	Stenocardia after myocardial infarction (SMI);Heart failure (HF);Pregnancy;Tachyarrhythmias	Asthma;Chronic obstructive lung disease (COLD);A-V block	Peripheral artery disease(PAD); Glucose intolerance (GI);Athlete
ACE inhibitors	HF;Left ventricular dysfunction; Post-myocardial infarction; Non-diabetic nephropathy;1.Type Non-diabetic nephropathy;Proteinuria	Pregnancy;Hyperkalaemia;-Bilateral renal arterystenosis (BRAS)	-

Table 1 shows which drugs are used for certain indications. For example, if the patient has tachyarrhythmia, then according to Table 1, use of Beta-blockers is recommended for patient, but just if he has not one of the contra-indications: asthma, COLD, AV block, PAD, GI, athlete. This information has been structurized into decision trees and afterwards described with production laws. There are difficulties with knowledge formalization because of large number of decision trees (together 21) and a situation when some of the indications for one drug group may be contraindications for other drug group.

Contraindications pointed exclude definite drugs, other drugs are usable that is why authors use ranked row, in which drugs are ranked from most optimal till least optimal. Ranked row is used in cases when there is an indication for drug group, but in the same time there is a contraindication which excludes use of this drug group so the decision is to choose most optimal drug group from ranked row. This approach enables to choose the most suitable drug for each case.

IV. FOUNDATION OF KNOWLEDGE BASE

Knowledge base consists of two type production laws: 1) laws founded based on the decision trees; 2) production laws which exclude drug appropriate for indication if there are contraindications.

Second type production laws are called “excluding laws” and they are used to eliminate drugs which are prohibited for patient based on existing contraindications. Production laws are considered in following manner: first of all second type production laws and afterwards first type production laws are considered.

V. DECISION MAKING PROCEDURE IMPLEMENTATION IN MEDICINE COMPUTER SYSTEM

Based on the previously developed knowledge base medicine computer system for patient appropriate drug selection has been created. Input information of the system are indications and contraindications of a patient. Computer system first analyzes contraindications and excludes drugs from ranked row. In the next step first type production laws are considered, which point out appropriate drug group.

VI. CONCLUSIONS

Hypertension evaluation and treatment guidelines, founded by European hypertension and the European Society of Cardiology is usable material for knowledge base development and can be used for decision making in medicine computer system.

Computer system which was developed should be tested and approbated in further research because real life cases always introduce different level changes and improvements.

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The usage of an industrial robot for education and research- a survey and experience of Riga Technical University

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***Keywords* – industrial robots, robot control systems, education.**

I. INTRODUCTION

Solutions of industrial automation and robotics are widely used in manufacturing, forestry, chemistry and other industrial spheres. Industrial robots in the world and also in Latvia perform various tasks and improve the overall efficiency of automation. By using robotic solutions it is possible to plan the usage of available resources more efficient. Mostly higher education institutions provide various courses and study programs about robotic sphere. Also Riga Technical University provides courses and a special robotic study program where students can obtain advanced knowledge about the construction and control of a robot. The main goal of this article is to summarize the experience of Riga Technical University in creating the study courses of industrial robots, make a survey of developed algorithms, methods for the adaptive and intellectual control of an industrial robot and to mark further education/ research goals.

II. THE USAGE OF AN INDUSTRIAL ROBOT FOR EDUCATION

On March 19th, 2009 a new fully equipped industrial robotics classroom was opened in the institute of Computer Control, Automation and Computer Engineering (Faculty of Computer Science and Information Technology) [1]. The classroom was created by the collaboration of three faculties: Faculty of Computer science and Information Technology, Faculty of Power and Electrical Engineering, Faculty of Transport and Electrical Engineering. The classroom consists of ABB Irb1600 industrial robot with peripheral devices and programming software RobotStudio. At the first study semester a full practical works where not held, but students were introduced with the basic functions of Irb1600. Then a visit to Tallin Technical University at the beginning of year 2010 was organized. After this visiting a basic outline of study courses where created and starting from the spring semester of year 2010 fully organized practical works where provided.

Bachelor and master students have an opportunity to obtain the basic and advanced knowledge about the ABB irb1600 robot and industrial robots in general. Within the practical works students have an introduction of the usage of automation software for the programming of industrial robots. Then practical knowledge about the modeling of the environment of industrial robot is obtained. Practical courses also include programming of an industrial robot, development of an adaptive and intellectual behavior and the establishment of an automation sector including conveyors, multiple robots and other automation elements.

III. RESEARCH AND DEVELOPMENT

The main goals of a research and development (further R&D) of the available industrial robot Irb1600 is to explore and extend possibilities of the control and performance. The main R&D results are summarized as a final bachelor and master thesis. Also annual report of study program "Automation and computer techniques" includes the summary of all the activities. R&D results of the industrial robot Irb1600:

1. Developed tools for an external monitoring and control. These tools are used to store all available information about the robot in external databases. Virtual private networks (VPN) are used to establish and provide a remote link to the robot and supervisory control and data acquisition systems (SCADA) is used for monitoring and control purposes. By using these functionalities it is possible to provide students with e-education possibilities;
2. An adaptive control of the Irb1600 robot. In the initial step, the Irb1600 robot was able to typewrite defined text by using standard PC keyboard. Then applications for handwriting, calligraphy and painting were created. Also the usage of CAD/CAM systems was tested and as a result it was possible to generate machining paths based on 3D objects;
3. Development of an intellectual behaviour. Bachelor and master students in collaboration with study personal developed various games to use and develop methods of intellectual behaviour. TicTacToe, Checkers and Scramble are the games which were developed by using computer vision and Irb1600 robot. These applications use various artificial intelligence methods and algorithms which were adjusted and implemented by using high level programming languages.

IV. FURTHER OBJECTIVES

The main goal of further research is to expand the intellectual behavior of industrial robot. Also the priority is to developed new algorithms for adaptive control. In education the main task is to improve the study courses, create and publish study materials in English. To improve overall knowledge and expertise of teaching personel it is very important to hold partnership with other higher education institutions and improve the collaboration with industry members.

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Knowledge-based systems in business process automation

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Keywords **– Expert systems, ITIL, Case-based reasoning, otrs**

I. Introduction

People combine abstract knowledge about the world with their previous experience to make decisions and find the best solution for a problem, but sometimes a human factor interferes – people are not able to stay calm in stressful situations and lack speed, when a lot of information should be correctly processed. For example fire department Call Centre operators receive a call, retrieve all necessary information, arrange a request ticket, check if no similar calls have already been made, find a free firemen group and escalate the task to them. It is a time-critical incident therefore it should be handled in a matter of minutes. I would like to present a model that automates these tasks and theoretically could replace a first line support specialist (operator).

In conceptual model fire department Call Centre was replaced with ITIL-based Service Desk systems, which operates with time-critical business processes. Actions usually made by operator are simulated by Expert System that operates with knowledge base acquired from ITILv3 Service Management books and during interviews with one specific support group.

II. ITIL - The Information Technology Infrastructure Library

The Information Technology Infrastructure Library (ITIL) is a set of practices for IT service management (ITSM) that focuses on aligning IT services with the needs of business. ITIL encompasses a set of best practices proposed to improve the overall quality of IT software development and support through the life-cycle of software development projects. ITIL books aggregate knowledge and experience of many organizations, which lets using them as a core for knowledge base. In particular "ITIL Service Operation" book was used to form and group parameters, which are used in Incident classification process.

In ITIL Service Desk Incidents are reported by phone, by e-mail, or by completing a web-form. Integration with Active Directory (AD), internal customer history database and equipment database (Configuration Item database) may provide additional information for classification therefore it was decided to use these convenient data sources. After request initiation specialist should fill in missing fields, set according Priority (based on agreement signed with a customer, service affected, and Impact on business), find appropriate support group, and escalate request to a free support agent with according knowledge about the subject.

III. Task formalization

It was decided to divide the task in 3 major steps, to make realization simpler and to use the most appropriate handling method for each of the subtasks.

A. Prioritization step

To assign correct priority Case-based reasoning approach was used – current incident is compared with a set of "etalon" incidents. In this step incident text is compared with dictionary of keywords and etalon incidents to find similarities. Data retrieved from the Active Directory (Department, Customer name, equipment assigned to customer etc.) also participates in process. To find the best match inversely proportional Euclidean distance is used (1).

$$D_{i,j} = \left(\sum_{j=1}^{N} (x_{ij} - x_{kj})^2\right)^{\frac{1}{2}} \qquad (1)$$

B. Categorization step

To allow system choose according support group, a simple production rules expert system was built, where all variables and initial data was retrieved from AD, internal database and from the request text. It seemed convenient to use structured type of production rules, instead of usual IF..THEN form. The rule was built in form of PERL hierarchical hash (associative array), which dramatically simplified data mining (XML import), keyword search (each found keyword stored in a hash variable) and comparison of data sets. For example:

```
'ID15' => { States => ['new', 'open'], Locks => [$lock],
     New => {Criticality => 'Urgent', },  },
```

Is equivalent to:

```
15)IF (States = 'new' OR States = 'open') AND Locks = $lock
THEN Criticality is 'Urgent'
```

C. Assignment step

For task assignment it was decided to use method based on incident solution statistics. When case is solved, specialist closes it and sets it in one of the two solved cases - "closed successfully" or "closed unsuccessfully". According to number of successful/unsuccessful incidents a solution is made, which support specialist to assign for this task.

IV. Results

The main goal was to make a system capable of replacing first line support specialist, which partly was implemented. A case where incidents are registered by Phone still requires a person, who manually should record the conversation (although in nearest future speech recognition algorithms may be used for this purpose). During creation of a physical model one more goal was set – make the system based on open-source or free solutions, which will make it valuable and usable for wider community, so prototype used Fedora Linux operating system, Apache web-server and OTRS Service Desk platform as a basis.

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Scanning of optimization parameter combination space of biochemical models under metabolite concentration constraint

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Keywords **– dynamic modelling, kinetic parameters, optimization, convergence dynamics.**

I. INTRODUCTION

Optimization of biochemical pathways has gained high importance in fields of systems biology and synthetic biology enabling better understanding of features of designed systems. Optimization methods are widely used to design improved biochemical pathways [1], [2]. Increasing number of optimization methods and tools enable different optimization strategies.

All the variety of optimization strategies give wide range of possibilities to choose 1) the optimization method and tool and 2) the duration of optimization run for particular method and tool. Both decisions are depending on the peculiarities of particular model and perhaps even on the set of adjustable parameters [3].

Another optimization strategy influencing factor is the set-up of constraints of the model [4] which increase the credibility of modified model and reduces the feasible space of parameter values under steady state precondition as a side effect.

Influence of introduction of metabolite concentration constraint [4] on the best values for different number of adjustable parameters and convergence properties of optimization runs is analyzed for dynamic model of yeast glycolysis [5].

II. MATERIALS AND METHODS

COPASI [6], build 35, is used as optimization tool. Pyruvate kynase is maximized to increase the production of ethanol. Two global stochastic optimization methods are applied: 1) evolutionary programming with following method parameters: Number of Generations: 30000; Population Size: 20; Random Number Generator: 1; Seed: 0 and 2) particle swarm with following method parameters: Iteration Limit: 2000; Swarm Size: 50; Std. Deviation: 1e-06; Random Number Generator: 1; Seed: 0. The values of adjustable parameters were allowed to change within a wide range from -99% up to 900% from their initial values. "Steady state" subtask of optimization was chosen.

Five adjustable parameters were used as components of solution space building 31 combinations of adjustable parameters.

Five optimization experiments using CoRunner [7] and ConvAn [8] software were performed for each combination of parameters for each optimization method on a server running 64-bit Microsoft Windows Server 2008 Standard Service Pack 2 operating system. Server has 4x QuadCore Intel Xeon MP E7330 2400 MHz CPU and 32,768 MB of RAM. Several optimization experiments were run in parallel. Single processor per task was used as COPASI does not support optimization with parallel task distribution.

III. RESULTS AND DISCUSSION

Maximizing the production of ethanol production [4] it is found that the best value of criteria in particular runs is reached within two hours in case of all parameter combinations without metabolite concentration constraint and within six hours with metabolite concentration constraint within 20% corridor of steady state metabolite concentrations of unmodified model.

The best value of ethanol flow (corresponds to the flow of pyruvate kinase) decrease dramatically after introduction of metabolite concentration constraint. Wider corridor of constraint can be discussed to increase the ethanol flow.

IV. CONCLUSIONS

Scanning of optimization parameter combination space of the sample model of yeast glycolysis we have determined that introduction of metabolite concentration constraint increases the optimization time for full scan of parameter combination space and decrease the best values of optimization criteria in case of maximization task.

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Analysis of the traffic intensity on the multi-lane higways with one control zone

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***Keywords* – Multi-lane highways, traffic flow, control zone, time intervals, regularities.**

I. INTRODUCTION

The number of vehicle (V) in the country is increasing and the traffic flow (TF) increases accordingly in cities as well as on two-lane and multi-lane highways thus the necessity of information on various TF and V parameters becomes topical. Very important parameter of the TF used by traffic organisation and management specialists as well as road construction specialists is TF intensity – the number of V passing by in a particular time unite. This TF parameter is recorded by using automatic device that receives information from the V sensors that might be placed on the road in various ways. The researches done related to the time interval split between V in changing conditions [1, 2] provide credibility of qualitative and quantitative evaluation of TF intensity automatic, uninterrupted control data at various control zones on both two-lane and multi-lane highways. The work analyses the error of V automatic control (recording) caused by situations when two or more vehicles simultaneously cross one control zone that is placed on a multi-lane highway.

II. PLACING ONE CONTROL ZONE ON A MULTI-LANE HIGHWAY

When placing one control zone on a multi-lane highway, the loss of the data arises when two or more vehicles simultaneously appear at the control zone. This is possible during passing by manoeuvre (the same as on the two-lane highway) and by vehicles freely moving on various lanes.

The actual number of vehicles N that cross the control zone is calculated taking into account take-off data of one control zone M and total data loss that arise if suddenly several vehicles appear in the control zone, simultaneously driving on various lanes, as well as total data loss that arises during a passing by manoeuvre in the control zone [3].

Traffic flow intensity and its distribution on multi-lane highways by placing just one automatic control zone of transport flow on the whole highway (one direction) are analysed in the work. Performing the automatic control of traffic flow total intensity some errors occur due to the fact that vehicles cross the same control zone while driving on various highway lanes or while passing by simultaneously. Expressions for the detection of those errors are offered. Those include total probability of unrelated vehicles appearing simultaneously, when two or more vehicles cross the control zone at the same time. In its turn, to detect errors that arise when a V performs a passing by manoeuvre in the control zone, the length of the whole manoeuvre and the part where two V could appear simultaneously during that manoeuvre as well as the possibility of the passing by manoeuvre should be considered. Expression allowing the detection of the total real number of vehicles on the multi-lane highway at a particular time unite using one control zone is offered. Comparative error of the automatic control device for vehicle detection has been compared to the theoretically calculated possible error of the automatic control device.

III. EXPERIMENTAL RESEARCHES

Experimental researches were performed on the highways of Latvia with three lanes in each direction. In conditioned control zone intensity on every lane – thus also the total intensity – was recorded as well as appearance (crossing) of the conditioned control zone by two or more V simultaneously. Simultaneous appearance of two V in the conditioned control zone during a passing by manoeuvre was also recorded. The evaluation of the produced model was performed by comparing theoretically calculated automatic device comparative V recording errors to comparative errors that were noted while recording appearance of two or three V in the control zone. The comparative error of intensity determination, placing one control zone on three-lane highway (one direction) in wide intensity range, changes relatively linearly, but already at a medium intensity it reaches a significant value, i.e. at the total intensity of 1000 V/h recording of V relative mistake is 18%.

IV. CONCLUSIONS

Experimental researches carried out on the multi-lane highways using one V automatic control recording zone in the width of the whole lane (one direction) and the offered interconnections allow drawing of the following conclusions:

Since the V recording automatic control device relative error can be compared to the theoretically calculated automatic control device probable error, it is possible to conclude that the offered approach of the intensity calculation is adequate to the real process;

The results of the theoretical material and experimental researches can be used by specialists of traffic organisation and construction.

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E-services systems design methods

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Keywords **– YAWL, BPEL, e-service, simulation, transformation.**

I. INTRODUCTION

The article discusses the basic steps of the electronic service design method using several languages, transformations between them and simulation. The approach proposed by the authors is based on the creation of business process in the YAWL environment in order to simulate the process model which could resolve some of the design-time problems as well as provide hints to correct initial process. The primitive description – protostructure – is represented as oriented graph and is used to transform the YAWL workflow to another hierarchic language. The method which segments the process activity graph is evaluated. Merge requirements taking into account the process control flow are proposed to be implemented in the segmentation method. The solutions provided by this method can be interpreted as BPEL orchestrations, defining which activities could be implemented as web service calls. To create process description in BPEL, pattern recognition algorithm is used on the segmented process primitive description. The resulting BPEL process is then evaluated, comparing it with initial YAWL workflow.

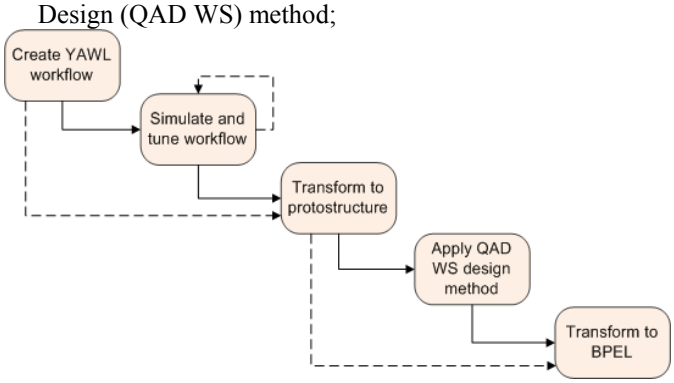
II. APPROACH

Existing business process modeling languages can be divided in two groups. The languages of the first group are favored by the academic community, but rarely used in real-life solutions. These languages are based on Petri nets, process algebra; they have formal semantics, which allow the validation of the models described by these languages. The languages of the second group are used in real-life projects much more than in academic researches. BPEL, WSFL and WSCI are among these languages. These, so called business languages, often lack proper semantics, which could lead to debate on how to interpret the business models described by these languages. The availability of different implementations of these languages from different vendors does not facilitate the situation either, yet they are used much more, compared to seldom used models described by academic languages. If a situation arises when business process model described by business language needs to be validated using Petri nets, one must either abandon the validation or transform the process model to another model, described in academic language, for example YAWL. The authors propose reverse approach – first, a process is created using academic language. The design problems of the process model can then be solved by mathematical means. Second, the verified and updated model is transformed to model described in business language. The advantages of the approach described follows:

- If a model is created using academic language, it is more readable and maintainable than the model, which is a transformation result itself. It is also easier to perform analysis of untransformed model, because the transformation could lose some design information.
- Model, transformed to business language, is already validated and ready to be executed. The alternatives of the execution environment for the model are much more than the environments for academic languages; in addition to that, they have superior technical support.

The model of the business process can be changed and improved during the transition from one language to another – the approach proposed by authors consists of following phases (Fig. 1, dotted lines show that some phases may be omitted):

- The design of the business process using academic language;
- The validation and simulation of the business process model designed;
- Transformation of possibly improved model to primitive structure;
- The segmentation of primitive structure represented by graph using Quality Attributes Driven Web Services Design (QAD WS) method;



- The transformation of primitive structure (or its segmentation) to process using business language.

Fig. 1. The phases of proposed design approach.

Similar approach is proposed by Pornudomthap and Vatanawood, but their solution is based on straightforward conversion of YAWL workflow to BPEL process. The approach proposed in this article allows transforming the workflow to any business process language and to simulate and optimize the process flow as well.

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Autonomous Mobile Unmanned Outdoor Robot Design

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***Keywords* – Research robot; Real Time System; Timelines; TUF; Physical model.**

I. PAPER THESIS

Autonomous mobile unmanned outdoor robots are used for agriculture, urban utilities and in hard environment which can be dangerous for man.

New education and training mobile research robot design is urgent, despite now there are different ready-made researcher robots.

Article "Autonomous mobile unmanned outdoor robot design" is devoted to two stages of robot development.

At the first stage robot is proposed as embedded cluster network of sensors and actuators. Real time analysis is made for acting phases of the robot.

Phase one (time interval T_1) – activity environment estimation and route map building;

Phase two (time interval T_2) – robot turning on to required direction;

Phase three (time interval T_3) – movement of the robot by calculated route map to first, second, or Nst objects;

Phase four (time interval T_4) – investigation of parameters of the object;

Phase five (time interval T_5) – obstacle avoidance.

When all five phases are executed in hard deadlines d_{hi} – the robot can be determined as hard RTS, and $\sum_i^5 WCET_i = D_h$ worst-case execution time can be used for estimation of the robot.

For sophisticated autonomous mobile robot timelines estimation, with task start times, completion slack times and some probability $p_{i(+)}$ of missing the soft deadline d_s – utility accrual UA approach is proposed [1].

For the five phases: the Time/utility $UA = \sum_i^5 UA_i = D_s < D_h$.

At the second stage physical model of mobile robot is being developed and used for experimental estimation of time cost, reliability and energy consumption. Two physical models are designed. Main differences between first and second mobile robot models are in Video and Navigation systems:

- Video camera system. For the first robot model used CmuCam3 module with low image resolution, low data transfer rate, low camera matrix sensitivity to the red color. For the second mobile robot used PDA HTCc Flyer with built in High-Quality – High Resolution 8Mpix camera. This increased image data transfer and processing rate.
- Navigation system. As navigation system the first robot used electronic compass, encoder system, and range finders. The second robot uses AHRS module which includes 3 axis magnetic compass, 3 axis gyroscope, 3 axis accelerometer and embedded processor for data processing and transfer purposes.
- The second robot is able to act in 2 modes. In the first mode robot acts fully autonomously using programmed algorithm. In the second mode robot is being controlled by operator using terminal such as PC or PDA and is capable of communication using 3G or Wi-Fi networks, with it operator can control it and get telemetry data from any place of the world where is available connection to the Internet.

Both physical models design used equal platforms.

For the proposed new unmanned outdoor research robot for agriculture and urban utilities commercial platform is selected.

The developed physical models are advisable and used for student education.

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Techniques and architecture improvements for fast wireless data acquisition network

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***Keywords* – wireless data acquisition, embedded systems, time critical systems.**

I. Introduction

Current paper presents ongoing research under FP7 project "STRATOS" [1]. Previous paper - "Wireless sensor network setup for fast data acquisition" [2] presented overall system's architecture and wireless data transmission techniques. Further research provided wireless networks coexistence and lower energy consumption information. Improvements were made based on new techniques and detailed architecture planning. The results of this research are presented in this paper.

II. Current situation analysis

First system setups used TelosB wireless nodes for sensors' data transmission. To achieve required sensor nodes amount and transmission frequency, all available ISM wireless bandwidth were used. Since STRATOS project involves one more wireless network (IEEE 802.11b/g) there might be interference with wireless sensor network (WSN) nodes. Paper provides test results of nRFGo (NordicSemiconductor) wireless nodes that proved to be robust to the interference. Thanks to their higher data rate, average power consumption is also lowered.

Systems architecture proposed in previous paper was relying on interference free ISM band. Proposed system and WiFi (IEEE 802.11) network were tested on coexistence. The tests show high packet loss. Next chapter presents techniques used to solve this problem.

III. Proposed improvements

To lower the chance of losing the packets and increase energy efficiency, two techniques were used. WSN modules use different signal modulation method, in comparison with WiFi (IEEE 802.11) network.

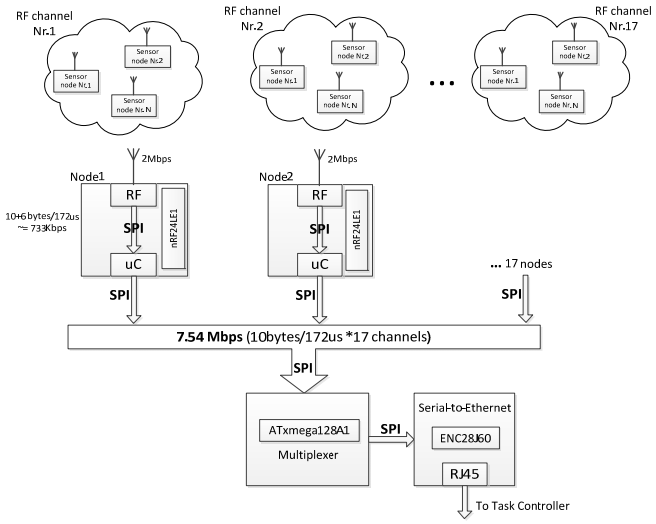

Fig. 1. Proposed system's architecture

Existing WiFi network is permanently assigned to non-overlapping bandwidth channels. It became possible to occupy less bandwidth, since nRFGo nodes' modulation allows tight channel stacking.

STRATOS project's aim is to collect sensors' readings to central station (Task Controller). To realize this task, the gateway between sensor network and Task Controller should be able to process and retransmit all incoming sensors' data. To achieve the aim, systems architecture was updated with detailed specification of the hardware, wired/wireless protocols and timing/bandwidth requirements (see Figure Nr.1). It is proposed to use modular structure, where all components are using standard interfaces and protocols. In this way it will be much easier to migrate to other platform or expanding nodes amount by occupying the rest of free bandwidth channels.

Proposed architecture allows expansion not only horizontally, by adding wireless nodes, but also vertically, by combining gateways.

IV. Test results

As can be seen on figure Nr.1 all sensor nodes will generate ~7.5 Mbps traffic. All gateway modules are able to sustain above mentioned traffic. The test results will be published soon.

The advantage of NordicSemiconductor over TelosB nodes is not only in higher data rate, but also in ease of low level hardware programming. Also stability of programmed parameters in nRFGo was higher. E.g. the jitter of received packets interval in TelosB nodes was 68µs, where nRFGo result was under 2.5µs (Fig. 2). It shows that nRFGo nodes are more suitable for time critical applications.

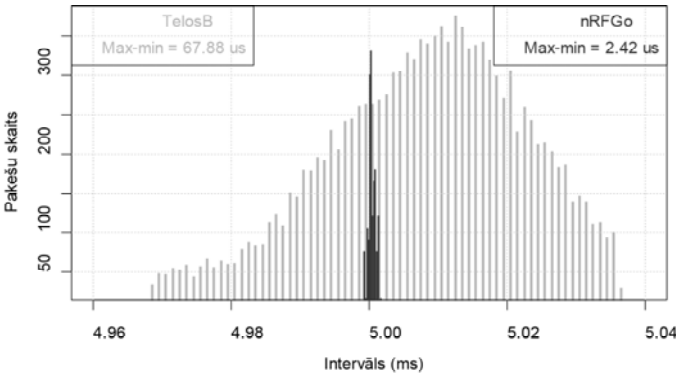

Fig. 2. Transmission interval stability comparison

Detailed analysis of wireless nodes transmission technique revealed the limits of hardware and shown the way to further improvements.

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Multiple mobile gateways for wireless sensor networks

Gundars Miezits (Riga Technical University), Valery Zagursky (Riga Technical University), Romans Taranovs (Riga Technical University)

***Keywords* – wireless sensor network, mobile gateways, initialization protocol.**

I. Introduction

Wireless sensor networks (WSN) are formed of small nodes that collect data of physical world. Due to fact that WSN gateways (GW) use more energy than sensor nodes we need a solution for GW that can be recharged. We propose to use quad copters that act as mobile GW. But due to their free movements we have to develop protocol that can be used for GW initialization and for acquiring cluster data.

II. Related Work

During Framework 7 project – STRATOS – we have investigated what kind of GW hardware platform is more suited for time critical application and which is not.

In [1] is described use of mobile GW which is attached to human that moves around in WSN and forms cluster in N hop vicinity. Sensor nodes from this cluster then send data to GW.

The rest of digest is organized as follows, In III and IV chapter we propose infrastructure of multiple mobile GW approach and initialization protocol, respectively. In V we conclude our digest.

III. Infrastructure for Multiple Gateways

Firs there must be defined characteristics that GW, cluster and communication between them must have.

A. Characteristics of gateways and clusters

Among major characteristics are:

- GW must be capable to communicate with each other;
- GW can communicate with multiple cluster heads;
- at least one GW must be able to communicate with user through some global network;
- clusters are formed prior GW arrival;
- cluster sink and GW exchanges with information;

B. Network architecture

In Fig. 1 are proposed WSN architecture improvements. Continuous lines show possible communication paths between nodes. And architecture is divided in two layers because this approach simplifies protocol development and WSN scaling.

IV. Initialization Protocol for Gateways

Proposed initialization protocol consists of two parts – initialization phase and access phase. In first phase it initializes GW and in second GW become able to move and read data.

Protocol performs these steps. When GW switches on it waits for incoming messages (1) for some time. If there are no commands it sets its communication priority to 1 (highest) and starts to send initialization start (2) command in environment. If no ACK is received for certain time GW goes in sleep mode (3). After some time it repeats step (2). When it gets response from other uninitialized GW, main (with highest priority) GW

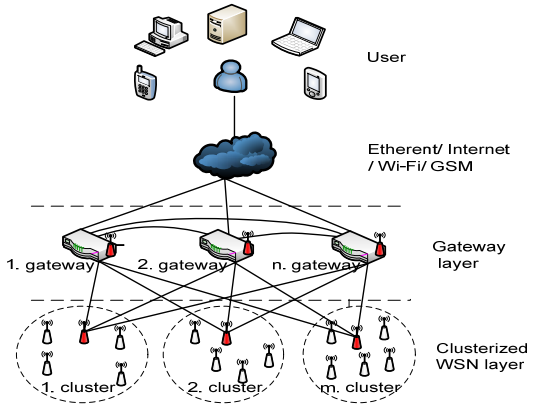

Fig. 1. Improved architecture of wireless sensor network and gateways.

increments total GW count (4), decrements its priority (5) and informs all initialized GW of its state (6) with GW broadcast message. GW under initialization acquires this information and sets it priority to 1 (7), other GW, if any, accordingly decrements their priorities and set other received state variables (8). Now main GW sends command requesting to respond any other uninitialized GW (9). If in certain time there is no ACK, main GW assumes that initialization is complete and proceeds with next step (10). If it receives ACK, GW proceed with step (4), (5), (6), (7), (8) and (9).

When initialization is complete GW with highest priority sets variables that are responsible for moving GW, i.e. sets quad copter parameters, and informs other GW of these parameters (10). It still is needed to find these parameters (like flight speed, incline/decline height, etc.).

Now second part of protocol can be executed. After step (10) GW sets lowest priority and sends priority change command to all GW (11). All other GW increment their priorities. Now main GW can start receiving data from WSN. GW with highest priority sends data request to cluster sinks (12). First cluster sink to respond now can exchange information between GW and itself (13). After some time, GW decrements priority (14) and sends priority change command to other GW (15). Now main GW repeat (12), (13), (14), (15).

When any of GW faces obstacle it send interrupt command to other GW informing of obstacle. All GW react on this command and change for example their altitude simultaneously. Upon battery depletion GW return to base.

V. Conclusions

In this digest we propose to use quad copters as mobile GW that exchanges information with clustered WSN and forward it to user through global network. And is proposed protocol responsible for initialization and data acquisition.

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An Efficient Clustering Approach for Hierarchical Wireless Sensor Networks

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***Keywords* – wireless sensor network, clustering, collision-free, hierarchical structure.**

I. Introduction

With the development of technology of MEMS (micro-mechanical systems), the wireless sensors have become research objects with great capabilities. Wireless sensors are grouped into network thus enabling careful an efficient object or an environmental data gathering. Wireless Sensor Networks (WSN) are widely used in environmental monitoring, like temperature, humidity, etc., as well as in army/battlefield, disaster, etc [1]. In described fields of interest sensor nodes are placed in unmanned manner. Thus various protocols, like communication and topology control protocols manage nodes' cooperation and data transfer to the sink. The main function WSN must support is self-organization. In some cases self-organization is done by structuring a WSN in clusters [2]. In case of clustering a special node arises in each cluster. The node is called a clusterhead (CH), than maintain cluster functionality. CH can be predefined or may be dynamically elected from common nodes.

Grouping nodes into clusters provides increased network extendibility, as well as routing table minimization because it is not necessary to have a network table in each node. As well network topology becomes more stable on sensor nodes level. Stability is achieved because sensor nodes are interested in their connection to a CH only.

In the paper a novel clustering scheme is proposed. The scheme is specially designed for collision-free Medium Access Control (MAC) protocol [3]. Collision-free communication is required by in-medicine control applications [7]. The applications suffer of data losses caused by collisions on receivers, thus decreasing an overall quality of service or even a vital information loss. Thus a collision free formation of clusters possibility is shown.

The proposed clustering scheme has been designed for hierarchical network described in [4], but it is free to use it for another similar one.

II. Related Work

The classical clustering approach – Low-Energy Adaptive Clustering Hierarchy – LEACH [5] and its extension TL-LEACH [6] are mainly aimed to minimize energy consumption by sensor nodes. Thus a CH rotation is assumed and a CH is elected in terms of minimum energy required for a communication. Cluster establishment is done by broadcasting messages using Carrier Sense Multiple Access (CSMA). For an in-cluster communication a Time Division Multiple Access (TDMA) scheme is used – in scheduling neighboring nodes. Moreover Code Division Multiple Access (CDMA) scheme allows each in-cluster communication be collision-free to neighboring in-cluster communications. But such approach utilizes three medium access techniques that only minimizes collisions but not exclude them.

Another clustering scheme approach is described in [7], named Energy Efficient Heterogeneous Clustered (EEHC). Clusters are formatted within *k*-hops from a CH. CH are selected randomly with a probability *p*. The algorithm is designed to use it in large networks with minimized energy-consumption. The scheme does not work in collision-free manner – that is sometimes is desirable or even necessary.

III. Proposed Clustering Algorithm

The proposed clustering algorithm is designed to be used in two level hierarchical scheme of WSN, where:

- First level – is sensor nodes' level. From placed there sensor nodes CHs are elected. After that clusters are formed in decentralized manned.
- Second level – it is a gateway level. Each gateway may collect data from its cluster and transmit it to TCP/IP network.

In-cluster 1-hop connectivity is used, because of faster data transfer from a cluster to a sink. CH maintains a cluster that is performing its formation and members' inclusion procedures.

A cluster formation starts from the collision-free MAC protocol main phase, which is an analyzing of CH election. In this step a multi CH may arise and its cluster nodes' communication may result in collisions on some nodes. To fully avoid collisions a switching to different channels is performed. A CH with nodes, that wants to become cluster members, switches to a random channel. Channel is selected by CH as well as it broadcasting to other nodes. At a new channel CH with its nodes listen for a time 2T if the channel is free it starts CH election process to avoid two CH switching to the channel. But if CH with its nodes will receive a broadcasted message on selected channel, they switch to the next channel. Previous operations repeats while a free channel will be found. If no free channel exists, CH and its nodes may switch to every cluster they desire.

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Functional State Evaluation System with Distributed Intellect for Elderly and Disabled Persons

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Keywords **–clinical decision support, vital signals, monitoring system, complex systems.**

I. Introduction

The development and adaptation for use in practice of new methods for evaluation of complexity was one of aim of this work. It is likely that early assessment of complexity changes will enable to start earlier usage of preventive means with intention to preclude the manifestation of various disorders in human organism. Recent advances in medical information technologies allow us to change the way health care services are deployed and delivered [1]. Focus on prevention and early detection of disease or optimal maintenance of chronic conditions promise to augmented existing health care systems that are mostly structured and optimized for reacting to crisis and managing illness [2]. Another possibility for performing of preventive task could be estimation of values of individual physical activity. This prospective method designed for safety of elderly at home is a new diagnostic technology, and development of this technology is one of goals of ITEA2 08018 GUARANTEE [3].and EUREKA E!4452 EDFAS [4] projects.

II. Materials and Methods

The lowest level of monitoring system encompasses a mobile patient recorder (MPR), the second level is the smart phone, and the third level encompasses a network of remote server for medical experts. The MPR consists of intelligent sensors for simultaneously recording transmission of three ECG leads, three accelerometer signals, plethysmogram and oxygen saturation channel. The mobile phone is provided real time data analysis software and the remote server is used for off-line data analysis software and data base.

The architecture of human monitoring and analysis system is presented in Figure 1.

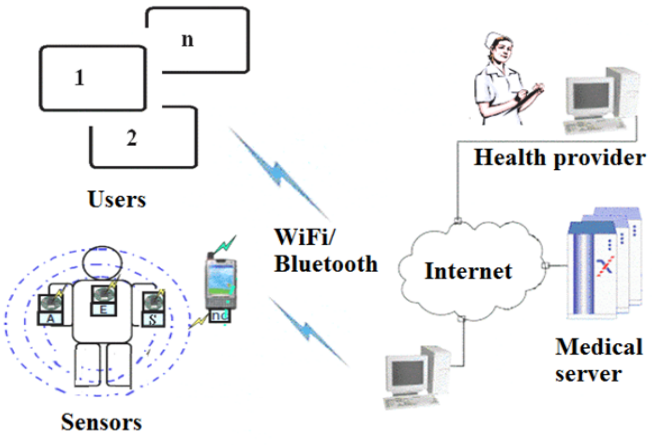

Fig. 1. Architecture of system

The ECG analysis algorithm consists of complexes identification, parameters measurement and classification of ECG complexes. Decision-making about person functional state is performed by principles which are based on methodology of distributed intellect. The criteria of parameters for person functional state evaluation are rule based and depend on individual elderly vital signs values. The monitoring system makes a main decision about patient state changes from the calculated parameters by using convolution of Moore and Mealy automata. According to received analysis results the software forms warning signals to patient. In case of appearances of dangerous situation for patient, the software sends the results of analysis to physician.

III. Results

The presented work reflects three main results: developed hardware of monitoring system, proposed data analysis, with decision algorithms and developed software.

The developed hardware of monitoring system consists of intelligent sensors for synchronous acquisition and wireless transmission of three ECG leads, three axes accelerometer, plethysmography and oxygen saturation data channels.

Algorithms were developed by Microsoft Visual Studio 2008 Professional Edition. The operating system was Windows Mobile 6.5. The mobile patient recorder was tested on 30 elderly and disabled volunteers. Rate of false positive cases of alarm generation was 9percents and false negative 3percents.

IV. Conclusions

The new feature of developed human data monitoring system is capability to analyse multi processes in some functional connections of investigated persons. Integrated assessment of person functional state is adapted for user requirements in individual level. If patient is in danger or needs external help, the data could be sent to medical service center.

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Introduction to Regularized Direct Filter Approach

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***Keywords* – overparameterization, parameter shrinkage, high-dimensional data, time series.**

I. Summary

Data richness encountered by a researcher nowadays requires tools that are capable of dealing with high-dimensional data in effective ways. The traditional methods such as ordinary least squares are bound to break down as overparameterization is an inevitable side-effect of using high-dimensional data. Therefore, shrinkage methods are used to control for the degrees of freedom. This paper introduces the regularized direct filter approach whose regularization features are similar to the Tikhonov regularization but deals with three types of regularization - cross-sectional, longitudinal and coefficient smoothness. The paper shows the effects of each regularization feature and illustrates their usefulness in dealing with potentially high-dimensional time series matrices.

II. Regularized Filter

Regularized multivariate direct filter approach is a regularized version of the customized multivariate filter developed in Wildi (2011). However, the multivariate filter contains many parameters whose number increases with the cross-sectional or time dimension of a filter. Thus, the filter in Wildi (2011) cannot be too long or cannot contain tens of variables due to the limited sample size, otherwise the filter would be overparameterized and the filter output would be of poor quality in out of sample. One way of increasing the cross-sectional dimension of the filter would be to accordingly decrease the length of the filter. However, the length of the filter cannot be decreased infinitely since it is bounded to zero and too short filter would result in deteriorating quality of filter output. Therefore, similar to standard econometric practices in parameter shrinkage (ridge regression, Lasso, least angle regression, Bayesian shrinkage), it would be thoughtful to attempt to shrink filter parameters as well, in order to allow for controlling degrees of freedom and using potentially high-dimensional data as input. Such an attempt is done in Wildi (2012) that introduces three shrinkage parameters that control for cross-sectional shrinkage, shrinkage along time dimension (lag decay), and that impose smoothness of filter coefficients. The three shrinkage dimensions can be imposed in any of their combinations, or all of them can be set to zero such that the filter replicates the one discussed in Wildi (2011).

III. The Effect of Regularization

In order to understand the extent of overparameterization in a multivariate filter, consider an unconstrained filter applied on nine monthly variables targeting an ideal lowpass of yearly growth of euro area gross domestic product with the cut-off wave length 12 months. The filter length is set to depend on the cross-sectional dimension of the filter and the sample length and is proportional to the ratio of the two, with the lower and upper bounds being 12 and 48 months, respectively. Thus, the maximum length of the filter is 17 observations for full sample and the minimum length of the filter is 12 months for smaller subsamples. While the estimation routine can estimate a 9-variable filter on the full sample (170 observations long), it crashes for smaller subsamples because of the degrees of freedom having been shrunk to zero for all subsamples shorter than 9*12=108 observations. A further reduction of filter length might be a temporary solution but not for long and not without consequences on output quality. Therefore, an unconstrained 9-variable filter output is infeasible for the considered data samples. Thus, some sort of parameter shrinkage is necessary.

In order to illustrate the effect of the parameter shrinkage induced by the regularized filter, consider the estimated filter coefficients for an unconstrained and nonregularized 9-variable filter on the full data sample. The number of estimated parameters is 9 variables times 17 observations long filter which gives 153 parameters to estimate on a 170-observations long sample, which gives only 17 degrees of freedom. Figure 1 shows that the estimated filter coefficients look erratic, unsmooth and do not show a similar behaviour between the variables nor an evident decay towards zero with an increasing lag.

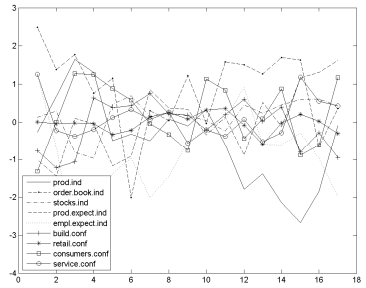

Fig. 1. Filter coefficients without regularization.

Figure 2 shows the effect of regularization by applying mild coefficient smoothness restriction. The coefficients are evidently smoother and the effective degrees of freedom has been increased to 109, i.e., more than six times.

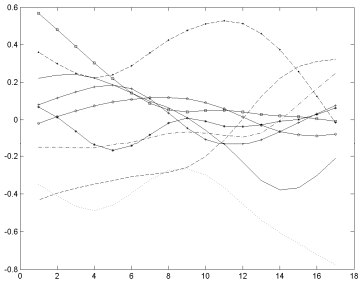

Fig. 2. Filter coefficients with mild regularization.

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Tracking Business Cycle of European Union GDP in Real Time

Ginters Buss (*Riga Technical University*)

Keywords **– real time signal extraction, monthly indicator for GDP, multivariate direct filter approach**

I. Introduction

The paper proposes a new real-time indicator tracking business cycle developments in European Union gross domestic product. The indicator is based on a recently developed direct filter approach and shows decent out of sample performance.

II. Methodology

Direct filter approach is concerned with estimating a signal - e.g., a trend, business cycle or seasonally adjusted series - in real time.

Let

$$y_t = \sum_{j=-\infty}^{\infty} \gamma_j x_{t-j} \tag{1}$$

be the ideal output signal of a symmetric, possibly bi-infinite filter. A real time estimate of y_t given a finite data set $\{x_1, \ldots, x_T\}$ is

$$\hat{y}_t = \sum_{j=0}^{T-1} b_j x_{t-j} \tag{2}$$

Let $\Gamma(\omega) = \sum_{j=-\infty}^{\infty} \gamma_j \exp(-ij\omega)$ and $\hat{\Gamma}(\omega) = \sum_{j=0}^{T-1} b_j \exp(-ij\omega)$ be the corresponding transfer functions of filters in (1) and (2). For a stationary process x_t, the mean square filter error can be expressed as

$$\int_{-\pi}^{\pi} |\Gamma(\omega) - \hat{\Gamma}(\omega)|^2 \, dH(\omega) = E[(y_t - \hat{y}_t)^2], \tag{3}$$

where $H(\omega)$ is the unknown spectral distribution of x_t. A finite sample approximation of (3) is

$$\frac{2\pi}{T} \sum_{k=-[T/2]}^{[T/2]} w_k \, |\Gamma(\omega_k) - \hat{\Gamma}(\omega_k)|^2 \, S(\omega_k), \tag{4}$$

where $\omega_k = k2\pi/T$, $[T/2]$ is the greatest integer smaller or equal to $T/2$, and the weight w_k is defined as

$$w_k = \begin{cases} 1 & \text{for } |k| \neq T/2 \\ 1/2 & \text{otherwise.} \end{cases} \tag{5}$$

The above univariate DFA can be generalized by using discrete Fourier transform (DFT) $\Xi_{Tx}(\omega_k)$:

$$\frac{2\pi}{T} \sum_{k=-[T/2]}^{[T/2]} |\Gamma(\omega_k) - \hat{\Gamma}(\omega_k)|^2 \, I_{Tx}(\omega_k) = \frac{2\pi}{T} \sum_{k=-[T/2]}^{[T/2]} |\Gamma(\omega_k)\Xi_{Tx}(\omega_k) - \hat{\Gamma}(\omega_k)\Xi_{Tx}(\omega_k)|^2 . \tag{6}$$

Let y_t be defined as in (1), and assume additional m explaining variables Z_{jt}, $j = 1, \ldots, m$. Then, a multivariate version of the filter becomes

$$\frac{2\pi}{T} \sum_{k=-[T/2]}^{[T/2]} \left| \Gamma(\omega_k)\Xi_{Tx}(\omega_k) - \hat{\Gamma}_x \Xi_{Tx}(\omega_k) - \sum_{n=1}^{m} \hat{\Gamma}_{Z_n}(\omega_k)\Xi_{TZ_n}(\omega_k) \right|^2 \tag{7}$$

which is used to preduce the real-time indicator in the next section.

III. Results

Take European Union quarterly GDP, year-on-year percentage change, seasonally unadjusted, available from 1996Q1 onwards. Linearly interpolate to monthly frequency Use confidence indicators published by DG ECFIN as explanatory variables for GDP, particularly: 1) production trend observed in recent months (industry), 2) assessment of order-book levels (industry), 3) assessment of stocks of finished products (industry), 4) production expectations for the months ahead (industry), 5) employment expectations for the months ahead (industry), 6) confidence indicator in construction, 7) confidence indicator in retail trade, and 8) consumers confidence indicator. All series are seasonally unadjusted. All explanatory variables are standardized to have zero mean and unit variance, and their starting time period equated to that of the GDP. Therefore, the length of explanatory variables is 187 months, 3 months longer that that of GDP, which ends in June 2011.

The resulting real-time indicator for the EU GDP is a result of targeting an ideal lowpass of the yearly growth of the EU GDP and is plotted in Fig. 1. The resulting indicator is well aligned with the target signal, is timely and smooth.

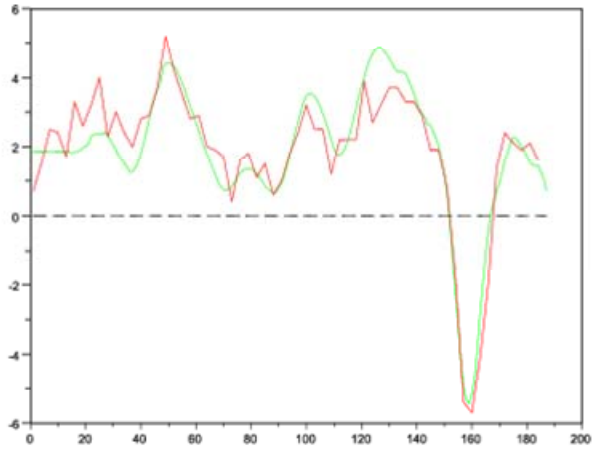

Fig. 1: Multivariate filter output (green) vs EU GDP (red).

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Software defined radio based embedded automatic identification system receiver for nano-satellites

Juris Polevskis, Martins Krastins, Gundars Korats, Kaspars Kondratjevs, Janis Trokss (*EI VIRAC*)

***Keywords* – AIS, software-defined radio, embedded system, Raspberry Pi, FUNcube Dongle.**

I. Introduction

The Automatic Identification System (AIS) is a maritime VHF communications system that provides information about ship identification, location, course, speed etc. to other ships and ground stations with goal of assisting with ship collision avoidance, security and vehicle tracking [1]. Ground stations have limited range and therefore are not only unable to gather information about ships far from coast, but require a large number of such stations to cover the entire coastline.

AIS messages are transmitted in two channels – A, 161.975 MHz and B, 162.025 MHz, using 9.6 kbps GMSK modulation over 25 or 12.5 kHz channels. To avoid message collisions a self-organizing time division multiple access (SOTDMA) scheme is used. The system uses the concept of 1 minute long time frames consisting of 2250 message slots [2].

A satellite based AIS receiver faces additional challenges when dealing not only with reduced signal-to-noise ratio, Doppler shift and environmental conditions, but also the possibility of packet collisions. As TDMA of AIS signals work on a local level but satellites have large coverage area, there is the possibility of ships that are not in view of each other to be both transmitting AIS messages on the same time slot. Collisions could also be caused by different path lengths making the adjacent time slot messages overlap. Although such situations would be rare in open seas, in areas with larger amounts of maritime traffic, which are of greater interest, the loss of data could be significant [3].

During the last decade there has been a push to implement space-based AIS receivers. Using nano-satellites for AIS monitoring provide data for vessel traffic in distant off-coast areas and give an insight into the collision of AIS messages in high-density traffic areas. One of the problems is to build the payload for such satellite - flexible and efficient AIS receiver system that meets low energy, size and weight requirements.

II. Solution

A. Hardware

Embedded platforms like Raspberry Pi and PandaBoard are a cheap alternative to traditional computing solutions with enough computing power to be suitable for advanced signal processing also meeting the requirements for low power usage in satellite systems. Easy software development and adaptation for the ARM architecture makes these boards an optimal solution for development platform.

FUNcube Dongle, developed as a part of AMSAT-UK's FUNcube satellite project, is a small software-defined radio receiver designed to make collecting of information from space available to anyone [4]. In a combination with a small embedded platform like Raspberry Pi it can be used as the main hardware for an embedded AIS receiver.

B. Software

GnuRadio, an open-source software development toolkit for software defined radio solutions in combination with Linux operating systems like Debian or Ångström and a control service application provide the software base for a nano-satellite system. It enables wide range of generic software defined radio solutions - easily adaptable and reconfigured even in an orbital environment. AIS messages can be decoded in real-time mode or in post-processing using Gr-ais module for GNUradio.

III. Results and Discussion

Embedded software defined radio based AIS receiver gives several advantages over traditional terrestrial AIS receivers used for most space purposes currently. Software-defined system can be used as a traditional real-time AIS receiver and also as a radio spectrum recorder *(Fig.1)* allowing the captured data to be decoded in post-processing. This enables implementation of advanced signal processing algorithms to deal with Doppler shift, environmental conditions and packet collisions.

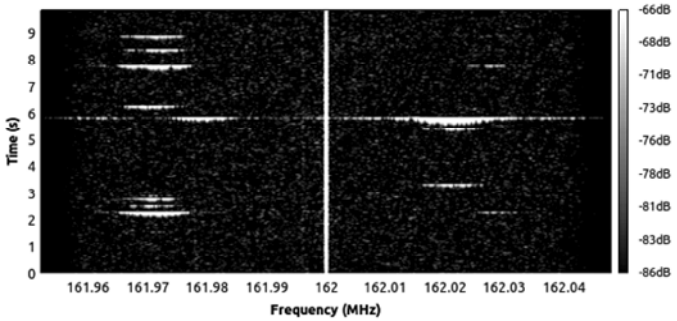

Fig. 1. Spectrum of AIS messages in the A (left) and B (right) channels captured with FUNcube Dongle

IV. Acknowledgements

This research was funded by the European Regional Development Fund (project Nr.2010 /0262 /2DP/ 2.1.1.1.0/ 10/APIA/VIAA/117).

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nanoRTU based radiation tolerant modulator for satellite to Earth communication

Aleksejs Skorodumovs (*Ventspils University College, Latvia*)

***Keywords* – SDR, SDPSK modulation, FPGA based modulator**

I. INTRODUCTION

It is impossible to reprogram a satellite hardware modulator after the launch. However it may be necessary to change the modulation scheme to adjust the balance of data rate vs link reliability, enable coding or encryption system, change communication protocols, etc. nanoRTU FPGA-based controller produced by ÅAC Microtec may be programmed as a modem back-end for software-defined radio (SDR) in satellite communication system. This allows to make a low power radiation tolerant reprogrammable satellite modem back-end for satellite to Earth communication.

This paper describes implementation of a low data rate modulator utilizing a robust and reliable symmetric differential phase shift keying (SDPSK) [1] modulation scheme combined with sinc pulse shaping filter [2] in nanoRTU.

II. SOLUTION STRATEGY

Modulator consists of several logical blocks which can be described separately: 1) universal asynchronous receiver, 2) clock generator, 3) Tx data buffer, 4) data encoder, 5) pulse shaping filter using sinc value table, and 6) SPI driver for digital to analog converter. Data encoder and shaping filter blocks basically are the SDPSK modulation scheme, and can be reprogrammed to utilize standard DBPSK or DQPSK schemes. These blocks are all written in VHDL especially for nanoRTU circuit board. Various techniques were used to minimize the size of resulting logic circuit.

Since troubleshooting the whole design is too difficult, three test designs were made to incrementally test modulator blocks for flaws. All three designs were tested, and the modulator output was compared to pre-calculated waveforms to ensure that every logical block functions correctly.

Data is sent to nanoRTU digital IO pins as if it was an ordinary UART receiver set to widely used 19200 8N1 settings. Output consists of three digital warning signal feedback and two analog output channels - I and Q. Warning signals are fed to a controller, which helps in preventing the buffer over- and underflow problems. Analog channels output - a shaped I/Q signal which would modulate the intermediate frequency oscillation when connected to a RF front end.

III. RESULTS AND DISCUSSION

Modulator backend was implemented in nanoRTU using only 1/6 of available FPGA resource.

Test schemes were implemented for easier troubleshooting.

Modulator analog outputs were compared to the pre-calculated results.

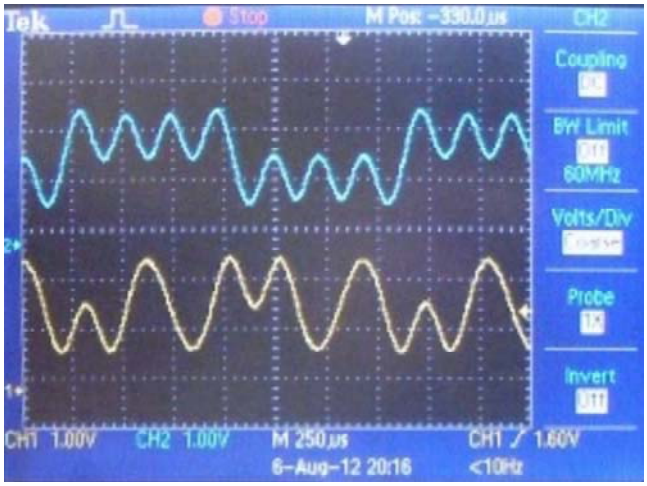

Fig. 1. Oscilloscope trace of I and Q modulated signal channels – continuous transmission of 0x9D byte.

ACKNOWLEDGEMENTS

This research was funded by the European Regiona Development Fund (project Nr.2010 /0262 /2DP/ 2.1.1.1.0 10/APIA/VIAA/117).

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Computer Science

Applied Computer Systems

Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
The 1st Congress of World Engineers and Riga Polytechnical Institute / RTU Alumni

Scientific Journal of Applied Computer Systems: Looking Back and Moving Forward

Janis Grundspenkis, Leonids Novickis and Oksana Nikiforova (*Riga Technical University*)

***Keywords* – Scientific Journal of Applied Computer Systems.**

Exactly twelve years have passed from 2000, when the first issue of the 5th series "Computer Science, Applied Computer Systems" was compiled in the Scientific Journal of Riga Technical University. According to the Chinese Zodiac, which is a scheme that relates each year to an animal and its reputed attributes, according to a 12-year mathematical cycle, the Scientific Journal of Applied Computer Systems is signed as Dragon. Dragon is a mythical powerful creature worshiped by Chinese culture symbolizing strength, health, harmony, and intellectuality. Many consider Dragons extremely lucky and blessed. Most entities under this eccentric Chinese Horoscope sign are generally charismatic, gifted with great powers, and can evolve to become great inventors, scientists, actors, lawyers, politicians, and managers. Similarly, it seems to us the Journal publishing the research results in traditional fields of Institute of Applied Computer Systems born under Dragon's sign is endowed with all these features. The first 12-year cycle is closed, and co-editors of the Journal of Applied Computer Systems would like to give brief overview looking back on the history of the journal's formation and becoming such as it is.

The first issue was published in 2000 in response to professor Ivars Knets to regenerate scientific traditions and to give ability to scientists to publish main results of their research. The volume contained 9 papers presented at the 40th RTU International Scientific Conference. In turn to continue the tradition to publish scientific papers in the journal next year the editors issued the call for paper with announcement that the applications from PhD students are of special interest. The amount of the submitted papers was increased twice. And the second issue was compiled bridging 20 years gap between so called "old" scientific school leading by professor Janis Osis, who established the new original approach to complex technical system diagnostics based on topological models, and the young generation of scientists. Meaningfully, the first paper of this issue is the paper about history of research on system modeling at RTU, where professor Janis Osis in honor of 40-year anniversary of the faculty of Computer Science and Information Technology described the evolution of the faculty's scientific school during last 40 years and representing its structure.

The third issue in series starts with five papers presented at the international conference "Information System Development" (ISD) which for the first time was held in Eastern Europe and organized by the Division of System Theory of RTU. Papers devoted to traditional problems investigated by scientists of the Institute of Applied Computer Systems are also included. In 2002 editorial board had already 38 submissions of papers and was forced to review them carefully. Therefore, the evaluation of papers for this issue is characterized as the first with two blend reviewers for each paper, where disputable papers were additionally evaluated by one of core editors. Figure 1 shows the statistical data on the amount of the published and rejected papers for all 13 issues published during last twelve years.

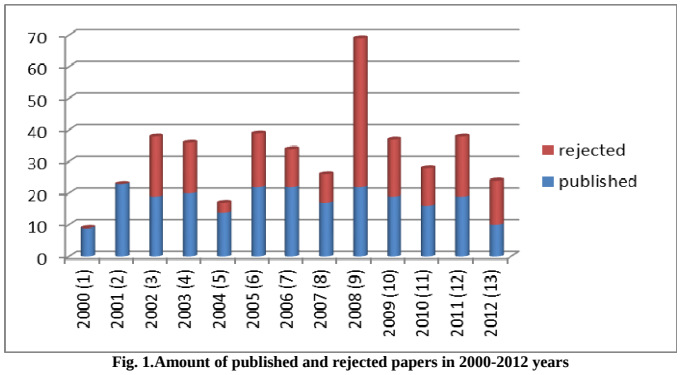

Fig. 1.Amount of published and rejected papers in 2000-2012 years

According to traditions to publish papers of both generations of scientists, the fourth issue of the journal starts with two papers in which the founders of two research directions of the faculty, namely, professors Janis Osis and Janis Grundspenkis, outline new perspectives of topological and structural modeling. A new generation of scientists also is widely represented in this volume. They are authors of two thirds of the accepted papers. Young scientists have obtained new results in formal methods, organization theory, object oriented approach in systems design and many other urgent topics. In this issue the traditional problem domain such as application of information technology in learning, insurance and knowledge management are included, too. Besides, various topics of programming languages and software engineering are represented in this volume. The new feature of the fifth issue is that in this volume we had a pretty good number of papers presented by young scientists from our neighbors – Lithuania and Estonia. The sixth volume again was compiled in connection with ISD conference, where 11 papers of its doctoral consortium held in Lithuania were published in our journal. Statistics in Figure 1 represents only the amount of topics on Applied Computer Systems. The same the third issue is represented only by a number of journal's submissions not the papers from ISD conference.

In the seventh volume the traditions of previous years to give an opportunity for young scientists to publish their research results are continued. For about eighty percent of the authors or co-authors are the young scientists. In this issue the traditional research fields of Institute of Applied Computer Systems are covered: development and testing of software, database technologies, applications of intelligent systems in learning, computer-based education systems, and others. The paper which described results of the research of study programme improvement marks a new trend to widen traditional topics covered in the volume.

In the eighth issue additionally to traditional research fields relatively large amount of papers was devoted to analysis of situation in Latvia in such fields as knowledge management, professional education and improvement of study programmes.

The characteristic feature of the ninth issue is the fact that the set of traditional research topics is extended by new ones among which optimization, navigation of autonomous systems, software product quality, studies of foresight methods and multifractal system properties' analysis, as well as investigation and implementation of different transformation methods should be emphasized. In total, the topics of this volume reflect the actual research fields of Institute of Applied Computer Systems supplemented with works of researchers of Agriculture University of Latvia. This issue is characterized also by record amount of the submitted papers, which can be explained by a great number of scientific projects being active at the institute at that time period. But also the amount of the rejected papers after the evaluation was very large and the number of published papers is not so expressive to keep the achieved level of quality of the journal. It is worth to point out that for the first time all papers are published in English providing the full citation in international databases of scientific publications, such as CSA (Cambridge Scientific Articles) and EBSCO Publishing.

In 2009 editorial board of the journal was welcoming all our readers with tenth anniversary of this issue and expressed our gratitude to all who with their enthusiasm, ideas and hard work have promoted its qualitative and quantitative development. The characteristic feature of the tenth issue was that among different research directions represented in this issue two already traditional topics predominated, namely, the development of multiagent systems for tutoring and knowledge assessment and model driven architecture. A half of all publications in this issue were devoted to abovementioned topics which, in fact, started to become central in research activities of Institute of Applied Computer Systems. Besides, papers on integrated approach for effective organization's management, identification of requirements for changes in information systems, information security governance, graph visualization, and regression model building also are included. Survey papers gave insight into classification of MDA tools, software reuse, and test-driven aspect-oriented development.

Readers of the eleventh volume "Applied Computer Systems" in Computer Science series of Scientific Proceedings of Riga Technical University can notice that papers have a new format while the issue itself has changed into the Scientific Journal of Riga Technical University. Quality of papers were stimulated by precisely defined procedure in accordance with which papers are accepted for publication only after presentation at the annual international scientific conference of RTU, international reviewing and elimination of drawbacks and shortcomings. The twelfth issue of "Applied Computer Systems" in Computer Science series of Scientific Journals of Riga Technical University continued the tendency of improving the quality of the journal because the editorial board constantly was working out more and more precise procedures for acceptance of submitted papers. All submitted papers are carefully evaluated. The first precondition for submission of the paper is its presentation at the annual international scientific conference of RTU. After that the paper is reviewed by two reviewers, one of which is the member of the editorial board or the invited reviewer who is not employed by the Institute of Applied Computer Systems. The final decision on acceptance of the paper is made only after all shortcomings and drawbacks which reviewers have pointed out are eliminated by authors.

The thirteenth volume of the scientific journal of the Applied Computer Systems published in 2012 closes the twelve year cycle mentioned at the beginning of the digest. Publishing of the issue is connected with two factors. First, in the future the volume will be published under a new title – Applied Computer Systems keeping the enumeration of the issues starting from the first published in 2000 and continuing with the 14th to be published in 2013 to ensure the indexing of the journal in several scientific data bases in addition to mentioned above. Second, the conference held in 2011, also marked the first time that at the plenary session of the scientific conference of the Faculty of Computer Science and Information Technology, in honor of the 50-year anniversary of the faculty, six professors, founders of their own scientific schools, presented history and results of their research. Thus, the tradition established in 2001 continues and gives us the hope for moving forward in formation of our journal. Papers included in the 13th issue expand the traditional spectrum of research because the first three publications are devoted to a new topic – development of multi-robot technology. There are also several papers, which represent new results in traditional research directions of the Institute of Applied Computer Systems, namely, development of concept map based intelligent tutoring systems, as well as modeling and transformation procedures in the framework of model-driven architecture. Besides, readers will find also papers dedicated to specific problems in computer science and information technology. So far, in recent years the portfolio of the editorial board contains almost two times more submitted papers then are published after serious reviewing and evaluation (at an average twenty papers are published annually). The editorial board has put in efforts improving the procedure of paper submission and the evaluation form. The obligatory requirement is that one of the reviewers must be the scientist working in foreign countries. All submitted papers are written in English. Thus, not only the readership of our scientific publications is noticeably wider, but also included in two scientific databases mentioned above.

We would like to thank all nine professors – Jānis Bārzdiņš, Jānis Bubenko, Albertas Čaplinskas, Jānis Grundspeņķis (editor in chief from 2002), Hele-Mai Haav, Audris Kalniņš, Leonīds Novickis, Oksana Ņikiforova and Jānis Osis, who were with the issue from the very beginning, gained experience, bore the brunt tailoring the first five and following issues, and still are the core of the editorial board. We also would like to thank professors H. Linger, W. Wojtkowski, M. Buiķis, A. Lupeikiene, Z. Markovičs, W. Bodrow, D. Dzemjdiene, Z. Huzar, R. Kuusik, A. G. Nilsson, K. Wang, B. Wangler, O. Vasilecas, G. Arnicāns and K. Freivalds, who kindly agree to join our editorial board, as well as the reviewers invited specifically for several issues M. Gills, A. Kajackas, D. Kumlander, N. Goranin, E. Celms, J. Tepandi, who carefully and in essence have evaluated each of the submitted papers. The editor Vita Graudiņa joined the editorial board starting from the sixth issue or a year later and currently continues her contribution in making the issue. And, of course, the great thank is to all 147 authors, who have been published in the journal since 2000. With efforts of above mentioned colleagues and thanking to authors' contributions the scientific journal „Applied Computer Systems" has grown into serious and widespread information "Dragon" which has its regular readers among the faculty, students, and representatives of industry.

Integrated robot localization approach for indoor robotic systems

Agris Nikitenko, Aleksis Liekna, Martins Ekmanis and Guntis Kulikovskis (*Riga Technical University, Faculty of Computer Science and Information Technology, Institute of Applied Computer Systems)*

***Keywords* – robotics, multi robot systems, robot localization**

I. Introduction

This paper proposes an approach for indoor robot localization using artificial landmarks. The proposed approach is based on the combination of visual landmark tracking, dead reckoning sensors data and inertial sensors data fusion into single pose estimation.

II. Proposed approach

Our approach is based on assumption that indoor environment is available for landmark use which in turn means that it is possible to install specially designed landmarks for robot positioning in global coordinates, thereby in comparison with landmarks that can provide pose and position data only in local coordinates frame decreasing positioning complexity and increasing pose estimation accuracy. We propose to use unique rotation variant landmarks – glyphs (see Fig. 1) installed on ceiling at known positions thereby providing useful information about position and pose of the robot when appropriate landmark is noticed and recognized.

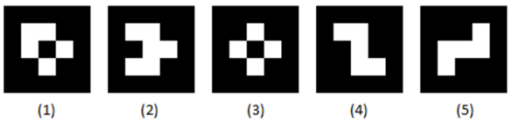

Fig 1. Landmark examples: (1) and (2) rotation variants while (3) – (5) are rotation invariants [1].

As depicted in Fig 2 (1), while one or more landmarks are in a sight of the robot's camera, it is possible to use information about the recognized landmarks in order to estimate system's pose and position in global coordinates with reasonably high accuracy. However there might be situations when none of the landmarks are in sight recognized for some period of time like depicted in Fig. 2 (2).

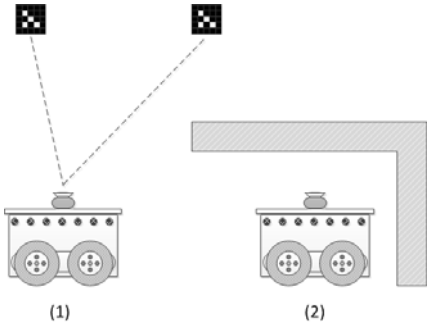

Fig. 2 Robot's and landmarks possible positions.

In such situations one or more additional sensors might be used to provide position and pose data, for instance, magnetic compass, wheel encoders, accelerometers and others. Whatever sensors used, due to their limited accuracy and local nature they produce time integral error, which has to be controlled while global position data is not available – landmarks are not in sight. The problem is addressed by fusing all incoming data into a single pose and position estimation taking into account time constraints of different data refresh rates from different sensors used. Pose and position estimation is accomplished by three major steps: 1) Sensor data forecast to estimate their true values all at the same timestamp, 2) Data fusion using multidimensional Gauss product and 3) Applying Kalman filter for final estimation and error propagation. Schematically it is depicted in Fig 3 [2,3].

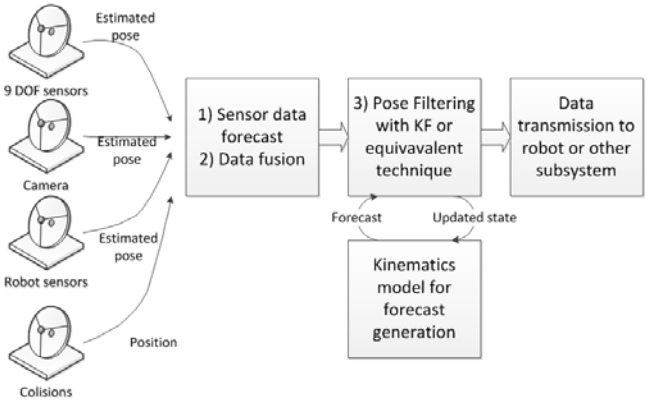

Fig 3. Pose and position estimation schema

III. Evaluation of the proposed approach

We have developed an experimental real time multi robot system that employs .NET infrastructure for communication among different subsystems in a service-oriented manner. All the data regarding landmarks, their position, size and dimensions are stored in central database that is used by every robot in order to provide landmark recognition functionality. The visual data processing is achieved via integrating Grafts library [1] – an open source .NET library for real time applications.

Our experimental prototype system provides data fusion functionality assuming that at least one landmark always is in range of sight in order to test the proposed position and pose estimation concept. It clearly shows that the whole solution is already fully applicable in fields where robot's environment is available for use of artificial landmarks like warehouses, greenhouses, etc. Our experiments indicate that the positions estimation error does not exceed 2cm under different operation modes. This is far enough for indoor use in most applications.

IV. References

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Software Architecture for Mobile Robot Indoor Localization Using Artificial Landmarks

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***Keywords* – artificial landmarks, indoor robot localization**

I. Introduction

In this paper we propose software architecture for Robot localization that is the central problem that must be addressed always when a mobile robotic platform is under consideration. Our approach is based on specially designed landmarks for robot positioning in global coordinates, thereby decreasing positioning complexity and increasing pose estimation accuracy.

The proposed architecture enables robots and human-operators to interact with particular landmark data in a straight-forward way providing means for effective and precise indoor robot localization.

II. Proposed architecture

Our localization concept is based on assumption that the robot's environment is available for installation of artificial landmarks, which, when used in appropriate manner. We propose to use unique rotation variant landmarks – glyphs (see Fig. 1) installed on ceiling.

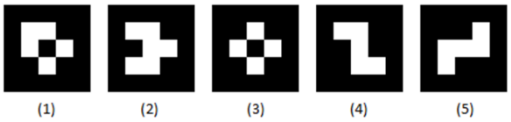

Fig 1. Landmark examples: (1) and (2) rotation variants while (3) – (5) are rotation invariants [1].

This approach requires properly designed software that uses, stores and processes landmark data in effective way providing means for accurate real-time localization. The proposed architecture consists of two software parts – the robot part and the server part.

The server part consists of a database that holds all possible glyphs and glyph setups. All possible glyphs are automatically generated according to specially designed algorithm (see full paper for details). Glyph generation procedure is executed only once in system lifetime. Users are then able to choose glyphs they want to attach to specific setup and specify the coordinates of each glyph in the context of that setup. Glyph setup can be viewed as robot environment – different setup means different environment and at any given time robot operates only in one environment. If the environment changes, the only thing to do is to switch current active glyph setup and robot is good to go.

When robot observes a glyph using its camera, it looks up database for the corresponding record that contains coordinates for that glyph in the context of the current setup. Moreover, the localization only depends on current observations, which means that localization error is not aggregated in time. If robot can observe more than one glyph at a time, we use Gauss product to estimate the current pose and position [2,3].

In order not to enforce permanent connection to server database, robot holds a local copy of a server database that needs to be refreshed only when glyph setups (environments) are modified. If the environment is static, the robot needs an active connection to the server database only once in a lifetime.

III. Implemented prototype

Prototype setup is as follows. Glyphs are attached to ceiling and the camera attached to robot is pointed upwards. In order to provide necessary computing power, a laptop is installed on top of robot. IRobot Roomba is used as the robot platform. The entire architecture is implemented in Microsoft .NET using C# as the programming language. Server side consists of Microsoft SQL Server database and a GUI application for glyph generation and glyph setup modification. Microsoft Sync Framework is used to provide synchronization with server database. On robot side local database cache is used in conjunction with SQL Server Compact database. This allows for automatic synchronization without the need to manually implement complex synchronization scripts.

IV. Results and discussion

Experiments conducted within the prototype show a maximum of 2.5 cm error in robot position estimation and about 1 degree in robot heading estimation. The source of this error is mainly the imprecision included in glyph installation that is done manually by hand.

The proposed architecture is flexible in the sense of changing environments. Adding new or reconfiguring an existing environment involves only a change that user must input using graphical user interface provided and a synchronization operation that must be performed, for the robot to acquire the changes. No manual operation (such as adding fields to database) is required.

Limitations of the architecture are the following. First, while glyphs are installed manually the proposed architecture cannot be used in environments where additional installations are impossible. Second, the glyph recognition software requires proper computing power that cannot be provided by any hardware (i.e. cheap microcontrollers). Third, while not always robot sees at least one glyph at a time instant, additional localization techniques have to be integrated in final solution [2,3].

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[3] A.W.Stroupe, M.C. Martin, T Balch Distributed sensor fusion for object position estimation by multi-robot systems, Proceedings ICRA. 1092 - 1098 vol.2, 2001

Architecture and .NET Implementation of Multi-Robot Management System

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Keywords **– multi-robot systems, multi-robot system architecture, multi-robot management systems, .NET, WCF.**

In this paper we propose architecture for a multi-robot management system and provide analysis of how it can be implemented using out-of-the box features (such as WCF services and linked partial classes) of the .NET framework. We also present an evaluation of the architecture based on comparison with similar solutions. A prototype system is built to verify the presented ideas in practice as well.

Instead of going the traditional path of designing architecture and then trying to figure out possible ways to make implementation as close to the design as possible, the design is created keeping in mind that .NET platform will be used in implementation. We exploit out-of-the-box features provided by .NET framework that allows us to stay focused on functionality of the system while .NET provides the implementation framework out-of-the box.

A number of researchers have already found .NET platform a reasonable choice for robot and multi-robot system development [1], [2]. We go further and propose an architecture that is designed while keeping .NET in mind.

I. Concept of the Proposed Architecture

The proposed architecture consists of several applications and services as depicted in Fig. 1.

Robot Main Application runs onboard robotic system. It is responsible for the low-level control of the robot and serves as individual localization and mapping source. It also hosts Robot Command Service that provides interface to the robot for the rest of the system. Robot Command Service is used by Robot UI application, Server UI Application and Robot Server Application.

Robot Server Application runs at Server and serves as a central point of the management system. It monitors active robots in the system and is responsible for task allocation and scheduling among robots. It also hosts Robot Server Service that provides interface for task assignment and a list of active robots. Robot Server Service is used by Robot Server UI Application.

Any user of the system can run Robot UI Application on his/her PC to connect to individual robot, observe its status and issue individual commands (such as drive and stop). This is used mainly for debugging and observation purposes.

User can run Robot Server UI Application on his/her PC to acquire a complete system overview and issue tasks to the system, as well as send individual commands to active robots. Robot Server UI Application maintains a connection to Robot Server Service for a list of active robots. It can then individually connect to some (or all) of them for sending individual commands (used mainly for debugging purposes). In a typical usage scenario Robot Server UI Application is used for specifying system-wide tasks that are sent to Robot Server, which processes (e.g. decomposes) them and sends to individual robots.

II. Implementation Using .NET Framework

This section describes how individual components of the proposed architecture are implemented using .NET framework features.

Both Robot Command Service and Robot Server Service can be implemented as WCF services. WCF brings some important features into table. First, a WCF service can be hosted in a standard application eliminating the need for special HTTP hosting. Second, it provides binary TCP transport which is considered to be faster than XML HTTP. Third, it supports callbacks, allowing a WCF server to send messages to WCF client without setting up a WCF server at the client side. See full paper for details.

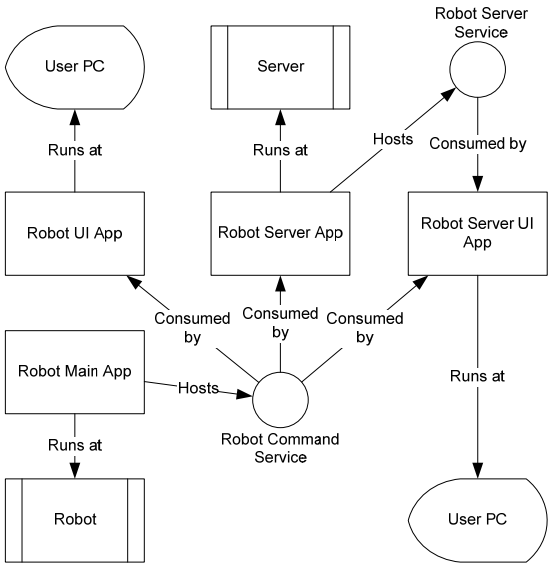

Fig. 1. Proposed architecture.

One of the most useful features of .NET is the possibility to exploit linked partial classes. This allows for a definition of a common data structure library and a specification of that library in several other projects. This way a reuse of a common data structure can be achieved across all the system, providing the necessary means of specification where necessary. See full paper for details.

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Mapping implementation for multi-robot system with glyph localization

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***Keywords* – multi-robot mapping, occupancy grid mapping, glyph localization, map merging.**

I. Introduction

One of the fundamental problems in mobile robotics is the environment mapping problem. Robots need to be able to construct a map of the environment and to use it for the navigation. This paper discusses the multi-robot mapping implementation in the case where glyphs are used for localization and only bumper sensors are available for obstacle detection [1].

To ensure that the robots can determine their precise locations in the room the glyphs are mounted on the ceiling and the robot uses camera to determine its position corresponding to those glyphs. With such a solution both coordinates and the heading of the robots can be acquired whenever glyphs are visible.

II. Mapping implementation

The mapping is implemented by using occupancy grid mapping. The occupancy values of the occupancy grid cells can acquire any value from 0 to 1 (0 corresponds to a 'free' area, 1 refers to 'occupied' area). For example, the closer the cell value is to 1, the larger is the probability that this cell is occupied. Each cell in each sensor reading is updated by using binary Bayes filter.

Usually sensors used for the mapping are ultrasound sensors, cameras or laser sensors. The robots used in this system are equipped with a camera. However, the camera is used only for the glyph recognition purpose and not for obstacle detection. Obstacle detection in this multi-robot mapping system is performed by using simple bumper sensors. The only way to acquire the information about the environment is to continually compute the space that is occupied by robot while moving and to register the collisions with obstacles.

Thanks to the glyph localization, the X and Y coordinates of the robots are always known. Despite this, the building of the map is not as simple as assigning 'free' or 'occupied' values to the cell that corresponds to the according location. As can be seen in Figure 1, the robot simultaneously occupies several cells and all of them must be marked as 'free' in the particular sensor reading. Therefore the size of the robot must be taken into account [2].

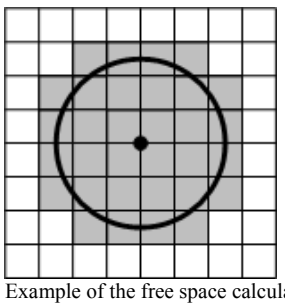

Fig. 1. Example of the free space calculation

If a collision with an obstacle occurs during the mapping, all the cells that correspond to the particular bumper sensor (left, right or both) are marked as 'occupied' in the current sensor reading (see Figure 2). In this case additionally to the location the heading of the robot is also taken into account to compute the cells that border the bumper sensor.

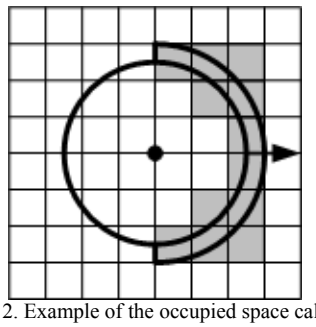

Fig. 2. Example of the occupied space calculation

If several robots explore the environment independently, the resulting local maps should at some time be merged into one common global map for navigation purposes. In multi-robot system with glyph localization the map merging can be easily implemented because the relative positioning of the local maps is easily acquirable. The common global glyph localization system provides all the information necessary for map merging.

At first each robot creates a local map of its own. After some exploring time the server collects the data from robots and creates a common global map and sends it back to the robots. The robots continue the mapping with this global map. The server repeats this process regularly. As the robots have access to their global coordinates, there is nearly no risk that map merging may be incorrect [3].

Future work includes further testing of the mapping implementation. Another important future task is the implementation of path planning by using the acquired global map. Path planning is needed so that the robots would be able to reach their destinations unhindered.

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Use of Learning Methods to Improve Kinematic Models

Kintija Priedniece, Agris Ņikitenko and Aleksis Liekna (*Riga Technical University, Faculty of Computer Science and Information Technology, Institute of Applied Computer Systems*)

Keywords **– mobile platforms, learning kinematics, genetic programming.**

I. Introduction

Kinematic models are commonly used to control motion and predict behavior of a robot. Unfortunately, while fixed based robot kinematic is more or less easy to build, obtaining mobile robot kinematic models are rather challenging. The main reason for that are number of parameters that are known but hard to calculate in particular practical implementations. Good examples of such parameters are: static and dynamic traction factors of a wheel on particular soil, exact position of mass center, etc.

This paper presents a method to improve kinematic model of a differential drive robotic platform using supervised learning to improve accuracy of existing differential drive kinematic model taking into account specifics of a particular implementations.

II. Related work

A number of researchers [1],[2] have used different artificial intelligence methods to improve fixed base manipulator kinematic models but they cannot be used for mobile robots. There are too many factors which affect performance of mobile platform and there isn't direct way to measure the robot's position and it must be integrated over time, so it leads to inaccuracies of the position estimate over time. Our aim is to provide solution how to apply learning in order to extract kinematic model of a particular mobile robot.

III. Proposed Method

If differential drive is looked at, than it can be said that there is some coefficient applied to each wheel (k_r, k_l) which effects motion of platform.

$$v_r = k_r \cdot \omega\left(R + \frac{l}{2}\right) \quad (1)$$

$$v_l = k_l \cdot \omega\left(R - \frac{l}{2}\right) \quad (2)$$

Particular coefficient values represent all possible deviations from ideal like disposition of mass center, reducers of mechanical resistance, etc. If a function which describes wheel velocity is assumed to be found, then it can be said that it is a regression problem. Therefore a good way to go is to apply genetic programming to get symbolic expression, which describes robot wheels velocities and mentioned coefficients. As depicted in Fig.1, the acquired expression can be integrated in control system to improve position estimate or control parameters.

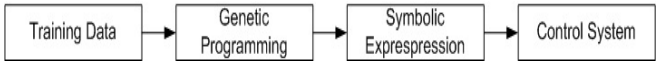

Fig. 1.Proposed method.

IV. Experiments

The experiments have been conducted in indoor environment. The training data contain parameters from which depends the trajectory of the robot: wheels velocities and radius of instantaneous center of rotation (ICR). To get all these parameters it is important to obtain exact trajectory of robot. We used drawing tool attached to midpoint of wheel axis for drawing that the trajectory. In these experiments one wheel velocity was constant. To obtain symbolic expression, which describes relation of parameters, *GPdotNET* application was applied [3].

V. Results and discussion

Fig.2. shows the graph of function obtained from training data using genetic programming. Largest absolute prediction errors are in situations when R→∞, but it does not affect performance of model. These results clearly indicated that there are manufactured differences between both motors used in this platform.

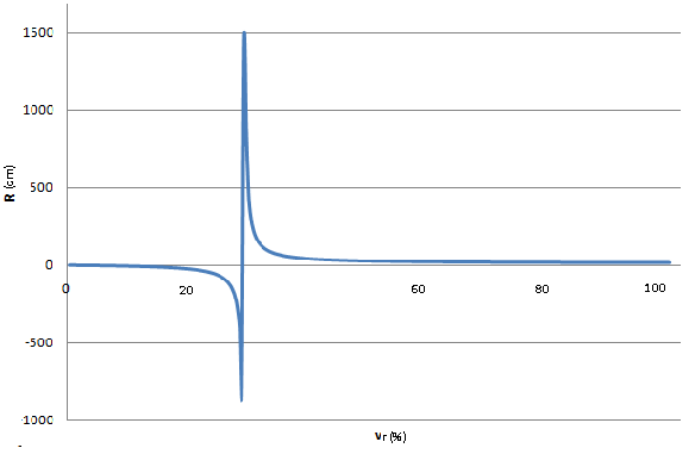

Fig. 2. Graph of obtained function (v_r- *velocity of right wheel in %*).

Kinematic model of mobile platform can be improved using artificial intelligence methods, but there is a need to be clear about environment and particular task specifications, because there are too many factors which effect robot motion. Obtained result would describe features of particular platform.

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Algorithm of Ontology Transformation to Concept Map for Usage in Semantic Web Expert System

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Keywords **– Ontology, Concept Map, Expert Systems, Semantic Web.**

The final goal of the research is to develop Semantic Web Expert System (SWES) [1], which will be capable to use OWL (Web Ontology Language) ontologies from the Web, to extract rules and to supplement its knowledge base in automatic mode. Indeed, it seems possible, because on the one hand there are more than 33000 ontologies encoded in OWL [2], and on the other hand OWL ontology expressions can serve as a material for rule extraction [3].

There are seven different cases when OWL code fragment can be transformed to rules. In the first case when class is not empty (that is concept has not properties) it can serve as a source for rule generation. It is obvious that if class has some unique defining properties, they can be used for this class detection. For instance, if there is "Arrhythmia" class with three properties P1, P2, P3, then it is possible to generate the following rule:

IF P1 **and** P2 **and** P3 **THEN** Arrhythmia (1)

In the second case there are two equivalent classes. For example, there is "Arrhythmia" class and class "A" which is equivalent to class "Arrhythmia". In this case it is possible to generate the rule:

IF A **equivalent** Arrhythmia **THEN** P1, P2, P3 ∈ A (2)

In the case when there is a relation between two classes it is also possible to generate a rule. For example, there are "Son" and "Father" classes and also "hasParent" relation between these two classes. In this case can generate the rule:

IF Son **THEN hasParent** Father, (3)

This rule means that if there is some instance of "Son" which belongs to class "Son" then this instance has relation "hasParent" to class "Father".

The following case is when two concepts are defined and one of them is the part of another one. For example, there is a class "Heart" that is the part of class "Organism". It is possible to generate such rules:

IF Heart **and** "part of" **THEN** Organism, (4)

This rule means that if there is an instance of class "Heart" and the class "Heart" is the part of class "Organism" then this instance belongs to the class "Organism".

The next case when it is possible to generate a rule is the case when there are three classes "Heart", "Organism", "Blood" and classes "Heart" and "Organism" are superclasses of class "Blood", that is, there are "part of" relations between the class "Blood" and classes "Heart", "Organism". Here it is possible to generate the rule:

IF Blood **and** "part of" (Heart **and** Organism)
THEN Heart **and** Organism, (5)

This rule means that if there is an instance of class "Blood" and the class "Blood" has the relations "part of" to classes "Heart" and "Organism" then this instance belongs to classes "Heart" and "Organism", too.

One more case that can provide with rules is when there is a class "Organism" which is of two classes "Heart" and "Blood" union (there are relations "part of" between classes "Heart" and "Organism", and also "Blood" and "Organism". Here can be generated the rule:

IF (Heart **and**/**or** Blood) **and** "part of" Organism
THEN Organism, (6)

This rule means that if an instance belongs to the class "Heart" and/or "Blood" and "Heart", "Blood" classes are parts of "Organism" class then this instance belongs to the class "Organism", too.

When it is defined that one class do not belong to another it can be transformed to a rule. For example, there is class "Heart" and it does not belong to class "Head". It is possible to generate the following rule:

IF Heart **THEN not Head**, (7)

This rule means, that if there is an instance of class "Heart" then it certainly does not belong to class "Head".

The previous paper showed transformation of OWL code fragments to rules in details [3].

The task of OWL code transformation to rules has to be changed to the task of OWL code transformation to concept map and then to rules. This sort of transformation has several advantages. First of all, OWL transformation to concept map enables to have such presentation of rules, which can be coded to different rule formats, as SWRL (Semantic Web Rule Language), Jena rules or others. The second advantage is that presentation of rules in the form of concept map permits to carry out some operations with rules comfortably. For example, among these operations may be different kinds of conflict resolution algorithms.

The main purpose of this paper is to describe the algorithm of OWL transformation to concept map and to evaluate the efficiency of this algorithm using ontologies with different features as ontology size, number of concepts and so on. Java programming language has chosen for implementation of this transformation algorithm as conventional programming language for applications in the Web.

It is planned that future paper will consist of several sections. They are introduction, concept map structure, transformation algorithm, algorithm performance and conclusion.

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Comparison of Ontology Reasoning Systems for Semantic Web Expert System

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***Keywords* – Ontology, Semantic Reasoner, Expert Systems, Semantic Web.**

This paper continues investigation in the area of new expert system, namely Semantic Web Expert System (SWES). SWES is an expert system, which will be capable to use OWL (Web Ontology Languages) ontologies from the Web, to extract rules and to supplement its knowledge base in automatic mode [1].

The main purpose of this paper is to compare available inference engines, according to worked out criteria, for choosing the most appropriate one to implement in SWES. Inference engine is one of the major components of any expert system, which utilizes knowledge base rules for generation of new facts. There are a lot of inference engines for the Semantic Web, and they are usually called as semantic reasoners. Among the most famous semantic reasoners are Bossam, Jena, Pellet, KAON2, Fact and others [2]. All of them have different features: some of semantic reasoners are free, while others are non-free; some of semantic reasoners utilize one reasoning algorithm, while others use another reasoning algorithm; some of semantic reasoners are able to process OWL constructs, while other semantic reasoners are able to process RDF (Resource Description Framework) triples only. All of inference engines are useful, but one of them is better for one task and another inference engine is better for other tasks. Speaking about basic requirements for SWES, it is necessary to mention that in the first place SWES has to be able to process OWL ontologies, because nowadays OWL is the standard for knowledge representation in the Web unlike the RDF or RDFS (RDF Schema) standards, which are less representative. Semantic reasoner for SWES has to support some rule format. It is necessary for SWES to be able to process rules from SWES knowledge base, which are generated, using possibilities described in [3]. The next feature of semantic reasoner for SWES is the possibility of processing two or more OWL ontologies without additional efforts for merging of these OWL ontologies. Certainly, semantic reasoner for SWES has to be rather efficient to be able to process real-world ontologies. Generally, ontologies from real life are large and contain a lot of concepts, relations and individuals, thus semantic reasoner, which works with such ontologies has to use fast and efficient algorithm. There are other features, which are important for SWES and which will be discussed in this paper.

As a result of practical work few semantic reasoners were tested. Among them are Jena, Pellet and others. A lot of different semantic reasoner documentation and publications were studied, too. It has been concluded that Jena features were the most appropriate for implementing in such a system as SWES. Jena is the most powerful tool for work with OWL ontology, and it means that it has a lot of features, which are collected in one tool. The first advantage is that Jena is Java framework, and it means that Jena uses Java programming language, which is very widespread for Web applications. The second Jena advantage is its flexibility. Indeed, Jena provides a programmatic environment for RDF, RDFS, OWL and SPARQL and includes rule-based inference engine (besides the syntax of rules of this rule-based inference engine is compact enough in contrast to other rule format as, for example, SWRL, t.i. Semantic Web Rule Language). Jena allows combining its OWL reasoner and its rule-based inference engine. This gives an opportunity to get more knowledge from OWL ontology in contrast to other inference engines. The third Jena advantage is that Jena supports plenty of forms of engines. They are forward chaining engine, backward chaining engine and hybrid engine. These different chaining mechanisms may be used in accordance with the available data and produce acceptable results, where other reasoners, which have limited capabilities of chaining mechanisms, do not cope with the problem. The next Jena advantage is its storage systems. Among them are TDB, which provides lightweight, scalable, non-transactional storage and SDB, which is a SPARQL database subsystem for Jena [2]. TDB is a component of Jena for RDF storage and query. It supports the full range of Jena APIs. TDB can be used as a high performance RDF store on a single machine [2]. SDB is a component of Jena for RDF storage and query specifically to support SPARQL. This storage is provided by an SQL database and many databases are supported, both Open Source and proprietary [2].

Certainly, Jena has some disadvantages. One of them is lack of some rule format support as SWRL and others. However, this disadvantage is compensated by means of the opportunity of combining Jena with other reasoners, as Pellet. Thus, the disadvantage turns to advantage. One more Jena advantage is its team of creators. It is known, that Jena was developed in HP Labs, and HP company has long development history and good reputation. This directly affected the high quality of Jena framework.

From Jena users point of view we can state that it is well documented and documentation corresponds what is Jena in reality. In addition there are a lot of Jena examples in the Web that on the one hand very facilitates using Jena and on the other hand testifies to the popularity of Jena and means prospects for the future. This is a key moment for any framework in the area of programming.

So, it is concluded that nowadays Jena is the best semantic reasoner for implementation in Semantic Web Expert System.

It is planned that this paper will have several sections. They are introduction, related works, semantic reasoning, semantic reasoners, analysis of semantic reasoners, conclusion.

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The Role of Feedback in Intellectual Tutoring System

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***Keywords* – Intelligent tutoring systems, interactive learning environments, adaptive learning, feedback, agent.**

I. Introduction

Improvement of IT technologies, expansion of internet and popularization of web technologies have enabled technology enhanced learning introduction in adoption of general matters and acquaintance of specialized problems. Thus researches on adoption of learning contents into e-environment have become more necessary as a result of such development. Besides technology enhanced learning lets one to pick the place and time where and when to study, which is great advantage compared to traditional full-time education.

Identical educational tools and learning methods may not be effective or is less effective for all students. It is possible to make the learning materials more flexible, modify educational approach according to competence and temper of the student and learning tasks, using Intelligent Tutoring Systems (ITS). Technology enchanted learning is learning where self-motivation, communication, efficiency and technologies are used. ITS is system and technologies where adaptive learning technologies are used, which help individualize and personalize learning process according to individual character and needs, analyze knowledge of the theme, student's mood and emotions, as well as learning style, typically ITS is constructed as multi-agent systems [1]. Adaptive learning may be defined as ''the process of generating a unique learning experience for each learner based on the learner's personality, interests and performance in order to achieve goals such as learner academic improvement, learner satisfaction, effective learning process and so forth".

II. Learning process, adaptability and feedback

Learning, methods and student's reaction to learning is not easily definable and describable. Learning methods and successful learning results may not be defined as particular thing, order of matters, sequence of events and thus guarantee successful outcome (student is trained and knows everything that he/she needs). That is the reason why adjustment of learning content to the student's competence is considered to be an open system problem, where adaptation capacity of the student, collaboration with learning environment as well as preferable result of system action plays great importance (it is even hard to define the necessary outcomes, as it is not possible fully evaluate persons' gained knowledge and its system). In the same way it is hard to define where system's effect on person comes to an end.

In natural environment teacher may pick up each student's individual abilities, character, reaction to learnable material and depending on these parameters, form more or less individualized task set for each individual. It is necessary to integrate analyze mechanisms and reactions to imitate or overcome natural environment achievements.

In the development of learning systems it is necessary to take into account both persons' needs and requirements, as well as resources of information technologies. It is also necessary to evaluate the use of didactic materials – cover learning theory matters, develop training content plan, training methods and organizational forms, all these operations would be arranged and subordinated according to their possible formalization forms for depicting and use in ITS. It is required to include student's reaction to the learning material and analyze the chances of learning outcome stimulation. Adaptability of the ITS can be realized as multi forms of learning materials, feedback of learning process and/or assessment.

III. Forms of feedback

Feedback is considered as a key aspect of learning and instruction. Effective feedback aims to:

1. Assist learners in identifying their false beliefs, becoming aware of their misconceptions and inadequacies, and reconstructing their knowledge.
2. Help learners to determine performance expectations, identify what they have already learned and what they are able to do, and judge their personal learning progress.
3. Support learners towards the achievement of the underlying learning goals.

Feedback should be aligned, as much as possible, to the learner's individuality, special needs, self-evaluation, self-explanation, self-regulation, etc. For assessment of the different forms of feedback ITS with computer based concept mapping have been analyzed. The feedback in such systems is provided about the quantitative score for learner's map accompanied of how the score is obtained.

Feedback in the ITS is realized as informative (text-based form or graphical-based form), tutoring (text-based form or dialog-based form) and student's feedback (dialog-based form).

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Requirements for knowledge search system

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***Keywords* – search for knowledge, e-learning, knowledge search system, system requirements.**

The use of the internet as an information source is becoming increasingly popular nowadays; consequently, the amount of information stored there also grows. So to find really valuable information a user needs to make a major effort, because search engines return only a list of links to websites where potentially the needed information is placed. The information search problem caused the appearance of so called systems for knowledge search that return specific information instead of list of links.

There are three types of systems for knowledge search: knowledge search engines, question answering systems (QA systems) and combined systems that join the features of two previous systems. The analysis of existing systems for knowledge search in the internet has shown their advantages and disadvantages, as well the fields of application were defined [1].

The most promising field of application is education. Modern learning standards includes list of key learning competencies including information competency. Information competency is the ability to recognize the need for information, acquire, evaluate, organize, maintain and interpret it. Thus, one of the main tasks of modern learning process is to teach an individual to work with information solely. The work with information also includes the search for it. But in the current case the concept *information* is referred to the information for creating knowledge, in other words, specific and precise-formulated information. So the systems for knowledge search can be used in learning process to acquire missing knowledge, to search for information for original works like graduate works, thesis, etc.

Unfortunately, the existing systems for knowledge search have many considerable disadvantages that do not allow using these systems in learning process, for example, the returned information often is not confirmed by reliable facts, the systems often do not understand or misunderstand user's queries, etc. That's why the application of systems for knowledge search in learning process is impossible without prior adapting them for educational purposes.

So this paper examines the requirements for knowledge search system that is being developed for use in learning process. The main objectives that were taken into consideration when defining the requirements are:

- the development of combined type system, because it is more universal than knowledge search engine or QA system;
- supported query types: keywords, questions, phrases with logical connectives;
- strict requirements for system answers to avoid the possibility of creating wrong knowledge based on the returned information;
- the opportunities for moving from current topic to more detailed description or to related topics.

In summary, these requirements determine general knowledge search systems requests, as well as the specific educational needs [2,3].

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Migration of databases to Google Cloud SQL

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***Keywords* – MySQL, Google cloud SQL, database migration.**

Cloud computing is a good way to raise productivity of offered service without investments into new infrastructure, training of the personnel or software acquisition. This technology expands potential possibilities of existing information systems. In recent years cloud computing grew from good business concept to one of the most demanded industry in information technologies. There is a review of functionality of a new platform of the cloudy Google Cloud SQL database on the basis of version 5.5 MySQL DBMS. Technical nuances, potential problems and risks connected with migration of the existing MySQL databases on a new platform are reviewed.

Cloud computing is a dynamic method of increase in productivity of service or possibilities, without investments in new infrastructure, training of the personnel or software licensing. This expands possibilities of existing information systems. In recent years cloud computing grew from good concept business to one of the most quickly developing industries of information technologies.

At the end of 2011 the Google Company announced a new service – Google Cloud SQL. The web service allows creating, forming and using relational databases which physically take place in the "cloudy" Google environment. Service provides complete service of databases of service's users, freeing them from additional expenses of time and resources. Today (May 2012) this service is limited (it is necessary to request specially access to this service, filling the corresponding electronic form) and in a preliminary test mode.

Google Cloud SQL cloud is a web service which allows creating, forming and using relational databases with App Engine applications. This is completely self-managed service which supports and manages databases, allowing developers to concentrate on implementation of applications and necessary services. Offering functionality of the MySQL database, service allows moving easily the data, applications and services to the cloud and out of it. It allows increasing mobility of data and provides faster exit to the market because there is a possibility to quickly scale an existing database.

To guarantee service availability for critical applications and services, Google Cloud SQL cloud replicates data in different geographical areas for ensuring high availability of data.

Main features of the Google Cloud SQL service are:

1. Ease of use – a rich graphical user interface allows for creating, configuring, managing, and monitoring your database instances;
2. Fully managed – no worrying about tasks such as replication, patch management, or other database management chores. All these tasks are taken care of for you;
3. Highly available – To meet the critical availability needs of today's applications and services, features like replication across multiple geographic regions are built in, so the service is available even if a data center becomes unavailable;
4. Integrated with Google App Engine and other Google services – tight integration with Google App Engine and other Google services enable you to work across multiple products easily, get more value from your data, move your data into and out of the cloud, and get better performance.

The Google Cloud SQL represents MySQL DBMS placed in a cloud. Service provides all the same functions which are offered by this DBMS, but with several limitations. Main restrictions of cloud service are following:

1. The size of a separate instance of a database is limited by 10 gigabytes;
2. User defined functions are not supported (UDF);
3. Replication functionality is not available for configuring and setting up;
4. Plugin support is disabled;
5. File based functions are blocked (such as DATA INFILE, LOAD_FILE etc.).

Migrations issues will be described in this chapter later.

With growth of number of users and companies which store the data in "clouds", more frequently the questions about safety come up. Despite all activity around cloud computing, business sector clients still don't wish to place their systems in cloud environments. Safety – the main reason which detains rapid development of the market of cloud computing. Also questions of a privacy of data and problem of its protection continue to influence the market of cloud computing.

Different technological risks will be described in this chapter later.

Unlike stand-alone MySQL DBMS, in Google Cloud SQL there is no possibility to connect to the database directly from any computer. Connection is carried out or by means of the web browser, or using the special Command Line Tool program tool.

In addition it is possible to use the SQuirrel SQL application, which actually uses the aforementioned program tool to execute commands on Google Cloud SQL.

In order to connect to the Google Cloud SQL database from a certain computer, it is necessary to generate an access key in settings of the service account and later submit it to the program tool on first use – this mechanism allows the recipient of service to supervise access to instances of databases.

Improvement of the Two-Hemisphere Model-Driven Approach for Generation of the UML Class Diagram

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***Keywords* – two-hemisphere model, UML class diagram, model transformation, binary route matrix, BrainTool.**

Two-hemisphere model-driven approach [1] proposes to generate UML class diagram from the so-called two-hemisphere model of the problem domain, which presents information about processes, information flows between these processes and pre-defined types of these information flows. The meaning of objects in an object-oriented philosophy gives a possibility to share responsibilities between objects based on the direct graph transformation, where the data flow outgoing from the internal process in the process model becomes the owner of this process for performing it as an operation in object communication (see on Figure).

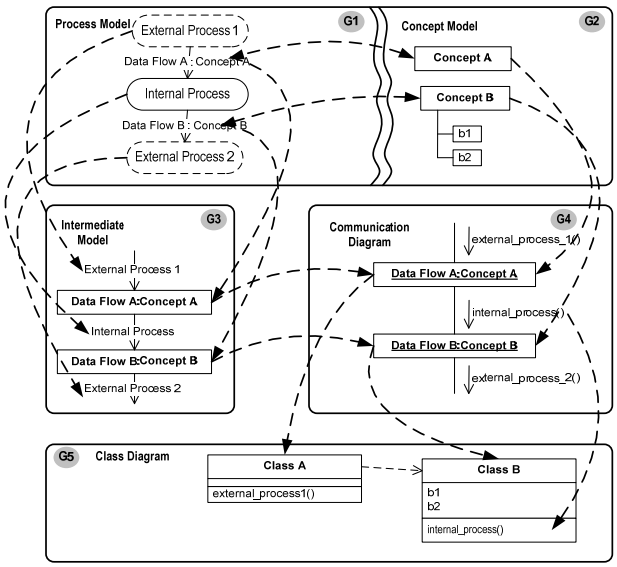

Fig. 2. Two-hemisphere model transformation into class model

Analysis of different situations which may appear drawing the process model, i.e. a number of incoming and outgoing data flows, variety of their types etc., has given a possibility to define various transformation cases depending on number of process input and output and their cardinality (a set of differently typed data flows incoming or outgoing from the process). At the moment transformations are defined only for cases, where either data flows (both incoming and outgoing) are defined of the same type, or the process has single outgoing data flow or multiple outputs are of the same type. In the case, when direct transformation is not possible, interface class for implementation of problematic process is created or developer of the two-hemisphere model has to create the sub-process diagram for the problematic process, let for any process would be defined only one outgoing information flow.

Successful application of two-hemisphere model transformation into the UML class diagram served as a motivation to support these transformations by software system. The first software prototype of tool supporting two-hemisphere model based transformation was introduced in 2008. The prototype used textual information in special format as a source and produced a text file containing description of the resulting UML class diagram as a specification, where classes, attributes, methods and relationships were listed in pre-defined textual format. Currently, the continuing research in the area of model-driven software development and an increasing demand in the industry for automation of the ability to bridge the gap between problem domain and software components, served as a motivation to develop the two-hemisphere model driven approach supporting tool – BrainTool [2], [3], which gives an ability to draw the two-hemisphere model in the manner suitable for the problem domain expert and to generate the UML class diagram from it.

Automatic abilities provided by BrainTool gave a basis to observe different UML class diagrams generated from two-hemisphere models defined for different problem domains. These experiments identified several eliminations of the initial set of transformations under the two-hemisphere model-driven approach, which enables to apply the transformations for multiple outgoing flows of processes. For the improvement of the current version of the two-hemisphere model-driven approach, authors have selected these problematic situations for deeper analysis and are trying to define at least semi-automatic support for the redrawing the problematic process. The result of this improvement is presented in the paper.

In order to get rid of problematic processes which have multiple outputs of different data types authors offer to add creation and analysis of transition matrix for two-hemisphere model. To create the transition matrix after initial creation of business process diagram, concept diagram and concept assignment to data flows modeler should be asked to perform primal validation of developed model. This can be done by asking series of questions if some concept is required to perform exact process and to get on output the defined concept. This allows generating methods with the same names for different classes even with different arguments sets. Based on the matrix of the required transitions the binary route matrix can be created in order to validate two-hemisphere model according to authors' defined constraints and to refine the set of the elements generated for the UML class diagram.

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UML Sequence Diagram: Transformation from the Two-Hemisphere Model and Layout

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***Keywords* – UML sequence diagram, two-hemisphere model, model transformation, layout, BrainTool.**

Model Driven Software Development (MDSD) built on principles of abstraction, modeling, reuse, and patterns, to provide software developers with an approach to identify and classify all of the system development activities and offer the usage of models and model transformations as a foundation for system development within every group of activities. Computation Independent Model (CIM) describes the system for its requirements analysis. System analysis results in platform independent model (PIM), which is then refined and transformed into platform specific model (PSM) to support the design activities in terms of software components. Then PSM is used to define code components and system implementation.

The primary benefit of MDSD is to give a big-picture view of the architecture of the entire enterprise. In order to use the MDSD approach, the developer should have a common modeling system. Nowadays, OMG's standard—Unified Modeling Language (UML) is widely used to represent system specification at different levels of system abstraction. UML defines a notation for a set of diagrams used for modeling of different aspects of the system (i.e., static and dynamic ones). A central part of static modeling in UML is class diagram, which defines a general structure of the system and serve as a basis for the development of software architecture. Class diagrams are investigated quite well in different researches. According to modeling of system's dynamic, exactly problems of its definition are one of the reasons why software development still doesn't succeed in the model-driven way.

The central part of modeling of system's dynamic is the construction of object interaction, where UML sequence diagram plays an important role and is used to present system's behavior. UML sequence diagrams allow describing interactions between system objects and actors of its environment. Sequence diagram describes sequences of communications that may occur in the course of a run of the system and traces the messages that are exchanged during this run. Sequence diagram is a popular notation to specify scenarios of the processing of operations as its clear graphical layout gives an immediate intuitive understanding of the system's behavior. UML sequence diagram is stated as one of the ambiguous UML diagrams, with an implicit and informal semantic that designers can give to basic sequence diagram as a result of this conflict.

UML sequence diagram shows objects, their lifelines, and messages to be sent by objects-senders and performed by object-receivers. Sequence diagram is used to present the dynamic aspect of the system, which in object-oriented approach is expressed in terms of message transfer among objects. The dynamic of interactions is defined by an ordering of the message sending and receiving actions. It serves as a basis for the definition of operations performed by objects to be grouped into classes, as well as to present and to verify the dynamic aspect of class state transition.

The problem, which is widely researched in the area of modeling of object interaction, is formal transitions among models presented at different levels of system abstraction. The transition from problem domain into system implementation expressed in terms of objects is required in object-oriented software development using principles of model-driven software development. Nikiforova in [1] has proposed how classes and its object's operations can be defined based on so called two-hemisphere model and how it can potentially be used also for definition of the UML sequence diagram. The presented paper is the continuation of that research, where authors are trying to perform deeper analysis of abilities given by two-hemisphere model for definition of the UML sequence diagram [2] and turn the attention also to the problem of automatic sequence diagram layout [3] after its derivation from the two-hemisphere model. Because it is very important that the models and diagrams are well built not only considering their content, but also how they visually represent information, how they are layouted. Important factor that can affect work productivity in visual representation of information is readable diagram layout. The importance of diagram layout shows also fact, that the criteria for "good" UML and other diagrams are widely discussed in literature. Layouting diagrams manually is time consuming and, in case of large diagrams, it can be ineffective, therefore this paper is also about automatic UML sequence diagram layout, its problems and solutions. Authors discuss general diagram layouting criteria and criteria specially adapted for sequence diagrams. Also authors discuss about existing algorithmic layouting approaches and compare them. As all existing algorithmic approaches are not very suitable for the specific character of sequence diagram, author proposes new algorithm taking into account existing methods. In the result, definition of two-hemisphere model received from its supporting BrainTool is used to apply authors' defined transformations for generation of the UML sequence diagram. Then the information of element placement and according coordinates are added to the definition of the received sequence diagram, thus creating the complete XML file describing complete sequence diagram received directly from two-hemisphere model specification. The visual representation of the received diagram is evaluated by importing the XML file into Sparx Enterprise Architect. In future the algorithm can be implemented into BrainTool itself or in any UML compatible tools.

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Code Generation from UML Model: State of the Art and Practical Implications

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***Keywords* – UML, model transformation, code generation, template, frame.**

Despite high levels of IT technology and IT fields, as such, the development problems that have traditionally attributed to the development of software is still not completely solved. Of course, development time and costs may always want to be decreased, but it must be understood that there is still much time that is devoted to routine work. Therefore, reusability is still an important theme, because technology is changing much faster than business processes of the problem domain. The first reason, why this problem is not yet solved, is the technological diversity, which in turn has an effect, that every system is over and over again overwritten in a case of the change in the technological architecture. Secondly, even if the problem domain is described using "traditional" CASE tools, it does not solve the problem, because created models are nothing more than documentation, so that they are not automatable to be transformed in executable program code.

Even more, further requirements are implemented directly in the code bypassing the system documentation and thus it does no longer meets the actual functionality. Thus, the fundamental problem of software development is a "semantic gap" between models and programming language, which permits the transformation of the problem domain description into the executable code.

Human brain perceives graphical information much better then textual one that's why it is useful to display a system as a model during its creation phase. To accomplish this, the Unified Modeling Language (UML) [1] which is used to model object-oriented systems was developed. UML was created not only as a system specification tool, but is positioned also as a tool, which will allow automatically generate code from UML models. With such a position Object Management Group proclaimed its new invention, Model Driven Architecture (MDA), in the end of 2001. Just that it will be possible to generate a software system from the thoroughly developed model of the problem domain. Since then, it is now already 10 years, and 15 years since UML was standardized. At that time, a lot of different CASE tools have been developed, which are advertised as more or less able to generate the program code from system model. These are both open source tools and environment, and commercial products. Nowadays MDA tools proclaim that they support translation of solution elements into software components, e.g. transformation form platform independent model to platform specific one, and code generation. While still not yet heard about a software system that could actually be designed based only on the principles of MDA.

Moreover, authors' previous research on code generation abilities in advanced modeling tools gave disappointing results [2]. The experimental model was created to check tolls' abilities to generate expecting program code from them. The experimental models contain more than 60 tests. The transformation results (generated construction) were classified into compilation errors, execution errors, information losses, missing notations etc. The authors have been making experiments for the following programming structures/UML notation: access modifiers (private, protected, internal); class modifiers (abstract, sealed, static); method modifiers (static, new, override, abstract); method parameter modifiers (params, ref, out); accessor methods; multiplicity; default values; read-only and derived values; constructors; destructors; stereotypes: constant, event, property; active class; constraints: ordered, unique, redefines; naming conventions and keyword usage; namespace scope; tag-values: precondition, postcondition, etc.

In many tests the investigated tools (Sparx Enterprise Architect, Visual Paradigm and Microsoft Visual Studion 2010) show different results. And it is not like one tool always demonstrates better result than other. There are tests, where it shows correct result, but other fails and vice versa. The analysis of the transformation result shows that the quality of the generated source code is very low (in our experiments). 14% (in Sparx Enterprise Architect), 18% (in Visual Paradigm) and 18% (in Visual Studio) of the tests are correct. Taking into account, that these tests didn`t include all possible elements of the UML class diagram, like, various relationship elements, the obtained results can be still considered as one of the main reasons why the class diagrams and code generation from models are not widely applied in the IT industry.

Therefore, authors state code generation as an object to research and try to investigate, why despite modeling standards describe efficient model creation techniques; they provide no clues of how to automatically transform a model of a complex system into a source code.

The goal of the paper is to research the main principles and approaches of the model to code transformations. The paper describes model-driven software development principles and code generation related standards which were created by object management group organization. The importance of code generation was substantiated. As this process is important, the related techniques, methods and approaches were studied more deeply, in addition the code generators taxonomy was created. It was then used to classify modeling tools built in code generators. The paper also shows the qualitative comparison of the tools using some comparison criteria. Finally, the description of the tool made by one of the papers' authors under the development of his bachelor thesis [3] is presented. Program realizes a combination of template-based and frame-based code generation approaches.

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Ensuring Domain Conformity by a means of the Topological Functioning Model

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***Keywords* – domain modeling, topological functioning model, traceability.**

I. Introduction

Ensuring conformity between system and software specifications and code is still a challenge in software development. The usual case is a not up-to-date specification for an end product.

In order to prevent this problem, Model-Driven Engineering (MDE) suggests using a specification as a source and a base for producing code. One of main MDE approaches is Model Driven Architecture (MDA) developed by the Object Management Group in 2001. MDA suggests using three models for system and software specifications, namely, a Computation Independent Model (CIM), a Platform Independent Model (PIM), and a Platform Specific Model (PSM). PIMs and PSMs are dedicated for specification of solutions, i.e., software. The CIM describes system requirements and the way the system works within its environment. Details of the application structure and realization are assumed to be hidden or as yet undetermined. The CIM is sometimes called a domain model and a domain vocabulary. However, domains that can be reflected by CIMs are not clearly stated in the specification of [1]. Later investigations showed that the CIM specifies both the problem domain and the solution domain. The problem domain, a system, is reflected in knowledge models and business models. The solution domain, software, is reflected in business models, too, and business requirements for the system. Software business models must be in conformity to system business models.

The following chain of domain conformity must be ensured: 1) from code to PSM to PIM: Business entities and execution logic in *code* and *data storage* must conform to business entities and execution logic in *software design models*, which in their turn must conform to business entities and business logic in a *software requirements specification*; 2) from PIM to CIM "to-be" to CIM "as-is": *The software requirements specification* must conform to *Business Requirements for the System* (the system "to-be"). *Business Requirements for the System* must conforms to *system "to-be" business models*, which in their turn must conform to *system "as-is" business models*. *System "as-is" business models* must conform to *Knowledge Models* about the System "as-is". Tracing this conformity links would facilitate change implementation during iterative software development and maintenance. Besides that, MDE transformations in accordance with this conformity chain would ensure that all specifications are up-to-date with code, and code origins are clear and traceable.

MDE transformations require formally defined specifications and mappings between them. The main challenge is formalism of CIMs, because these models deal with informal knowledge sources. This paper discusses application of a Topological Functioning Model (TFM) as a formal CIM of both systems "as-is" and "to-be" and tracing of conformity from this CIM to PIM to PSM to code.

The paper is organized as follows. Section II describes a TFM and continuous mapping in brief. Section III illustrates a mechanism for ensuring domain conformity and storage of tracing data during transformations. Section IV illustrates this mechanism by an example. Conclusions discuss the obtained results and directions of future research.

II. The Topological Functioning Model in Brief

A Topological Functioning Model (TFM) is developed at Riga Technical University by Janis Osis in 1969. It is a mathematically formal model that describes a topology among systems functional properties from the computation independent viewpoint. It is independent of any modeling and implementation technique. It comes about through the acquisition of the experts' knowledge about the complex system, verbal description, and other documents concerning the structure and functioning. The TFM has topological and functional properties. The topological properties are *connectedness, closure, neighborhood and continuous mapping*. The functional properties are *cause-effect relations, cycle structure, inputs and outputs.* TFM properties and application within MDA and MDE are described in detail in [2].

III. A Mechanism for Ensuring Domain Conformity

As Gotel and Finkelstein wrote in [3] "*requirements traceability is an ability to follow the life of a requirement*". A mechanism for requirements backward traceability, from the TFM to knowledge models, and forward traceability, from the TFM to code, is defined in this section. The traceability mechanism is implemented at the metamodel level. Tracing data are kept in a separate traceability model, which is created for each conducted transformation.

IV. Illustration of the Domain Conformity

The suggested traceability mechanism is demonstrated by an example of the system that manages a part of research group activities. It ensures verification of domain conformity.

V. Conclusions

The result of the research is ensured conformity of the solution domain models to problem domain models by means of a formal model, the TFM, and construct tracing during transformations of system and software specifications. Directions of future research are related to TFM verification by formal mechanisms, e.g., Colored Petri Nets.

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Integration of the MVC pattern and the Topological Functioning Model

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***Keywords* – software modeling and design, topological functioning model, model-view-controller pattern.**

I. Introduction

Architectural separation of concerns in specifications is a key principle in Object Management Group's Model Driven Architecture (MDA) and Model-Driven Engineering (MDE). Specification compliance is implemented as transformations between models of a system, where each model specifies a concrete viewpoint on the system. There are three viewpoints defined in MDE approaches: a computation independent, a platform independent, and a platform specific view. This research discusses a transformation from a computation independent view, which is represented by a Topological Functioning Model (TFM), to a platform independent view, which is represented by a filled-in Model-View-Controller (MVC) pattern. This transformation is implemented by using one additional model, i.e., an enhanced TFM.

The paper is organized as follows. Section II discusses the TFM and its applications in brief. Section III discusses the classical MVC pattern and its several variations in brief. Section IV shows the result of integration of the TFM and the MVC, i.e., the enhanced TFM. Section V illustrates the proposed solution by an example. Conclusions discuss the main results and directions of future research.

II. The Topological Functioning Model in Brief

The TFM is a formal specification in the form of cause-and-effect relations among system's functional or physical characteristics. It is grounded on principles of algebraic topology and system theory. The TFM is represented in the form of a topological space as a directed graph. The TFM has topological (come from algebraic topology) and functioning (come from system theory) properties. The topological properties are *connectedness, closure, neighborhood and continuous mapping*. The functional properties are *cause-and-effect relations, cycle structure, inputs and outputs* [1].

In the context of MDE, the TFM can be applied as a computation independent model of the problem domain, information system, or software system. Continuous mapping is a mathematical mechanism that allows formal tracing between TFMs of different related domains, such as a problem domain and an information system, an information system and a software system. Thus, it allows formal tracing between a domain and its sub-domains *at the computation independent level*.

In order to develop software, MDE requires transformations from the computation independent model to the platform independent model to the platform specific model to executable code. The platform independent model considers software from different aspects – behavioral and structural. By the present moment, research on transformations from the TFM to the platform independent model resulted in obtaining the following specifications: a use case model, UML activity diagrams, UML sequence diagrams, UML communication diagrams, and a topological class diagram. These specifications do not contain any specific software architectural solutions.

III. MVC Pattern in Brief

The platform independent model corresponds to a software design, although it does not show platform specific details. Decisions on required software architecture should be done here. One of wide-used and well-known architectural design patterns is *Model-View-Controller* (MVC). The goal of MVC is to facilitate software development and further maintenance by separating execution logic and a presentation layer. MVC separates an application into three layers [2]: *a model* that encapsulates operations with data sources and business logic; *a view* that responds for presentation of end results, and *a controller* that manages all operations between the view and the model. There are several elaborations of MVC, namely, patterns with a passive view and a presentation model, and a model-view-presenter pattern. Advantages of application of MVC are improved unit testing, elaboration of test-driven development and an "interface first" approach. It encourages a deeper participation of a customer and facilitates fast changes during software development.

IV. The Enhanced TFM

In order to define a possible transformation from the TFM to the MVC pattern constructs, a TFM metamodels and an MVC metamodel are overviewed. The result is a TFM metamodel enhanced with constructs, which correspond to the constructs of MVC. Instances of this metamodel are used as intermediate models in the transformation process, where each functional part of the TFM is associated with the MVC layers.

The process of transformation from the TFM to a platform independent model that applies MVC is as follows: 1) extend the TFM of the information system with software specific details; 2) transform the extended TFM to the intermediate model, i.e., an enhanced TFM of the software; 3) decompose the enhanced TFM into use cases or business processes; 4) transform each decomposed part to an UML communication diagram; 5) compose an UML class diagram.

V. An Example of the Application

The suggested integration is demonstrated by an example of the "Laundry" system.

VI. Conclusions

The result of the research is discovering of model, view and controller layers in the TFM. Future research is the analysis of advantages and limitation of the TFM use in the "interface first" development.

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Analysis of CSS3 Features

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***Keywords* – CSS3, HTML, Web Markup.**

There are few options to create styles and design of web documents using html. Firstly, it is possible to use standard element tags, for example, for headings there are `<h1>`, `<h2>`, `<h3>` and other, which make text appear in large font, `<strong>` and `<b>` elements emphasize text by making it bold. A web page may consist of images by using `<img>` tag as well. By using html tags it is possible to style and make custom web document design [1].

However, html tags have limited custom styling options, so that's where CSS (Cascading Style Sheets) comes in help. CSS is a style sheet language used for describing the look and formatting of a document written in the html. It is built to separate document content and document formatting and presentation, such as layout, colors and fonts. CSS brings to documents a lot of custom customization options: colors, positions, typography, and element selectors. It allows setting site-wide consistency in presentation, including inheritance of styles [2].

Work on CSS level 3 started around the time of publication of the original CSS 2 recommendation. The earliest CSS 3 drafts were published in June 1999. CSS3 introduces new selectors and element properties to make it easier to make custom styled web documents.

Among new features of CSS3 most popular and awaited were: “border-radius”, which allows creating boxes with rounded border corners, “text-shadow”, which allows adding one or multiple shadows to text in web document, background gradient, which allows making element’s background in gradient without using an image for it.

CSS3 makes it easier to maintain web documents styles in one place, by decreasing element and image count for developing complex custom styled elements, which, makes it easier to make necessary changes to element formatting as well. Another CSS3 advantage is page loading performance: for creating box element with gradient and rounded corners of it would require to load at least two images and creating few additional elements just to make one styled box in web document. CSS3 will require no images to load to make box with gradient background and rounded corners of it. That means that HTTP requests count decreases, as well less bandwidth will be used to download the web document.

CSS3 also expanded list of element selectors. Most used ones, which before CSS3 were realized by using JavaScript, are: attribute selector, for example input[placeholder=”Search”], selects “input” element, which has attribute “placeholder” with value “Search”, another one is “:empty” selector, which selects element, when it has no contents, as well selector “nth-child”, which selects every other element according to formula specified in selector. Before introducing these selectors developers were programming JavaScript selector functions, which would do the same, what CSS3 does now.

Although CSS3 was introduced a long time ago, desktop web-browser support of it varies from one web-browser to another. Some web-browsers support a lot of features of CSS3 (for example, Google Chrome), some support only few (Internet Explorer). But even those web-browsers that support a lot of features of CSS3 might require using specific prefix for CSS3 properties to work properly. This is made for compatibility to style CSS3 specific properties differently for different browsers, as actual rendering of the styles might differ in different browsers [3].

Distinctive from desktop web-browsers, mobile web-browser support for CSS3 is well supported. This might be made to allow developers make more optimized and lightweight styled web documents for mobile users: cellphones and tablet computers users.

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HTML5 in Development of Control Tasks for e-learning Systems

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***Keywords* – e-learning, knowledge control, types of control tasks, Internet technologies, HTML5.**

The fields of e-learning and knowledge control (KC) are subjects of interest to many scientists, including both teachers and IT specialists. There are many modern scientific conferences being held on that matter, such as IEEE ICALT, IADIS e-Learning, IASTED CATE etc. There are some scientific journals dedicated to these fields as well. Control tasks that are presented to students are to be compatible with the main course of the subject, should adhere to the provided study materials and standards and should be implemented accordingly. The paper deals with the problem of control task (CT) realization by the means of modern Internet technologies, such as HTML 5.

In general, each CT consists of two parts – the question and the answer (executive part). Popular task types usually consist of: "menu" or "closed" type tasks, "open" type tasks, "accordance" type tasks and "sequence" type tasks. Each of these task types defines the means of information representation that are to be used in order to show the "question" part. This also defines the "answer" type that most probably would be used. There are three common types of answers: choice, input and construction. In 2007, during the conducted research [1] that covered 70 computer programs that carry out knowledge control, it was stated that most of the computerized learning systems use "menu" type tasks (50%), "open" type tasks (38%) and others (12%), while most common answer types include: "choice" (32%) and one-word "input" type answers (17%).

In the recent years, it is possible to observe the Rich Internet Application abundance on the market. Most of the "stationary" desktop application types, such as cinema watching, office tasks etc., are now available online, without any installation. All the user needs is web browser and a broadband Internet connection. Internet is enormously popular today and a big part of the modern man's life happen in the Internet, including education. Introduction of HTML5 enhanced the process of interaction between user and the web application. Most of the modern mobile operating systems, such as Android, iOS, Windows Mobile, Blackberry and WebOS use HTML5 alongside with their native tools to create applications and their user interfaces, thus making HTML5 a single unified language that works on all of these platforms. By May 25, 2010, 46% [2] of Internet users already had browsers that support HTML5, and by November 28, 2011 the number of personal, non-mobile computers using this technology grew up to 51.7% [3]. Solid part of today's modern mobile devices also supports HTML5, which allows these devices to be used for e-learning purposes.

Bonuses that can be achieved in the field of e-learning via HTML5 should not be neglected.

For example, for language learning purposes it is imperative that student knows how to write and spell new foreign words. Thus, in CT, a word should be presented in both written and verbal form. Using HTML5 tag `<audio>` it is possible to place a built-in audio player that would correctly pronounce the word for a user on a web page, side by side with text.

One of the most popular modern studying styles is to learn via watching the video, where teacher explains all the things in theory and shows how they work in practice, etc. HTML5 `<video>` tag allows to use browser's built-in video player for film viewing. There is no need for a flash player to handle this, which iOS users can benefit from.

The use of HTML5 `<canvas>` tag allows to implement tactical or geolocational tasks, where user is forced to quickly solve some logical problems, such as optimal tactical unit dislocation during an enemy assault (Fig. 1.).

Fig. 1. Example of tactical unit dislocation in HTML5 game "Pirates love daisies".

In order to enhance the questionnaire type control tasks, it is possible to use the new `<input>` tag's enriched HTML5 functionality. With the help of `placeholder` attribute it is possible to define the default text that will be shown on the form's field, before user clicks on it. Until HTML5 came out, this sort of functionality was achieved with the help of JavaScript. The `<input>` tag's `autofocus` attribute allows speeding up the answering process by putting user's typing caret in the correct place (field). The `required` attribute may allow notifying the students, which fields are obligatory and which are not. The `datalist` attribute allows creating a list of predefined values that may serve as answers to a specific question and can filtered by the first symbol entered from the keyboard. Attributes such as `email`, `website`, `phone` help the mobile device's OS to choose which type of onscreen keyboard to show. The `number` attribute narrows the possible answer quantity to numbers only and can be used in math tasks. The `date` attribute allows using browser's built-in calendar and can be used in tasks connected to history. The `color` attribute allows the user to choose a specific color via browser's built-in UI.

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Applying the Model-Driven Approach to Measuring the Performance of Process Synchronization

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***Keywords* – concurrent computing, process synchronization, algorithms, performance, Model-Driven Architecture.**

Concurrent computing nowadays has become sufficiently widespread. Concurrent computing is defined as a form of computing which supposes that a computational unit (i. e., a computer program) is divided into several smaller computational units (processes, threads) which can be executed not only sequentially, but also simultaneously (or concurrently).

This allows to decrease the time needed for the program to execute, compared to the non-concurrent program equivalent by functionality. Therefore the main goal of using concurrent computing is to reduce the execution time of a program or, which is equivalent, to speed up the computations.

One of the main aspects of concurrent computing is that in order to accomplish a corporate goal for a program, its threads should communicate with each other in a certain way. All communications in a concurrent program are done by means of inter-process (or inter-thread) communication mechanisms. Process synchronization is one of most important types of inter-process communication; its aim is to assure a specific coherence of execution of actions between several threads (or processes).

As process synchronization mechanisms control the execution of threads, these mechanisms, operated by their own logic, pause and resume different threads. Such intermediation of synchronization mechanisms in the execution of other parts of a program obviously impacts the execution speed.

To measure the performance of specific process synchronization algorithms, the corresponding framework—PSPMF—can be used. Such framework can help determine and analyze the features of specific synchronization techniques in different cases, depending on different input parameters: a number of threads, a pattern of thread interaction (including both possible thread interaction mechanisms and specific cases of thread interaction), a pattern of waiting for external events etc.

The main use case of the results obtained by the use of the PSPMF is to see, which concurrent system (combining with its environment) can afford better performance. Moreover, the results should not only be used for arranging concurrent systems in a specific order, but also should give quantitative information about the degree of difference between the measurements. Therefore, the framework is to be reliable enough in order to make acceptable conclusions despite possible influencing factors.

The full PSPM framework is to be able to handle concurrent systems specified on different abstraction levels—for each abstraction level of the model of the concurrent system being analyzed. This implies that the framework is to be organized in several layers. The most abstract level of a system model is a mathematical model which formally and fully describes the system, but at the same time not considering any implementation details specific to any execution environment (or software and hardware platforms). The least abstract level of a system model is an implementation specific model, which fully describes not only the logic of the system, but also the execution environment of the system.

Depending on the necessity, any number of intermediate models of a system can be introduced. Such flexible granularity of model abstraction levels is reasonably important especially in the context of the performance analysis of process synchronization algorithms.

The PSPM framework is to be able to:

1) specify a concurrent system in an abstract way – i. e. without any reference to a possible execution environment;
2) specify all possible execution environments of a specific concurrent system;
3) to the extent possible automatically detail a model of a higher abstraction level to a lower abstraction level (i. e. automate making a model more specific).

These three above mentioned facts perfectly fit to a philosophy of the Model-Driven Architecture (MDA). MDA is defined as "an approach to IT system specification that separates the specification of functionality from the specification of the implementation of that functionality on a specific technology platform" [1].

Table I shows an outline of a possible correspondence between MDA models and specific abstraction levels of models of data stored in the PSPM framework.

TABLE I
CORRESPONDENCE BETWEEN MDA MODELS AND DATA STORED IN PSPMF

Model	Contains information
Computation Independent Model (CIM)	—
Platform Independent Model (PIM)	Logic of the system described in an abstract language
Platform Specific Model (PSM)	PIM + all details how the system will use specific features of execution environment
Implementation Specific Model (ISM; source code)	Source code that can be straight executed on a machine
Platform Model	Detailed information about execution environments: software, hardware and other technological platforms

Speaking about more detailed specification of the framework, there exist several performance metrics which can be used to get quantitative values of the impact of synchronization algorithms on the execution speed [2]. However, it could be an issue the way how to obtain the measurement results. As two main alternatives, either real system observation or simulation can be used. The former method is easier, but taking more time and much harder in context of generalizing the results; the latter method is more complicated, but faster and easier for generalization.

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Recent Trends and Solutions in Software System Logging

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***Keywords* – Computer-system logs, Log analysis, Logging framework.**

Since the initial years of software development, there is widely used practice to include log function calls in the various places of the source code. The main intent to do so is to facilitate software debugging. Nowadays such mechanism has been largely extended with additional goals. It is due both to the huge increase in software systems' size and complexity and to the purpose of logging. The purpose of this digest is to outline the current state of the art for software system logging and to propose an extensible asynchronous logging framework which follows the best practices of the topic.

Initially, the main purpose of logging was just to output (subset) of program state so that the values could be inspected and analyzed regarding valid or invalid program functionality [1]. In its simplest form, logging consisted of ordinary "print()" function calls which outputted textual data to the console screen. However since then, such output functions were replaced with specialized logging functions which allowed not only outputting to the console but also appending to specific files on the disks or sending via network to some centralized logging server.

Also the purpose of logging has extended from just facilitating debugging to troubleshooting of production systems, studying performance bottlenecks, and detecting of malicious intrusions, among other.

This means that logging must not be regarded as unimportant aspect of the proposed software system, but be carefully planned ahead so that to gain the most from such facility. Typical issues which must be taken into account are the following.

First of all there should be independent log targets in regard to the purpose – debugging logs must be saved in the different files than, for example, the performance or security logs. This is not only because it makes it easer for inspection but also that access to different log targets can be restricted with limited rights.

Second, it must be clear for everyone who will use selected logging facility, how to construct new log items so that they contain only the important information – it is sad if the contents of logs are (partly) unusable [1]. Typical information that is saved in the log item is: date/time of creation; type (usually used to denote various levels of log, e.g. trace, debug, informational, warning, error, fatal); context (e.g. module and function name); and the description itself. Every aspect of such log item must be carefully planned out so that for each item there is no missing and no unusable/prohibited information available [1]. The format of log item storage also must be planned ahead, because it will influence how easy log items could be parsed and/or analyzed – if they mostly will be used by humans, the log items could be just plain lines of character data, but if logs are supposed to be analyzed by tools, then is it better that log item parts are separated (e.g. in columns).

Third, depending on the purposed of logs and the planned amount of growth, the log facility must be selected in such a way that does not influence the overall systems' performance [1]. For example, it is known that disk subsystem performance in comparison to random access memory performance is in order of magnitudes slower. Therefore if each log item addition lasts while it is successfully saved to the log file on the disk, the performance penalty of such logging facility will be rather high. As a solution, there can be used various asynchronous intra- and inter-process communication mechanisms (e.g., threads), with common synchronized log item queue.

These are just some of the issues which must be taken into account. Others could vary depending on the system's architecture (e.g., whether it is client-server, distributed, or service-oriented), implementation technologies or hardware restrictions.

Because of the importance of logging and the relative simplicity of creation own simple logging facility, there have been developed unnumbered logging infrastructures. The vast majority of them have incompatible interfaces, log formats and functionalities. Because of so many aspects, there cannot be developed one universal logging facility. However there are logging facilities that have gained more popularity than others or built in-house. For example for JVM compatible languages the Apache log4j is the most known. For .NET Framework there can be named Apache log4net. But regarding the native logging for C/C++ languages, there is no single dominating library.

Therefore, by taking into account all abovementioned, we have designed an architecture and implementation of rather simple yet powerful asynchronous logging library. The main reason was not that we couldn't adopt one of the freely available libraries, but because we needed logging library which do not have unneeded functionality but at the same time follow the typical practices of logging. It has configurability to select required verbosity, logging targets and provides different interfaces to connect with the compatible implementation technologies.

Also our library is extensible in a manner that allows to plug-in third party adapters, therefore extending the log targets and the implementation technologies with which our library can be used.

Because of asynchronous nature, the performance penalty is comparable to the simple console output, but as log targets can be provided not only file systems, but also remote network endpoints, e.g. logging servers.

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Agile software development

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***Keywords* – Agile, Expert systems, Extreme Programming, Scrum, Microsoft Solution Framework.**

Agile software development has become more and popular, not only in foreign countries but in Latvia as well. There are several advantages and disadvantages in using agile methods and each agile method are not equally popular. In order to understand which method or method combination to use and what the best practices are, research on agile methods is created. Research consists of four parts. The first part describes agile method popularity, the second part describes agile method most common problems and survey results about particular problems in Latvia, the third part describes future trends of agile software development, and the closing part describes expert system usage in agile software development.

I. Agile Method Popularity

In order to find most popular agile methods, web research has been made. First step of the research included finding of resources which mention some top of agile methods. In particular case 7 web resources where used. By using this summary list of methods, another web search has been made. Information about all methods in the list was searched in search engines: bing.com, google.com and book store Amazon.com in order to determine resource amount for each of the methods. Information from each resource was ordered and given a weight, as a result ordered list of methods was created. Results are seen in Table 1.

TABLE I
Agile Method Popularity in Resources

Method	Google	Bing	Amazon	Total
Dynamic System Development Method (DSDM)	10	10	30	50
Crystal	30	30	10	70
Lean Software Development	20	40	40	100
Scrum	40	20	70	130
Feature Driven Development (FDD)	50	70	20	140
Unified Process (UP)	60	60	50	170
Test Driven Development (TDD)	70	50	80	200
Extreme Programming (XP)	80	80	60	220

Five most popular methods and their properties are described in more details in full paper.

II. Problems Of Agile Software Development

All agile methods are similar in some ways, but also have some key differences in process. Also all agile methods have some individual and common problems in their implementation. In order to understand the key problems for using agile search for problems was conducted. And following problems were mentioned most frequently: Unreliable team (1), Poor communication (2), Specification or requirement is too abstract (3), Retrospective is not implemented (4), Knowledge is not stored (5), Metrics are not used (6), Insufficient use of time (7), Scope creep (8), Team or organization not ready for agile (9). To test the situation in Latvia 14 different developers were asked to share their knowledge about their experience with agile. As a result survey was conducted with 10 questions about each popular problem and about this problems impact on every day basis. Developers had to scale each problem from 1 to 10 where 1 is not the problem and 10 is definitely the problem. Most interesting about the survey results was, what there is no common opinion about the impact of the particular problem, each developer have evaluated each problem differently. To my opinion this could mean, what each problem is evaluated differently because organizational environment differs and used agile method differs.

III. Future Trends

In order to understand in which direction to go with agile software development, decision was made to research conference materials from 2008 till 2012 of Agile Alliance organization [1]. Agile Alliance is one of the biggest organizations handling and organizing agile conferences each year. In each year there are approximately 300 sessions about agile software development. Those session materials can give good insight on the trends in agile software development. To see the trends each article in this conference has been assigned with particular keywords. All keywords afterwards will be grouped and ordered to see the trend of agile software development. This research is still in progress and will be ready till submission of full paper.

IV. Expert System Usage In Agile Software Development

Last part of the paper is all about possibility to use expert system when working with agile software development [2]. The idea to use expert system came from list of the most popular problems, which indicated what most of them are people based. In such cases expert user opinion could be crucial, in this case expert user could be expert system which allows seeing the problem or situation more clearly or in more depth.

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Importance of Configuration Management

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Since late Eighties the development computer software has changed and evolved a lot. This has improved the development process and its value to business. Any of that would not be possible without Configuration Management and absence of it usually leads projects to over budgeting and even failure. Still, the term Configuration Management quite often is misunderstood and forgotten during development and under high pressure. Continuous Integration and Continuous Delivery are terms from Configuration Management and missing proper tools nowadays.

Whilst Configuration Management is essence in product development and some companies spend a lot of efforts on it, companies in Latvia and even well known international companies keep struggling with typical problems because of different myths and lack of knowledge about it. There are no certifications or official studies in this area so sometimes development teams look at Configuration Management as some archivation process. Other common misunderstanding is Configuration Management as Continuous Integration whilst other essential parts of it are forgotten.

Configuration Management is a must in any type of project. It is a process which wraps product development starting from first written code till end of project. There are differences between Waterfall and Agile Configuration Management but common understanding and necessity remains as inherent part of software development. Based on different polls worldwide it is clear that Configuration Management is taking bigger and bigger role in delivery process to improve feedback time on every product change.

Continuous Integration is one of Configuration Management essences and can raise development quality significantly but only when used appropriately and discipline is well known word in project. Next generation of Continuous Integration is Continuous Delivery and Deployment Pipelines which becomes more and more popular worldwide but sometimes key points of it are misunderstood and efforts are spent in wrong areas. Most important key point of these systems is feedback time or change lifecycle what makes them inefficient without continuous support and improvement.

There are different open source and enterprise solutions to start Continuous Integration process in company but none of them fulfills all primitive requirements of Configuration Management or at least not in an easy way. Current practices in Continuous Delivery recommend setup and integration of two or more systems to support it what makes changes lifecycle hard to read and requires additional maintenance efforts so as results becomes inefficient for rapid development.

It is clear that in evolving Agile development and growing business needs also software must be developed more rapidly. Improvements in Configuration Management tools are required as well. New solution is required which focuses on Configuration Management process instead of build system, artifacts management and reporting. Such solution should ease implementation and support of Configuration Management in development processes by generic process control and management. It should focus on monitoring and measurement of product changes lifecycle to discover bottlenecks in development and build processes as soon as possible. To avoid hardware limitations of build processes improvements, solution should support scalable environments and offer virtual build environment to split build tasks on build machines in background.

Aim of this article is actualize problem of Configuration Management misunderstanding and absence in software development companies. In addition author proposes architecture for new software which will focus on Configuration Management process and its metrics instead of artifacts build and reporting.

Latvian Language Technologies in Multi-lingual Information Society: Tilde's Experience

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Keywords **– language resources, language technologies, multilingualism, machine translation.**

In the last decade communication and information exchange between people has grown rapidly. Linguistically the world is very diverse and thus we need to overcome language barriers. Modern language technology and linguistic research can make a significant contribution to breaching these linguistic barriers. When combined with intelligent devices and applications, language technology can help Latvians communicate easily and do business with others even if they do not share a common language.

Tilde creates language technology solutions that overcome language barriers. These technologies help users communicate in their native languages and by developing technologies especially for "small' languages Tilde gives these languages access to modern applications that are already enjoyed by widely used languages. .

About 20 years ago Tilde released their first electronic dictionaries as desktop applications. Now Tilde's dictionaries contain more than 15 language pairs and are available for users with different usage paradigms, e.g., on the web, on mobile devices etc.

Besides translation lexicons, Tilde collects and provides access to terminology resources. The EuroTermBank portal[1] is the largest internet terminology portal which provides a single access point to more than 2.3 million terminological units in 27 languages. This resource is actively used by translators in Latvia as well as in different European institutions.

Although a dictionary is an indispensible resource in multilingual communication, to overcome language barriers we need more advanced technologies. Thus researchers and companies have spent a lot of energy to create machine translation systems (MT). The development of MT systems is not a trivial task; it requires powerful tools and computer resources, as well as large bilingual language resources (at least several million parallel sentences in a particular domain) that are used by computer to "learn" translation.

For "small" or under-resourced languages the necessary resources exist (if any) only for a limited number of domains and in many cases the size of these resources is too small to train good machine translations system.

To overcome this scarcity of parallel data Tilde together with leading European universities and companies have been working on innovative methods how to find and harvest language resources from the web that can be used for machine translation. Recently developed algorithms and techniques allow extraction of translation equivalents not only from texts that are translations of each other, but also from similar texts, e.g. news in different languages (Pinnis et al., 2012).

However, in many cases there are still not enough parallel text fragments available, thus we have researched methods that adapt MT system for a particular domain by integrating named entities and domain specific terminology. For instance, in the automotive domain, transformation of the translation model phrase tables into term-aware phrase tables allowed us to boost the quality by 24.1% over the baseline system

Besides solving complicated research problems, Tilde also develops innovative solutions based on state of the art techniques. LetsMT![2] is a cloud-based online collaborative platform for data sharing and MT building ((Vasiļjevs et al. [3], 2012). Here users can upload their parallel corpora to an online repository or use publicly available data from the repository to generate user-tailored statistical MT systems. The generated MT system can be used for translation not only directly from the webpage of LetsMT!, but it can also be integrated into web browsers, user's applications and computer-assisted translation tools for professional translation. The LetsMT! platform currently contains more than 730 million parallel sentences in almost 50 languages. During 4 months since launching platform, 82 SMT systems have been trained.

Another problem is high fragmentation which leads to the problem of finding relevant data to build particular application. Tilde together with other European institutions (currently 57 research centres from 33 countries) is working on establishing an open linguistic infrastructure META-SHARE[3] for sharing linguistic resources (Vasiļjevs et al. [2], 2012). Among different language data that can be considered useful for different purposes, META-SHARE places a strong focus on data that are important in language technology development for building applications useful to the EU citizen in his everyday communication and information search needs. META-SHARE provides facilities for describing, storing, preserving, and making publicly available LR repository in an open, user-friendly and trusted way.

We would like to conclude that recent advancements in several areas of language technology, e.g., MT, make us believe that with targeted efforts and cooperation between research institutions, funding organizations, universities and industry Latvian can become one of the most technologically advanced languages of multilingual Europe.

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Accenture – The World's Largest IT Consulting Company in Latvia

Vladimirs Nikulsins and Dmitrijs Pozdnakovs (*Accenture Latvia*)

***Keywords* – Accenture Latvia, Riga Technical University, SAP University Alliance program.**

- Accenture Latvia – the largest IT professionals team in Baltics.

Accenture Latvia started its operations in 2002 and during these years became the leading IT company not only in Latvia, but in the Baltic States. Considering IT stuff it is the largest IT company in Baltics today. Accenture Latvia mostly exports its services and cooperates with customers in different countries in European Union. In general Accenture is a global company in consulting, technology and outsourcing. We unite 246,000 people in more than 120 countries. Accenture Latvia delivers for Nokia, BMW, Nokia Siemens Networks, Vodafone and other customers known all around the world. In Riga we are a 400+ company working with Java, .Net, C*, SAP, Oracle.
Accenture is for people with great ideas, a devotion to technology, a passion for making this world a better and more interesting place, through the creative application of information technologies.

- Research and Development: Accenture Technology Vision 2012

High performing business leaders now accept that their organizations' future success is tied to their ability to keep pace with technology. Today's CIOs have a key role to play in helping these business leaders recognize and seize the opportunities enabled by new trends—but the price of progress will have to be paid, along with new risks assumed.
The annual Accenture Technology Vision offers CIOs unique insight on six emerging technology trends that will have the greatest impact —and their business implications for the C-suite. Accenture Technology Vision 2012 discloses a view of what conversations will be most important over the next three to five years.
http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Technology-Vision-2012.pdf#zoom=50

- Main interst platforms: SAP, Java, Oracle, other advanced solutions and technologies

Accenture Latvia operations are based on the listed technologies and our employees are considered to be the most experienced experts in these fields. Accenture Latvia provides consultancy and development of most demanded and modern systems, including SAP - the market leader in enterprise application software. SAP helps companies of all sizes and industries run better. From back office to boardroom, warehouse to storefront, desktop to mobile device, SAP empowers people and organizations to work together more efficiently and use business insight more effectively to stay ahead of the competition.

- RTU students in Accenture Latvia – successful cooperation history

For 10 years of operations Accenture Latvia has successully cooperated with RTU to support future IT students. Many of them became IT professionals by working in unique projects realized by Accenture Latvia. Some interesting facts and statistics of RTU students working in Accenture Latvia shows that the cooperation gets stronger every year.

- RTU and Accenture Latvia cooperation in SAP University Alliance program

In 2010 Riga Technical University (RTU) became SAP University Alliance program member thus gaining possibility to provide SAP technology course.
During all these years Accenture Latvia has supported RTU with this program providing the university with SAP environment and organizing professional guest lectures.
For faculty and universities, the SAP University Alliances program provides a multitude of benefits and opportunities. Universities offering hands-on experience with SAP help increase graduate recruitment rates, making member institutions hubs for the new talent needed in today's global workforce. For students, a deeper understanding of SAP can jumpstart their careers by combining business process knowledge with enterprise software expertise to develop the most valuable skills portfolio in the market today.

- Advantages brought by Accenture Latvia to RTU students

RTU has remote access to SAP systems and related technical infrastructure at University Competency Centers (UCCs) around the world. These centers covers hardware, hosting facilities, database infrastructure, application management, helpdesk and application support for RTU academic personnel and students. This infrastructure is used to support learning of ABAP programming within RTU course of business programming languages.

- Job opportunities in Accenture Latvia for RTU ABAP course students

Career-ready graduates, as part of an educated workforce, are fundamental for competitiveness and success in today's global business environment. At regional and global levels, a combination of business and information technology (IT) skills as well as industry expertise, promote stability and economic growth. However, with the increased need for a business- and IT-savvy workforce, caused in part by the accelerated need to innovate in business, industry experts foresee a skills shortage in the coming decade. Helping students develop 21st century skills prior to entering the workforce is critical, and provides the opportunity for institutions of higher learning to offer tailored and career-impacting curricula.Accenture Latvia supports students that have chosen SAP as a study direction and is ready to offer jobs to the most successful students.

- Accenture Latvia Free Programming Schools

Accenture Latvia Programming Schools are free of charge intensive trainings with a mixture of workshops, self study and hands on practical experience. Depending on the preferred subject (e.g. Java, .NET, SAP, C++ or Project Management) the course may be 2-4 weeks long.
Successful candidates that pass the course obtain a certificate acknowledging courses attended and will be offered a programmer position in Accenture Latvia.

Computer Science

Information Technology and Management Science

Security Management Improvement Using Real Time Log Analysis

Dāvis Pēterkops (*Riga Technical University*) and
Vladislavs Minkevičs (*Ministry of Finance of the Republic of Latvia*)

Keywords **– log analysis, log management, real-time log analysis.**

I. INTRODUCTION

The importance of identifying security incidents as soon as possible is with no doubt an issue for organisations. Security incidents can lead to unexpected expenses and disturbance of organisations business processes. Different solutions – firewalls, antivirus software, unified threat management systems and many other assets are used to ensure information and organization data protection. During the process these assets make useful information – describe systems operation and security situation, which is stored in the system log files.

II. IMPORTANCE OF LOG DATA

It is essential that information which is recorded in the logs would be analysed as much as possible – ideally – in the real time [7].

Information regarding events, registered in the form of logs, would enable Network and System administrators to assess:

- Identifying security incidents
- Policy violations
- Fraudulent activity
- Application's functional and operational problems
- Auditing and forensic analysis
- Supporting internal investigations
- Establishing baselines

Unfortunately most organisations do not spend enough time to analyze log data. It can be clearly seen that for any reasonable sized computer system, the log files easily gather huge amounts of data and it is difficult to immediately extract useful information from logs [9].

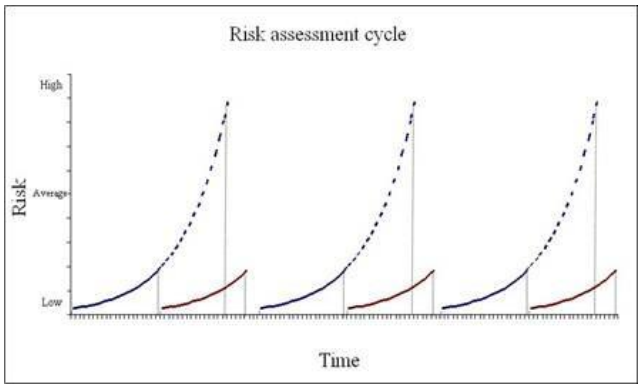

Fig. 1. Risk assessment cycle.

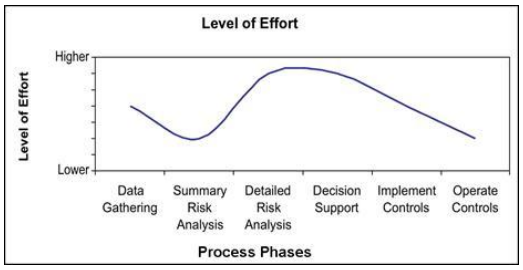

Fig. 2. Level of effort during risk assessment phases.

III. REAL TIME LOG DATA ANALYSIS

The aim of the research is to develop a method based on decision-making method for the log data analysis in real time.

This method provides threats being classified into certain areas and are used to determine what threat belongs to what kind of risk, in order to inform organization security manager in real time on possible threats to system security [3].

Information systems security expert would be able to make decisions earlier and more effectively and protect information systems from threat in case of using the software based on the usage of this method.

During the research the experiments were conducted with the log data, converting these data in binary form; using methods of decision-making was determined whether particular log data pose threats to the system or not. The rating scale of the threat is based on the expert assessments; therefore, for different experts, obtained results may also differ.

On decision-making methods based approach in log data analysis may give an essential support in organizations security manager's daily work. The research provides that in the future, on the basis of this method it would be possible to develop a real software tool.

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A Method for Effective Reuse-Oriented Software Release Configuration and Its Application in Insurance Area

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Keywords **– software configuration management, reuse-oriented process, insurance business processes.**

I. INTRODUCTION

The paper presents the results of the ongoing joint research activities related to the improvement of systematic software processes for the maintenance projects of large information systems. The main objective of the study is to identify and implement the effective and reusable solution for building high-quality releases that include not all, but only tested changes. The topic has a particular significance since the proposed approach may provide some economic and organizational benefits by increasing the quality of product releases, by reducing development and operating costs, and by efficient utilization of development expertise [1].

II. RELEASE BUILDING ALGORITHM

Being a fine-grained part of the process dimension within the reuse-oriented framework proposed in [2], the effective reuse-oriented release configuration process assumes proper development of:

- technological infrastructure that includes a configuration management and quality assurance functions to support operations, as well as enforcement of testing, and
- managerial infrastructure in the form of a set of functions, responsibilities, reporting requirements, and reward, which are required to ensure proper operation of the processes.

The following context is set up for the purpose of defining the high-quality release building algorithm:

- The maintenance project is set up and all problems dealt with are registered in the defect tracking system (e.g. JIRA), where each change has a unique identifier.
- The product source code as a set of files is stored in a centralized version control system (e.g. Subversion).
- The iterative approach is adapted for the maintenance project, when a new version of the product is released every second week and includes changes resolved and tested during a particular two-week period. Only successfully tested changes should be included into the release.

The mandatory requirement for the algorithm is the need to specify the change identifier from the defect tracking system in the VCS revision description. The algorithm performs the search for the revisions that are related to changes planned for inclusion into the release. It is necessary to ensure that each revision includes information if it was included in any of the releases ("Included to the release" attribute). The main steps of the proposed release building algorithm, that includes only tested changes, are the following:

1. Get tested change identifiers from the defect system.
2. Prepare a data structure to hold information about the failures in the build.
3. Get the list of VCS revisions for each defect from 1.
4. Get the list of modified files for each revision from 3.
5. For every modified file perform the following:
   1. Find the revision of the previous file modification.
   2. If the revision found in 5.1. has an empty "Included in the release" proceed to 5.3. Otherwise, go to 6.
   3. Get defect tracking system identifier for the revision found in 5.1. Proceed to 6 if the identifier belongs to the set from 1. Otherwise, create a new record in the data structure from 2.
6. Save the revision number from 3.
7. Release can be build for the original set of changes if the data structure created in 2. is empty. Otherwise, release should additionally include changes from this structure.
8. The result of the algorithm is the list of VCS revisions saved in 6. that should be included to the product build, so that only tested changes are delivered to the customer.

III. IMPLEMENTATION AND APPLICATION OF THE RELEASE BUILDING ALGORITHM

The Java utility application was developed as the proof-of-concept implementation of the proposed release building algorithm that can be used with Subversion version control and JIRA issue tracking systems.

Currently the application is in the stage of verification in the area of insurance sector. Insurance Information Systems must provide fast and easy modification and extension that is particularly important for the Eastern European insurance market. The product is a large insurance information system that includes several sub-systems for supporting different insurance business processes [3]: Contract Management, Reinsurance/Coinsurance, Damages/Claims, Accounting, Reserves Calculating, Financial Monitoring and Management.

IV. ACKNOWLEDGEMENTS

This work is partly funded by the ERDF (ERAF) project (No.2011/0008/2DP/2.1.1.1.0/10/APIA/VIAA/0 18
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On-demand Remote Data Integration Architecture

Janis Kampars (*Riga Technical University*)

***Keywords* – data integration, service oriented architecture, late binding, data as a service.**

I. Introduction

Data combination from different sources and acquisition of a single comprehensible view on all of the combined data is called data integration. Business intelligence data integration focuses on gathering and transforming data for analytical purposes. The required data is often located outside of the organization.

The traditional approach requires creating a data warehouse and performing the data integration process using an ETL (Extract Transform Load) system. However the solution has proven to be inefficient and hard to implement [3]. An appropriate technical infrastructure has to be created and regular data updates must be performed, to keep the data up to date.

Alternatively remote data sources can be used to retrieve only the required amount of data when it is necessary for data analytics. The approach can be referred as DaaS (Data as a Service) [2] or on-demand data integration. In this case data sources are web services and the data retrieval process is performed by calling their API (Application Programmable Interface) methods. Traditional data integration solutions are not suitable for the particular data integration scenario due to semi-structured data format and heterogeneity of the remote data sources. The paper defines On-demand Remote Data Integration Architecture (ORDIA) that can be used to build data integration solutions.

II. Technical solution

The ORDIA (Fig. 1) is based on abstraction approach. Abstract data retrieval operations and their corresponding data models are defined and a mapping between them and the physical data source methods is provided by using abstraction layers.

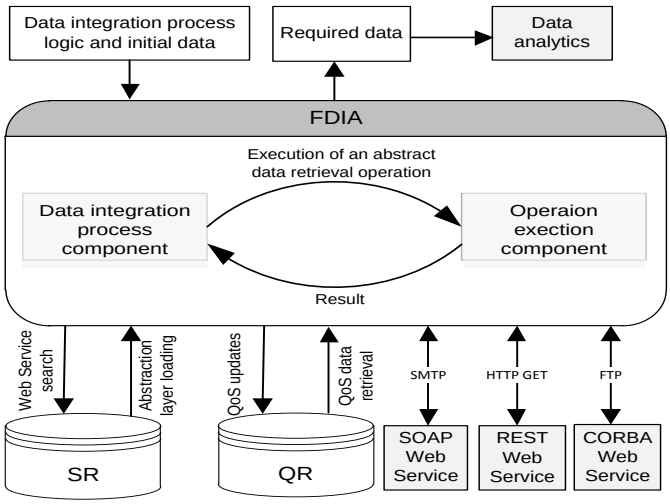

Fig. 1. On-demand remote data integration architecture.

The data integration process is expressed using XML and defines the relations between individual data integration tasks. The main part of the architecture is Functional Data Integration Adapter (FDIA), which consists of Data integration process component (DIPC) and Operation execution component (OEC). DIPC monitors the data integration process, transforms the input data according to abstract data retrieval operation input data model requirements, realizes loops, evaluates conditional expressions and performs data aggregation. When the data integration process contains a reference to an abstract data retrieval operation, DIPC uses OEC to find the appropriate data source and get the data from it. The technical details on data integration task execution and parallelization are described in [1]. While retrieving data, OEC monitors Quality of Service and saves the data in Quality Repository (QR). This information is later used in load balancing and late binding to minimize the data integration time. Abstract data retrieval operation data models and data source abstraction layers are stored in the Service Repository (SR).

III. Conclusions

Abstraction-based remote data source integration system architecture and the operation principles of its main components are defined.

Abstract data retrieval operations are defined and web service methods are mapped to them using abstraction layers.

The data integration process contains references to abstract data retrieval operations.

During the data integration process the corresponding data source is found in SR and queried via abstraction layer by the OEC.

The QoS data is gathered by the OEC, stored in QR and later used to provide more efficient data integration process.

Algorithm for adaptive nonfunctional and functional requirements based web service selection and load balancing is developed.

Algorithm for parallelization and interdependency detection of individual data integration tasks that is based on predefined data integration task states and XPath addressing is developed [1].

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Fitness Landscape Analysis and Optimisation in Delivery Planning

Galina Merkuryeva and Vitaly Bolshakov (*Riga Technical University*)

***Keywords* – fitness landscape analysis, optimisation, planning, simulation, transportation.**

I. Introduction

Application of heuristic optimisation methods requires a time for the comprehensive study of the problem and tuning of specialized heuristic software applications. To perform more intelligent optimisation, fitness landscape analysis methods can be applied.

A fitness landscape analysis may be used for the selection of an appropriate optimisation method and its configuration for the specific problem [1]. Based on the results of landscape analysis, an optimisation framework can offer a more suitable metaheuristic algorithm with good parameter settings and thus save time while giving the best solution.

II. Fitness Landscape Analysis

In the paper, the fitness landscape analysis is used to evaluate the difficulty of an optimisation problem and investigate the ability of the evolutionary algorithm to solve particular optimisation sub-problems of integrated delivery planning. The fitness landscape consists of three main components: the set of genotypes, the fitness function and neighbourhood relations between the solutions. The structures of the fitness landscape (e.g., hills, valleys) influence the performance of an optimisation algorithm.

A number of different techniques for fitness landscape analysis by evaluating their structural characteristics are described in literature [2]. Statistical (e.g., the autocorrelation function) and information metrics (e.g., the information content, density-basin information) are defined to analyse the problem fitness landscape in order to get better representation of the optimisation problem search space. These techniques are used to measure the landscape ruggedness, estimating the diversity of the local optima, modality of landscape and the degree of regularity of random walks. Both statistical and information analysis is performed based on the sequence of fitness values obtained by different types of walks (random, adaptive, etc.) on the landscape.

III. Optimisation Problems in Delivery Planning

Three optimisation problems are discussed and analysed in the paper. All problems appear on different stages of the integrated delivery planning approach [3]. These are vehicle routing (VRP) and vehicle scheduling problems (VSP) with time windows that are solved within an operational level of delivery planning. The third problem is devoted to customers clustering with multi-objective optimisation.

Vehicle routing is a very frequent problem in logistics and is aimed at defining shortest routes taking into account such constraints as vehicle capacity and time windows of customers. Vehicle scheduling is applied to the routing solution and is aimed to find best schedules for vehicles, which perform more than one route during day.

To define natural grouping of input data, e.g., by customers geographical locations and their demand data, multi-objective optimisation can be applied. In order to apply fitness landscape analysis techniques, the multi-objective optimisation problem here is transformed to a single-objective problem with a weighted fitness function.

IV. Landscape Analysis Results

As there are currently not many reference values in literature to compare fitness landscape analysis results, a grid of experiments is created to compare values between different fitness landscapes. A series of experiments was performed on different problem instances with both analysis techniques and with different types of walks on the landscape. Further analysis and optimisation experiments are implemented and performed in HeuristicLab optimisation framework.

Structural differences between landscapes of dissimilar optimisation problems are identified and discussed. For example, Fig. 1 shows how different are the values for the autocorrelation function after one step for the considered problems. Landscapes of VRP seem to be more rugged than the ones of VSP and region cluster analysis problem.

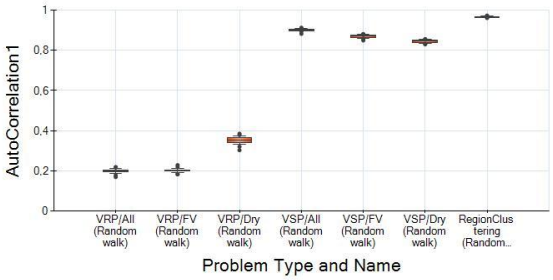

Fig. 1. Autocorrelation1 values for dissimilar problems and problem instances obtained in random walks.

The results of landscape analysis experiments show that each landscape measure and method of fitness landscape analysis can provide additional details about the structure of the investigated landscape.

V. Optimisation Results

Genetic algorithms and evolution strategy methods are applied to solve the defined problems. Detailed optimisation experiments with similar instances and parameters show that there are some small but important relations between the values of fitness landscape analysis measures and optimisation performance. The results of landscape analysis experiments are compared to the optimisation experiments and interpreted.

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Analysis of Latvian Higher Educational Institutions' Rating Data Using Clustering

Peter Grabusts (*Rezekne Higher Education Institution*)

***Keywords* – clustering algorithms, cluster validity, k-means, Rand index, rating data.**

I. Introduction

Data of Latvian higher educational institutions' rating have been published already for the fifth time. The methodology has been chosen as the basis for developing rating [1], where 10 criteria or indicators for evaluation have been considered. Rating data of Latvian state higher educational institutions for year 2012 [2] has been used as input data and the goal of the experiment was to show how by applying clustering methods the mentioned data can be analyzed in an alternative way.

During the research an attempt has been made to group the higher educational institutions with the help of k-means clustering algorithm [3] and to verify whether such division corresponds to the rate of certain higher educational institution in the rating data calculated mathematically. The validity of clustering has been evaluated with the help of Rand index [3]. Numerical values of rating indicators have been used in the research, obtained position in the rating table have not been taken into consideration.

II. Analysis of Rating Data

Sequentially choosing the number of clusters between 2 and 10 and by applying clustering algorithm k-means, the corresponding clusters and their components have been obtained (see Table I). The table shows that the higher educational institutions present in the first three clusters are in the top of the rating table. Similarly, it can be concluded that with respect to clusters 6, 7, 8 and 9 as a result of applying the algorithm the content of the five clusters calculated is constant. Differences occur starting from the sixth cluster. In order to verify clustering validity, quality index has been calculated – Rand index for ten clusters.

TABLE I

Obtained clusters and their components

N	Cluster content								
2	LU RTU RSU	Others							
3	LU RTU RSU	REA	Others						
4	LU RTU	RSU	REA	Others					
5	LU RTU	RSU	REA	LNAA	Others				
6	LU RTU	RSU	REA	LNAA	LJA	Others			
7	LU RTU	RSU	REA	LNAA	LJA	LMāA LMūA LKuA	Others		
8	LU RTU	RSU	REA	LNAA	LJA	LMāA LMūA LKuA	BA RPIVA RA ViA	DU LLU VeA LiepU LSPA	
9	LU RTU	RSU	REA	LNAA	LJA	LMāA LMūA LKuA	RPIVA RA ViA	DU LLU VeA LiepU LSPA	BA

Cluster structure C (consecutively with the number of clusters between 2 and 10 clusters) has been compared with specified divisions P containing various possible clusters.

Further, the total error has been calculated. Among all structures the lowest mistake occurs with 8 clusters, namely, an 8 cluster structure in this case is the most optimal. Figure 1 shows the calculated Rand index for 8 cluster structure.

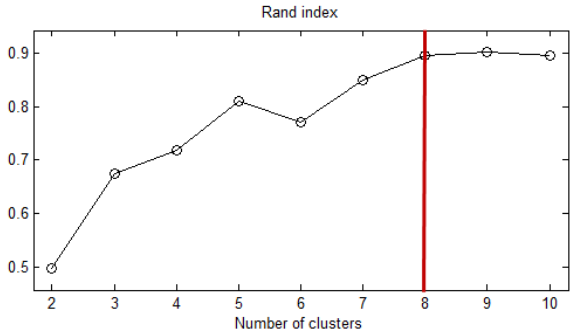

Fig. 1. Rand index in case of 8 clusters.

Thus, it has been identified that the selection of the given data is best characterized by 8 cluster structure. Taking into consideration the speeches voiced in the public space regarding the necessity for restructuring the higher educational institutions, from mathematical point of view 8 optimal clusters calculated could be further combined, upon obtaining "super cluster" with LU, RTU, RSU and REA. Resulting division into clusters is shown in Figure 2.

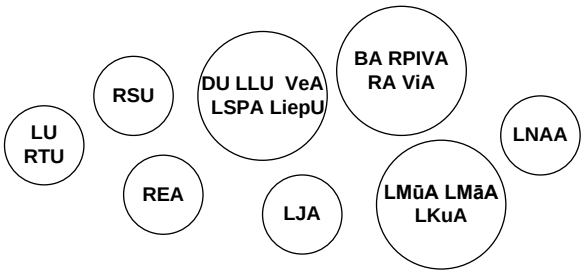

Fig. 2. Division of higher educational institutions in case of 8 clusters.

The results obtained in the research show that the higher educational institutions are divided according to the measure of their "closeness" that is defined by index values. Similarly, it has been concluded that the position in the rating table is significantly influenced by the value of index I8 (the number of publications).

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Development of an Integrated Geosimulation System for Public Transit Analysis and Planning

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***Keywords* – Geosimulation, public transit, multi-agent systems.**

I. Introduction

In recent years, new forms of simulation have come into popular use in urban, environmental and transportation research, supported by an array of interdisciplinary advances in many scientific areas, especially in the geographical and computer sciences. These models are most commonly based on Multi-Agent Systems (MAS) formalisms and are often applied to the simulation of spatial systems in dynamic and high-resolution contexts [1]. Modelling systems behaviour with explicit dependency of the geographic space requires a geographic information support that is usually accomplished with Geographic Information Systems (GIS).

A relatively new alternative for the research of urban systems is geosimulation [2], which tightly couples spatial data and process models within a single, integrated framework.

The domain of traffic and transportation systems is well suited to an agent-based approach because of its geographically distributed nature and its alternating busy-idle operating characteristics [3].

This paper describes an integrated software environment for multi-modal public transit simulation based on the principles of geosimulation that integrates the capabilities of multi-agent simulation, GIS and interactive visualization.

The goal of the presented research is to explore possibilities of population in one of Latvia's planning regions, called Vidzeme, to access state/municipal and other services by using public transport. It is also necessary to provide recommendations for public transit network development possibilities.

In order to achieve the defined goal, an integrated simulation environment for public transit analysis and planning is developed. It allows analysing the current public transport routing network optimality in Vidzeme by taking into account the population requirements, as well the available resources of public transit service providers.

II. Geosimulation System

For a simulation to be useful for transportation analysis and planning, it must not only support a wide variety of features, but it must also be applicable to large-scale, real-world applications.

The following list gives an overview of the main features of the developed transit simulation system:

- Multi-modal simulation of regional and intercity bus and train traffic.
- GIS based infrastructure for spatial data processing.
- Graphical user interface for simulation data preparation, presentation and analysis.
- Interactive real-time simulation and visualization with possibilities to speed-up the simulation runs by different time scales.

A. System Architecture

In Fig. 1, a general architecture of the public transit simulation system is shown.

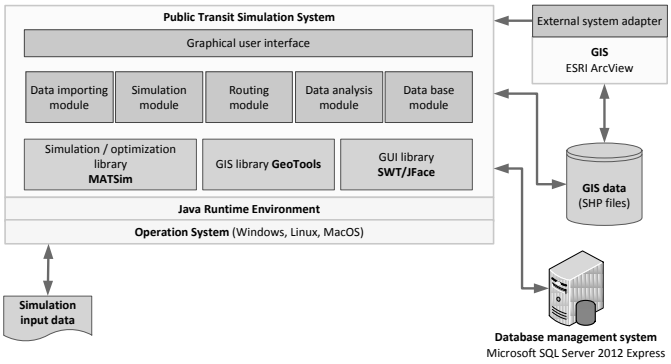

Fig. 1. Architecture of the public transit simulation system.

As the main system component the *MATSim* [4] (*Multi-Agent Transport Simulation Toolkit*) toolkit is there used that is an open source agent based transport simulation framework for handling of large transport simulation scenarios with millions of agents. For geospatial data handling the open source GIS library *Geotools* is used.

The model database contains both the spatial and non-spatial data of different bus and railway routes. The route data is stored and processed in a combination with transit schedules, fares and vehicle types.

III. Simulation Scenarios

This section describes how the transit simulation was applied for the Vidzeme region in Latvia, detailing the steps for data preparation as well as for configuring and running the simulation. It then analyses the computational performance of the large-scale application, as well as estimates the optimization possibilities and directions of the regional public transit network.

IV. Conclusions

This paper has presented an integrated geosimulation system for public transit analysis and planning that is a novel solution in the context of transportation planning in Latvia. The developed solution is considered as a useful tool in assisting decision-makers in development planning allowing evaluation of alternative public transit scenarios and planning options.

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E-Government Readiness in Latvia: Past and Present

Daiga Dumpe and Irina Arhipova (*Latvia University of Agriculture*)

Keywords **– e-Government, e-Governance, e-Government Readiness, Information and Communication Technologies, e-Readiness.**

I. Introduction

Progress in online service supply continues in most countries around the world. Many countries have put in place e-government initiatives and information and communication technologies (ICT) applications for the people to sophisticate public sector efficiencies and streamline governance systems to support sustainable development. Among the e-government leaders, innovative technology solutions have gained special recognition as the means to revitalize arrear economic and social sectors.

II. Materials and Methods

Many similar consequences, parameters and terms arise, among which is one important term that measures the capability of a government or an enterprise in adopting e-Governance initiatives - e-Readiness. E-readiness is a synonym for e-government development index (EGDI) [2]. To comply with e-Governance, one must first be e-Ready. Thus, e-Readiness is the ability to use information and communication technologies to develop one's economy and to foster one's welfare. A key indicator of e-readiness is infrastructure and in developing countries this is often a key challenge to the advancement of society. There are many elements to e-readiness, such as infrastructure, telecommunications, Internet connectivity and skills set as outlined in the contemporary resources [3], [6].

Six out of ten countries of Northern Europe (Table 1) were among the world leaders in e-government development index.

TABLE I
E-Government Development in Northern Europe during 2008-2012

Country	E-gov. development index			World e-gov. development ranking		
	2012	2010	2008	2012	2010	2008
United Kingdom	0,8960	0,8147	0,7872	3	4	10
Denmark	0,8889	0,7872	0,9134	4	7	2
Sweden	0,8599	0,7474	0,9157	7	12	1
Norway	0,8593	0,8020	0,8921	8	6	3
Finland	0,8505	0,6967	0,7488	9	19	15
Estonia	0,7987	0,6965	0,7600	20	20	13
Iceland	0,7835	0,6697	0,7176	22	22	21
Lithuania	0,7333	0,6295	0,6617	29	28	28
Ireland	0,7149	0,6866	0,7296	34	21	19
Latvia	0,6604	0,5826	0,5944	42	37	36

Some other Northern European countries also fortified their e-services, providing greater access and inclusion to citizens. Though they did not maintain their global ranking, other countries such as Lithuania (0.7333 – 29th), Ireland (0.7149 – 34th), and Latvia (0.6604 – 42nd) also improved e-government applications, networking, and other web services [3].

E-government development index (EGDI) consists of three indexes - the online service index (TPI), the telecommunication infrastructure index (TII) and the human capital index (CKI) [2].

Analyzing EGDI and its components for Latvia (Figure 1), it is evident that EGDI has a tendency to increase, which shows that government progress in e-government.

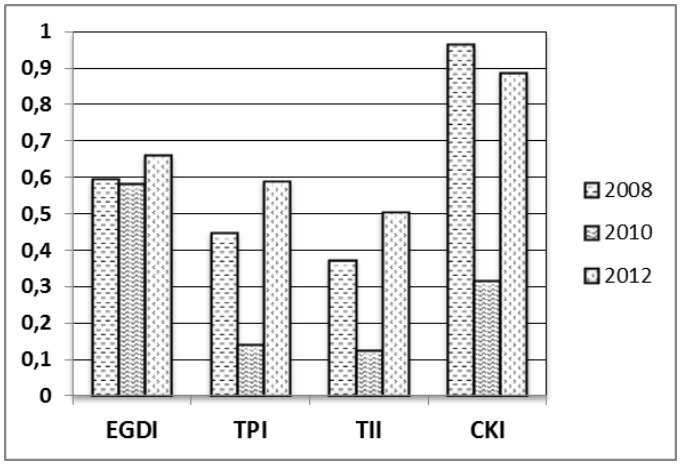

Fig. 1. E-Government Development Index and Components for Latvia.

By studying all three components of EGDI, it is clearly visible that there was a sharp decline in all of the components in year 2010, but in the year 2012 there was a significant increase. Comparing years 2008 and 2012 research shows that the index of development is increasing, excepting CKI, which had previously been very high. While the low drop for CKI in year 2012 significantly unaffected the total EGDI.

III. Results

Countries at all levels of development are still affected by a lack of integration of administrative simplification with e-government development plans, lack of infrastructure and human resource capacity and a gap between e-services supply and demand. Low-income countries, in particular, continue to contend with traditional barriers to ICT investment such as lack of technical skills, high costs of technology, and ineffective government regulation.

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Development of Sampling Drillhole Accounting System

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Keywords **- Sampling drillhole accounting system, groundwater monitoring data.**

I. Introduction

This work addresses a hydrological data collection, storage and data flow management problem. The inspection of data flow, management and reproduction solution of the Latvia Environmental, Geology and Meteorology Agency data system was done. After summarizing data flow information of LUA (Latvia University of Agriculture), Faculty of Rural Engineering, department of Environment and Water Management, monitoring data, there was decision to establish an information system for data storage and display. The new information system for Web environment was created using HTML, PHP, MySQL programming technologies, to make system convenient and practical to use.

II. Research

Water quality, availability and use always have been important. Especially nowadays it has become important, because the use of fresh food quantity and quality is tending to decrease [1]. Influenced by major climatic changes, increase in the number of population, intensive economic activity, as well as the active use of natural resources [2]. For situation case study scientific research is rapidly evolving.

Within the ESF project "Establishment of interdisciplinary scientists group and modeling system for groundwater research", unit of Jelgava (LUA), since December 2009 there is explored the impact of agriculture on groundwater in Latvia. This process involves groundwater quality monitoring, which is provided in six places, where 20 sampling drillholes are situated.

The sample of various water quality indicators on a regular basis has been taken, and as the result there is a large amount of monitoring data sets. At present there is no united data storage system, data is stored on different workstations, but they are not organized in one place and there is not possible single access for all of the users. The acquired data sets for water level observations, the chemical composition, surface and drainage runoff and other indices provides an opportunity to design information system (IS).

Within the scientific unit involved in the project, was decided to develop a sampling drillhole accounting system for hydrogeological research data, where to store the data collected within the time project, as well as of previous monitoring data and additional information required for data analysis.

The new system should be able to store data in one place, with the option to select, view, graph, download, compute elementary statistical calculations, and display information about drillholes on the map. The system must be available to everyone who wants to get basic information about the project, aims and tasks of it. The system must be easy to use for staff of project, faculty department and students who are involved in scientific research work. For easier access system must be usable from the World Wide Web.

III. Methodology

A. Analysis of currently used hydrogeological information systems

Environmental monitoring program in Latvia is coordinated by Latvian Environment, Geology and Meteorology Centre (LEGMC). LEGMC provides observations of the meteorological, hydrological, surface water quality, groundwater, precipitation, and water quality indices.

As the systems for monitoring data are highly specialized and designed for a narrow range of users, for existing system analysis the solution of LEGMC website and database system is chosen.

B. Studies of hydrogeological sampling process, data flow and user role research

In LUA monitoring stations various data is being collected: groundwater levels and electrical conductivity (EVS), the oxygen content in water (O_2), runoff, precipitation, phosphorus and nitrogen in the groundwater and drainage and surface run-off waters.

The various data time resolution is different; readings from data loggers are obtained on a daily basis (it is possible to obtain data in the hours, minutes or even seconds), but other data obtained by manually measuring - once a month. The acquired data sets for water level observations, the chemical composition of runoff, as well as other indicators provide an opportunity to design information system.

C. The choice of appropriate tools for system development

The main programming language for system development was chosen by the analytical hierarchy process method, the other tools was selected to be easily compatible with the main system of coding language - PHP. Tools for development: PHP, My SQL, HTML, CSS, Google Maps JavaScript API, the Google Chart API, CkEditor. All of the used tools are open-source, free of license charge.

IV. Results and Discussion

The sampling drillhole accounting system is easy to use and supplement. The system is functional and representative, respectively, is does provide information about the department, the monitoring done by the project, its aims and activities, and also contains observational data, and contains functionality that the data can be viewed, selected and used.

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Project Phase Dependent Configuration of Project Management Information Systems

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***Keywords* – project management information system, PMIS configuration, XCPM.**

I. Introduction

A project management information system (PMIS) is a standardized set of automated tools and techniques used in project management (PM) for planning, execution, management and closing of the project as well as for collecting, combining and distributing project information [1]. PVIS provides a wide range of functions directly supporting PM as well as tools for its configuration and modification. An approach for configuration of PMIS (referred to as ConfPMIS) has been developed [2]. For each project, it is necessary to find the most appropriate configuration depending on project situation and needs of the particular user's role. These needs also change during the different project phases. However, the ConfPMIS ensures definition of only one configuration for all project phases and all users.

The objective of this paper is to adapt the ConfPMIS for definition of requirements that depend upon the user role and project phase.

II. Background

The ConfPMIS allows configuring the chosen PM software application according to the project requirements and the configuration process is supported by PM knowledge [2]. The PMIS configuration requirements are defined with XML scheme for configuration of PMIS (XCPM) [3]. This scheme includes project data and process description.

The project life cycle consists of phase, iteration or other division. The classical project life cycle according to the PMBOK [1] consists of five phases: initiating, planning, executing, controlling and monitoring and closing. The phases for software development projects depend of the chosen software development model. Data and information processing requirements for users also varies from phase to phase. The user needs are managed through its role taken in the project.

An example of the role needs depending upon the project phase is shown in Table I.

III. Configuration problems

Main problems for configuring PMIS depending upon the user role and project phase are:

1) Events or milestones that identify the change of phase are needed.
2) PVIS must provide the process that handles the events of phase transition and reconfigures the system.
3) XCPM must provide multiple definitions of the role views to data element depending upon the phase.
4) XCPM must provide multiple descriptions of one process configuration depending upon the phase.

TABLE I

Example of the role needs depending upon the project phase

Role / Phase	Project manager	Performer
Planning	Project Plan Resource List Resource Calendars Deliverables Lesson Learned Risks	Calendar Project Plan
Executing	Project Plan Calendar Task Deliverables Reports Timesheet Change Requests Issues Lesson Learned Risks	Project Plan Task Calendar Deliverables Timesheet Change Requests Issues Lesson Learned
Closing	Reports Project Plan Change Requests Issues Lesson Learned Risks	Calendar Closing Report Lesson Learned

IV. Solution and its application

To creating the PMIS configuration depending upon the project phase, the existing ConfPMIS is supplemented with:

1) The new elements in XCPM for identification of the phase;
2) The definition of lifecycle process that ensures identification of the phase change.
3) The transformations of reconfiguration in PMIS. Activities in these transformations depend upon the chosen PMIS and it configuration options. For example, MS Project Server ensures storage and usage of all options for changeable configuration, but MS Team Foundation Server only partially.

V. Conclusions

The main benefit of the configuration that varies depending upon the project phase is that each role has access to its required data, and these data are tailored to the particular stage of project execution.

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Ground Space Monitoring Technologies

Julija Petuhova, Yuri Merkuryev (*Riga Technical University*) and Vyacheslav A. Zelentsov (*St. Petersburg Institute for Informatics and Automation of RAS*)

Keywords **– ground space technologies, natural technological systems (NTS) monitoring.**

I. Introduction

Effective management of local authority services, facilities, territories and ecosystems requires the application of a variety of monitoring systems, which allow obtaining, processing and visualization of necessary data in a form convenient for supporting decision making. The complete understanding of complex natural technological systems (NTS) which are usually elements of every local authority services and ecosystem is only possible when combining heterogeneous data processing methods, as ground and space technologies integration.

This paper presents the concept of INFROM project which is aimed at developing the framework for monitoring of NTS by integration of ground space technologies.

II. Application of Ground Space Technologies

Natural resource management is a broad field covering many different application areas, e.g. monitoring of agriculture, oceanography, forestry, roads, transport, urban studies, fuel-energy complex, housing and communal services, ecological environment of land-use and estate objects, hazard assessment (e.g., storm, flooding, fire, geothermal exploration, earthquake), nature management, quarrying and coordination of resource-mining objects, and many others [1].

Most complicated is monitoring of complex NTS. They are hydroelectric power station, bridges, engineering communications which are under the risk of floods, as well as forestry with included elements of settled infrastructure. Such objects are usually specified by a variety of heterogeneous elements whose monitoring requires application of different facilities (see Table 1).

TABLE I

MONITORING OBJECTS AND ELEMENTS

No.	Monitoring objects	Monitoring elements	Monitoring results
1.	Technological assemblies, devices	Sensors, detectors	Parameter values of controlled assemblies and devices
2.	Facilities and constrictions	GPS/GLONASS sensors	Parameters of buildings and constructions oscillations
3.	Operating personnel	Local positioning and identification systems sensors (RFID, biometrics)	Location coordinates of personnel in dangerous facilities
4.	Industrial territory, environment	Earth remote sensing data	State of the water and surface objects, flooding, release of chemically hazardous substances, etc.

III. INFROM Technologies

The general monitoring approach involves application of autonomous ground monitoring facilities. Lately, popular become GPS/GLONASS sensors, in some cases there are sensors for operating personnel and environment detection [2]. Although, applying several monitoring systems, the processing of results is conducted separately, so the final decision making, based on all provided information, is under responsibility of an operator (or manager). This makes the process of decision making to be a real challenge in a situation when the valid decision should be taken based on forecasts received from different monitoring systems, as well as decision making in emergency situation with a lack of time.

In spite of existing monitoring systems, INFROM technologies are focused on integrated processing of different data types. This allows providing users with qualitative information about current and future state of monitoring objects taking into account their interaction with the environment. There are two ways to achieve this goal:

- wide application of Earth remote sensing data (space technology);
- application of modern artificial information technologies for integrated processing of heterogeneous data and knowledge and visualization of result by means of geoinformation systems.

INFROM technologies consist of:

- conceptual framework for intelligent monitoring and control of NTS based on mixed-type data processing;
- IT tools for analysis and synthesis of an integrated intelligent platform for the cross-border NTS monitoring and control.

The structure of the intelligent IT includes these elements:

- unified models representing basic knowledge about monitored objects;
- methods, algorithms and methodologies for automatic synthesis of monitoring systems, including verification and optimisation;
- methods, algorithms and methodologies for structural and functional synthesis of information systems layout;
- operational environment for automated software design, with implementation of processes both monitoring and management;
- the executive system for continuous distributed input data flow processing.

IV. Conclusions

The monitoring of natural-technogenic objects is focused on the issues of changing ecosystem, geosystem, climate and providing services for sustainable economy, healthy environment and better human life by the following activities:

- Early warning of natural and anthropogenic disasters.
- Technogenic object security.
- Land cover/land change, natural resource usage.
- Human health and the preservation of the environment.

V. Acknowledgements

This research is supported by the project No.ESTLATRUS/2.1./ELRI-184/2011/14."Integrated Intelligent Platform for Monitoring the Cross-Border Natural-Technological Systems" as a part of "Estonia-Latvia-Russia Cross Border Cooperation Programme within European Neighborhood and Partnership instrument 2007-2013.

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Optimization of Business Processes "Receivables Management"

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Keywords **– Receivables Management business process, credit policy, business process optimization, Six Sigma, mathematic model.**

I. INTRODUCTION

Business process "Receivables Management (RM)" is a key position as in the system of financial management of telecommunication company, so in its operating activities. The emergence of receivables is an objective result, due to the risk during the settlement between counterparties on the basis of business transactions. It accounts receivable may result in a working capital deficit and serve as a means for increasing commodity circulation.

The necessity for optimization of the business process is determined by its direct influence on financial performance.

RM allows the telecommunications company to provide an adequate level of profitability, maintain a competitive position in the market. So, the question of optimization of this business process is appeared.

II. RECEIVABLES MANAGEMENT: FOUNDATIONS FOR MODEL-OPTIMIZATION TO INCREASE EFFICIENCY

Exploring the characteristics of telecommunications enterprises, business processes which are based on the optimal structural model enchased Telecom Operation Map, note that the unit processes "Payment of bills and accounts RM" is part of a group of business processes "Customer Relationship Management." Peculiar movement of business process management receivables from group support processes management in operating activities shows it prioritization within the client-oriented approach.

However, the low level of maturity of process management at Ukrainian enterprises causes of some problems in the management of accounts receivable. Analysis of the telecommunications companies allowed to provide such barriers to effective implementation of business process, namely: (1) lack of a unified approach to the understanding of accounts receivable and its constituent elements; (2) lack of reliable information about the terms of repayment; (3) lack of regulated work with overdue accounts receivable; (4) absence of analytical data on the growth of costs associated with an increase in accounts receivable; (5) lack of assessment debtors and their differentiation; (6) operations within the studied business process shared between different departments, there are no regulations of their interaction and not clearly defined process owners.

Optimization of Business Process accounts RM should aim to overcome these negative trends and to implement measures to minimize risks associated with increasing levels of debt.

Optimization of business processes should be performed in the methodology Six Sigma. Using this concept allows the company to develop measures to minimize the causes that lead to a decrease in the efficiency of processes based on the measurement of output parameters – indicators. The analysis of statistical information on business process carried out corrective actions aimed at improving the process.

In the design of effective management of receivables, the company should take measures aimed at deciding on the terms of service. One of these measures is to form accounts (or credit) policy.

At the heart of motivation monetary policy development is differentiation of customers with different parameters [1]. Formation of the principles of monetary policy reflects the conditions of offers of services within a client-oriented approach and aims to increase the efficiency of operational and financial activity of enterprise. The most significant and at the same time the least studied aspects of the enterprise credit policy is the question of debtors assessment, likelihood creation of debt in terms of consumers and design rules of service to achieve the optimal level of receivables.

Assessment of debtors is based on the proposed system of indicators: (1) equivocality coefficient; (2) receivables turnover; (3) collection period; (4) part of receivables; (5) part of bad receivables; (6) importance of customer; (7) part in total service; (8) stability of a service request.

Determining the probability of repayment of receivables by service customers of the telecommunication company is based on econometric modeling using lohit-regression.

The modelling of rules for granting and payment of services is based on the differentiation of customers depending on the calculated probability index. Grouping customers and providing them different conditions of services using will allow to achieve the optimal level of receivables for enterprise.

III. CONCLUSIONS

In the modern terms of business for telecommunications companies particularly important issue is that of effective accounts receivable management and optimization of this process.

The research developed a set of measures to optimize the business process in the method of Six Sigma, namely: (1) problems in the management of accounts receivable are defined; (2) formed a system of indicators to measure business process; (3) detailed eTOM process group "Payment accounts and accounts RM"; (4) divided responsibility for the process realization among employees; (5) the system of assessment debtors is created; (6) the econometric model of the probability of receivables formation is offered; (7) the model of forming service rules granting is proposed; (8) some approaches to determining the optimal level of receivables are proposed.

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Pricing of Financial Actives with Serial Correlations in Returns

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Keywords **– Discrete time stochastic difference equation systems, ARCH models, Markov chain, Black Scholes option pricing formula, option Greeks.**

I. Introduction

In the last years, a lot of papers were dedicated to the problem of autocorrelation in asset returns. Autocorrelation in short term stock index returns has been analyzed by Lo and MacKinley in [1]. They argue that positive autocorrelation shows up in index returns due to presence of stale prices of stocks included into the index. The above-mentioned happens when the increase in the number of stocks comes from inclusion of small capitalization stocks, which are known to trade less frequently than large ones. Due to infrequent trading in small capitalization stocks the observed index value does not reflect the true market value of the underlying stock portfolio as the index value is calculated using the last observed stock transaction prices. But when your discrete model contains unobservable state variables (like conditional variance) in the system, the likelihood of a nonlinear stochastic differential equation system observed at discrete intervals can be very difficult to derive, especially Nelson [11] is one of the first to partially bridge the gap by developing conditions under which ARCH stochastic difference equation systems converge in distribution to Ito processes as the length of the discrete time intervals goes to zero.

II. Serially Correlated Asset Price Process

Mezin [12] has found a relationship between asset price volatility, asset return volatility and asset return autocorrelation coefficient. The analytical solution obtained reduces to the well known Black Scholes option pricing formula for the special case of autocorrelation in asset returns. In Mezin's paper were created a framework of a log normally distributed asset price *S* with serially correlated returns and derived an analytic option pricing model, capable of providing an exact solution for a value of derivatives on such an asset.

The developed framework of random, normally distributed, process *x*, such that *lnS = x*, with autocorrelated increments ξ that have volatility σ^2 and autocorrelation coefficient ρ. Autocorrelated returns ξ were constructed using independent identically distributed normal random variables ε with arbitrary volatility σ_ε^2.

The simplest mathematical model describing development of stock's price S_t and involving assumption of serial autocorrelation in stock's returns under commonly used condition on risk neutrality of probabilistic measure P may be written in the following way

$$S_{t+1} = S_t(1+\varepsilon^2\mu+\varepsilon\sigma y_{t+1}) \qquad (1)$$

where y_t is a Gaussian random sequence with zero mean and unit variance. When it is considered that these random numbers are independent we may write that y_t follows AR(1):

$$y_{t+1} = \rho y_t + \sqrt{1-\rho^2}\,\xi_{t+1}$$

where $\{\xi\}_t$, $E\xi_t = 0, E\xi_t^2 = 1$ is i.i.d. Gaussian sequence.

The result obtained from model showed that the presence of return autocorrelation affects the volatility and expected value of asset price, making them functions of correlation coefficient and time to expiration. It was found that within the framework the asset price volatility can no longer be expressed as $\sigma^2 t$ where σ^2 is the variance of asset price returns. This finding implies that the traditional approach to estimating asset price volatility contains bias proportional to autocorrelation coefficient.

Both the above-mentioned parameters (volatility and autocorrelation coefficient) can be estimated using historical data, Hull (1999), Andrews (1993). Instead of heuristically based approach, it is possible to assume limit theorems which have been proposed by Carkovs [13]. These results states that for small ε, equation (1) can be approximated by distribution of vector $\{X(t_1), X(t_2), \ldots, X(t_n)\}$ defined by solution of stochastic Ito differential equation:

$$dX(s) = a(X(s))ds + \sigma(X(s))d\omega(s)$$

III. Conclusions and Further Research

We studied an analytical solution to such problem – tested a distribution of the asset returns volatility with different levels of autocorrelation and described this analytical solution with stochastic differential equation. Further we obtained results for option Greeks, which is broadly used in risk management. The approach can be applied to discrete time stochastic difference equation systems where volatility is stochastic or it is modeled by generalized autoregressive conditional heteroscedasticity process.

Another topic which was taken into account is how the convergence of discrete time stochastic difference equation to its continuous time approximation depends on autocorrelation coefficient.

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Simulation-based Cluster Analysis and Optimisation of Vehicle Schedules

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***Keywords* – tactical planning, vehicle scheduling, vehicle routing, cluster analysis, optimisation, simulation.**

I. Introduction

Nowadays, delivery planning and scheduling is a high commercial priority task in transport logistics. This problem is relevant to deliveries of multiple products from a distribution centre (DC) to a net of stores, when delivery time constraints are predefined. In real-life applications the problem has specific stochastic performance criteria and conditions, as well as a high number of decision variables, which complicates the solution process.

II. Integrated Delivery Planning Methodology

The methodology [1] is aimed at selecting an effective product delivery tactical plan for the upcoming week and optimising product transportation routes and parameters of corresponding vehicle schedules (Fig. 1).

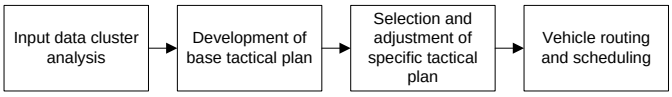

Fig. 1. Steps of a planning procedure.

First, typical dynamic demand patterns are defined by clustering historical daily demand data for different planning weeks. Then stores are grouped based on their geographical locations. Here, a cluster analysis is performed that embeds additional techniques which allow making groups of stores more homogeneous by the product demand per region. Next, several base tactical delivery plans each representing an appropriate product delivery time table for a specific group of stores and demand pattern are developed. Furthermore, a base plan is selected and adjusted to match a new or forecasted demand. Finally, vehicle routing and scheduling is performed by using optimisation meta-heuristic methods and software.

III. Data Analysis and Clustering

A. Cluster Analysis of Planning Weeks by Product Demand

Here, the *K*-means clustering algorithm and silhouette validation method [2] are used to divide a variety of dynamic demand curves and corresponding planning weeks into clusters and find the best number of clusters that represent groups of weeks with similar patterns. As far as the product demand is dynamic and variable, to assign an appropriate cluster an NBTree-based classification model, which induces a hybrid decision-tree and Naive-Bayes classifiers, is built.

B. Cluster Analysis for Assigning Stores to Regions

To reduce computational costs grouping of stores assumes that from DC a vehicle delivers only to stores from a similar group. This can reduce the dimension of the vehicle scheduling and routing problem. To solve the problem, the multi-objective optimisation Nondominated Sorting Genetic Algorithm II is applied, and solutions of the Pareto front provide good clustering results.

IV. Tactical Delivery Planning

When demand patterns are identified and stores are grouped, base tactical plans are developed taking into accounts the following main criteria: 1) the total quantity of delivered goods to all stores should be leveraged over the week days; 2) the delivery size for each store should be uniform during the whole week; 3) the number of planned deliveries should be minimized. To find the problem solution, heuristic techniques are applied.

V. Operational Level Planning

On the operational level of the delivery planning, vehicle routing and scheduling tasks are performed in order to determine the best routes and schedules for the vehicles to deliver goods from DC to stores. Both tasks are complicated with time window constrains to be satisfied.

A. Vehicle Routing Problem

The vehicle routing problem aims to route multiple vehicles which have to visit stores within a certain time frame with the shortest total distance. To find the problem solution, optimisation experiments using the Island Offspring Selection Genetic Algorithm were performed.

B. Vehicle Scheduling Problem

The vehicle scheduling problem is a transportation problem aimed at assigning a set of scheduled routes to a set of vehicles to minimise the total idle time for all vehicles. To enhance the quality of optimisation results, permutation encoding for the VSP solutions is applied. Also, the vehicle schedule simulation model has been developed to estimate an efficiency of solution candidates [3].

VI. Conclusions

An integrated approach to product delivery tactical planning and scheduling allows identifying typical dynamic demand patterns and corresponding product delivery tactical plans, and finding optimal parameters of vehicle routes and schedules. This allows reducing the effect of product demand variation on the delivery planning process and avoiding numerous time-consuming adjustments of tactical plans as well as ensures more qualitative solutions of the delivery and transportation task while decreasing its computational costs.

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Logistics Information Systems: An Overview

Oksana Soshko and Yury Merkuryev (*Riga Technical University*)

***Keywords* – Logistics, supply chain management (SCM), information technologies (IT), information systems (IS).**

I. Introduction

Logistics is a leading power for promoting information technology evolution in non-military area. The integration of logistics systems into global supply chains requires an application of modern information technologies, and moreover enunciates new specifications and standards for IT developers. However, the variety of IT products, including information systems diversity, makes the process of selection an appropriate logistics information system to be inexplicit. The current paper is focused on exploring the functionality of logistics information systems.

II. Logistics information technology

According to the Council of SCM professionals [1], SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities including coordination and collaboration with suppliers and customers. In its turn, logistics management is that part of SCM that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements. Within current paper, the both logistics and supply chain management are considered to be convertible terms.

However it is important to distinguish information technology and information systems in the context of logistics as sometimes those terms are used as coequal. Information technology is defined as both computing and telecommunication [2]. Information system is expressed as a network of hardware and software that people and organizations use to collect, filter, process, create, and distribute data.

Logistics information technologies include global positioning systems (GPS), geoinformation systems (GIS), object identification technologies, i.e. biometrics, widely spread bar-coding and recently promoted radio frequency identification systems (RFID). As communication it includes mobile technologies, Electronic Data Interchange (EDI), satellite navigation, and Internet technologies as well.

Logistics information systems (LIS), as well as SCM information systems are used to coordinate information between internal and external customers, suppliers, distributors, and other partners in a supply chain [3]. Enterprise Resource management systems (ERP) are the best known illustration of information systems used in logistics companies. ERP are focused on the single company operations and usually have SCM module within it.

III. Logistics information systems

Depending on the goals of managerial decisions, logistics information systems can be divided into two categories: supply chain planning systems and supply chain execution systems.

Supply chain execution systems are concerned with acquiring, processing and communication raw data about the company's supply chain, and with the dissemination of reports summarizing data, mostly in real-time. Therefore it could be categorized as transactional IS [2]. Examples are ERP, WMS (Warehouse Management Systems), TMS (Transportation Management Systems), OMS (Order Management Systems), MES (Manufacturing Execution Systems) etc.

Supply chain planning systems belong to analytical systems which are focused on strategic and tactical planning horizon. They include Advanced Planning and Scheduling systems (APS), forecasting systems, and others strategic and tactical planning systems etc. The distinctions between transactional and analytical systems are presented in Table 1.

TABLE I
Comparison of transactional and analytical IS

Aspect	**Transactional IS**	**Analytical IS**
Time frame addressed	Past and present	Future
Purpose	Communication, data management	Forecasting and decision making
Business scope	Myopic	Hierarchical
Nature of databases	Raw and lightly transformed objective data	Raw, moderately and heavily transformed data that is both objective and judgment
Response time for queries	Real-time	Real-time and batch processing
Implications to business process redesign	Substitute for eliminate inefficient human effort	Coordinate overlapping managerial decisions

Both analytical and transactional systems are created to assist managers in making supply chain decisions. Although apart them, there is a freestanding class of Decision Support Systems (DSS) which are designed for solving unstructured problems and provide users by mathematical, statistical and other models, which allow elaborating different alternatives of the solved problem and theirs evaluation. DSS systems usually include elements of artificial intelligence, as for example data mining.

IV. Conclusions

Nowadays multiplicity of logistics management task requires the application of information systems. However, often a selection of information system becomes a problem itself and leads to disappointment in the results achieved by investments in IS. Illustratively, many companies expect some analytical capabilities from ERP systems, however in fact they are transactional information systems. The selection of appropriate LIS requires understanding of managerial goals, as well as detailed analysis of provided LIS functionality.

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Assessing the Need for Information Technology Control Environment Establishment

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***Keywords* – IT controls, IT control environment, ITGC audit.**

I. Introduction

Information Technology (IT) controls are specific activities performed by persons or systems designed to ensure that business objectives are met. IT control objectives relate to the confidentiality, integrity, and availability of data and the overall management of the IT function of the business enterprise [1]. The IT control environment is an interrelated set of IT controls that are applied to an integrated IT environment. IT controls are defined and described in several international standards and methodologies like COBIT, ITIL and ISO 27001, 27002.

Empirical observations show that organizations frequently do not establish an appropriate IT control environment. The main aims of this survey are: 1) to assess efficiency of the IT control environment in Latvian companies; and 2) to evaluate impact of the IT control environment on organizations' performance in their core business areas that are dependent or closely related to IT.

II. Survey Design

In this survey, results of IT general controls (ITGC) audit are analysed at 61 Latvian companies, operating in following industries – insurance, technology, energy, transports & logistics, industrial production, real estate, wholesale, retail, service, finance and pharmacy.

The ITGC audit was held as a part of the annual financial audit. The following steps were performed during the ITGC audit: (1) understanding of organization IT environment; (2) understanding and evaluation of internal control components related to IT; (3) understanding, evaluation and testing of relevant ITGCs (scoping of relevant ITGC work; evaluation of design of relevant ITGCs; testing of relevant ITGCs; evaluation of results of ITGC testing).

To understand the IT related controls in organizations, the following areas were reviewed – IT governance, program development/program changes, computer operations and access to programs and data.

III. Survey Results

The research results show that 38% of identified deficiencies are related to access management area, 37% - to computer operations area, 13% - to program development/program changes area and 12% - to IT governance area. The most important of frequently identified deficiencies are: information systems (IS) are not protected with passwords or passwords security settings are weak, unclosed/unneeded user accounts, backup copies are stored in inadequate locations, IS changes are not tested prior implementation, internal wireless network is protected with a comparatively weak encryption protocol.

Figures 1, 2 and 3 show risk maps for three different groups of organization – (1) organization group A (organizations without IT governance and without IT control environment), (2) organization group B (organizations with IT governance, without IT control environment), (3) organization group C (organizations with IT governance and IT control environment). The figures show that risks are more significant for organization group A.

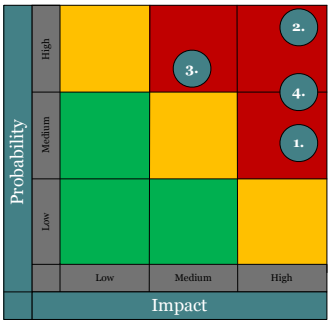

Fig. 1. Organization group A.

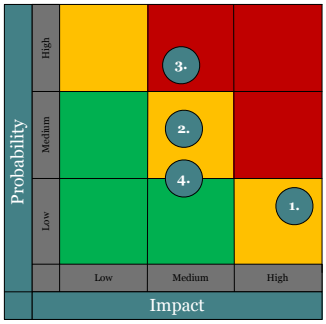

Fig. 2. Organization group B.

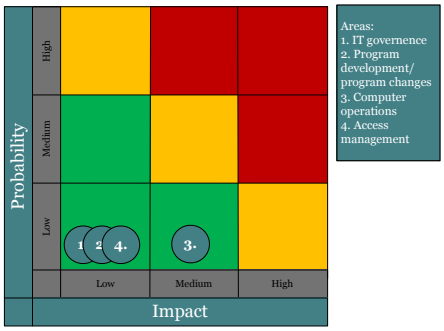

Fig. 3. Organization group C.

Additionally, it is observed that in several organizations IT managers lack the competence of all IT performed functions/administrated resources; IT environment controls are often made just before the audit; overall organizations internal IT control maturity level is low, most often – 2 (according to COBIT (0 non-existent, 1 initial/*ad hoc*, 2 repeatable but intuitive, 3 defined process, 4 managed and measurable, 5 optimized)); better IT controls are present in banks, international corporations and companies with the implemented quality management system.

IV. Conclusions

The research results provide evidence that organizations with the IT control environment (compared to organizations without the IT control environment) have a fewer deficiencies, and there are a fewer IT related risks; potential impact and probability of identified risks is lower; the IT governance is on a higher level; IT operate more effectively helping to achieve the quality goals.

These observations suggest that the IT control environment helps organizations to achieve better quality indicators and to reduce the IT related risks.

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Wavelet Transform Modulus Maxima Approach for World Stock Indexes Multifractal Analysis

Andrejs Pučkovs and Andrejs Matvejevs (*Riga Technical University*)

***Keywords* – Direct Continuous Wavelet Transform, Skeleton, Fractal Partition Function, Moment Generating Function, Local Scaling Exponent Spectrum, DJIA, AEX, CAC40, DAX30, IBEX, FTSE100, Nikkei225, SMI, STI, Wavelet Transform Modulus Maxima approach, Multifractal Formalism.**

I. ABSTRACT

The idea of this research is to provide an approach that is able to indicate difference in multifractal spectrums of various World Stock Indexes. This approach should be able to fix difference in multifractal behavior of various World Stock Indexes. This approach should be beneficial for the most European and Asia stock indexes forecasting and simulations.

II. INTRODUCTION

Financial markets are a complex system, which requires a deeper and comprehensive understanding of financial risks. Needs new risk measurement approaches and methods. For many years economists, statisticians, and stock market players have been interested in developing and testing models of stock price behavior.

There is one general assumption about stock price behavior. Expect the price of a stock or any other asset trading on the stock market is a multifractal process with fat tails and long-term dependency. Assumption about multifractal behavior of stock indexes goes to latest 90-Th and based on Multifractal Model of Asset Return (MMAR), which was maintained by B. Mandelbrot, L. Calvet and A. Fisher. The Multifractal Model of Asset Returns (MMAR) provides the price of the asset by compounding a Fractional Brownian Model with a Trading Time. The Trading Time is a multifractal deformation of the time.

In accordance with MMAR, stochastic process ***X(t)*** is called multifractal, if it has stationary increments and it satisfies:

$$E\left[\left(\left|X(t)\right|\right)^{q}\right] = c(q)\cdot t^{\tau(q)+1}. \qquad (1)$$

where: ***X*** – stochastic process, time series;
t – time;
q – some positive number $q = Q, Q \in [0,1]$;
τ - local scaling exponent;
C – moment coefficient, that is independent from ***t***.

In order to satisfy equation and estimate financial time series data local scaling exponent following methods are used.

III. METHODS

Multifractal analysis is provided using so called Wavelet Transform Modulus Maxima Approach, which involves two basic aspects: Wavelet aspect (Direct Continuous Wavelet Transform, Skeleton construction [2] and Multifractal formalism [3] (Fractal Partition Function calculation Moment Generating Function calculation [1], Multifractal Spectrum estimation).

Both aspects of Wavelet Transform Modulus Maxima Approach (Wavelet aspect and Multifractal formalism) are implemented for Multifractal analysis of World Stock Indexes.

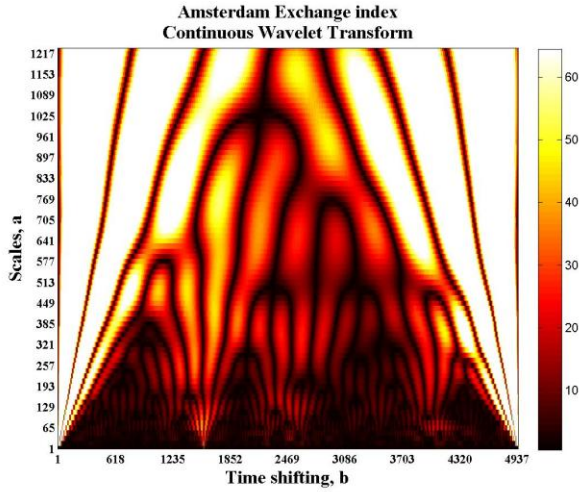

Fig. 1. AEX index Direct Continuous Wavelet Transform.

After Multifractal Spectrums are estimated, spectrums are approximated with polynomial coefficients. After all Multifractal Spectrums cross correlation analysis is done.

Here and further objects of research are considered.

IV. OBJECTS

In this article, most European and Asia stock indexes are considered. Objects of experiment are 9 worldwide stock indexes: Dow Jones Industrial Average, AEX, CAC40, DAX30, IBEX, FTSE100, Nikkei225, SMI, STI. The Dow Jones Industrial Average index is considered for the whole period available: from 01/01/1900 to 01/05/2012, other mentioned indexes were analyzed during the following period: 05/07/1993 to 01/05/2012. In this research World Stock Indexes multifractal nature is analysed.

V. SUMMARY

This research proves that all objects of research demonstrate strong multifractal properties. Multifractal spectrums of various World Stock Indexes are quite similar. That assumes an 'ability' to fix, hold and maintain information in 'certain way'. But in common that can show that all indexes are interdependent and global.

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Statbox Simulation System Concept for Spatial Analysis

Kaspars Chabs (*Riga Technical University*) and Marita Cekule (*University of Latvia*)

***Keywords* – video motion, gis simulation.**

I. INTRODUCTION

The process of urbanization creates fundamental changes in geographic space. An urban environment is a dynamic system which is constantly changing in terms of space and time. Interaction among functions is extensive and changeable, and people are the intermediaries in this process.

The use of the latest technologies makes it possible to regularly monitor of the development and direction of the spatial structures, as well as to evaluate and prevent ecological risks in these areas.

II. SYSTEM DESCRIPTION

The system consists of several STATBOX units and Main server. StatBox controls the given territory by means of video surveillance. If a visual change appears, it is assumed by the system that there is an object whose movement has to be monitored. In this case sensor saves video data for future analysis (RAW DATA). All raw data from sensor after a certain time period are sent to the Main Server (MS), which collects data from all sensors.

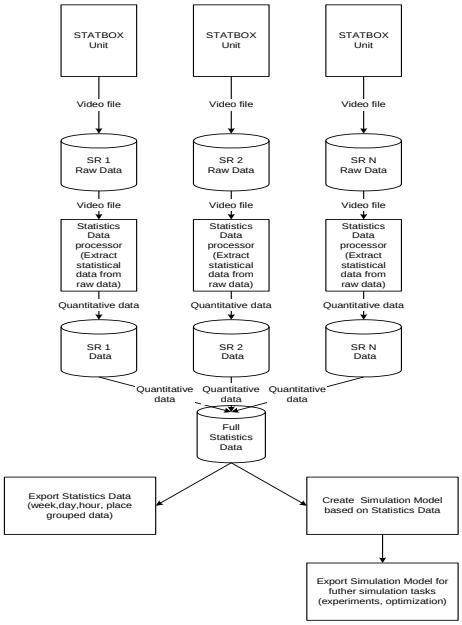

Fig. 1. STATBOX system concept.

After collecting raw data, Statistics Data Processor (MS internal service) processes all raw data and extracts all object movements into the database format. Database enables generation of statistical reports (how many objects have been monitored by particular sensor in a given period of time).

Based on database and GPS information from sensors and available map data, MS simulation process builds simulation model for analyzed territory. Users should place StatBox receivers in the chosen place for a certain period of time, and after the necessary data is collected and processed; users get ready simulation model for further experiments (see Fig.1.)

III. VIDEO MOTION

It is planned to use as the main library for video motion the OpenCV (Open Source Computer Vision Library: http://opencv.willowgarage.com/wiki/), which is an open-source BSD licensed library that includes several hundreds of computer vision algorithms. It is developed by Intel and now supported by Willow Garage.

Video analysis functionality includes recognition of objects in video file, extracting objects from video frame and creating metadata information necessary for object comparison with already saved objects from any of STATBOX units. Also video motion function should check objects movement direction, i.e., either objects are arriving to the analysed territory or are leaving it. In one video frame there can be more than one object; and one object sometimes covers the other objects.

For object recognition it is necessary to collect information from different angles of an object. This means that system has to collect object data not only from one frame, but from all frames.

IV. STATBOX SIMULATION

STATBOX simulation is based on geosimulation. Geosimulation is object-based multiagent modeling [1]. Simulation model can be described as a black box with input X and output Y

The main layer of data in STATBOX simulation is the GIS model of territory. In this model the set GIS objects used for movement are to be displayed (route objects in simulation), like streets, routes, ways, as well as the set GIS objects to which the simulation objects travel (stock objects in simulation), like houses, shops, etc. As the next layer, there are STATBOX units placed on the scheme (input/output objects in simulation).

When the main simulation model is created, the movement goal, speed and timeline is added to the movement objects in accordance with already collected statistics.

In the test part, a simulation model in GAMA simulation environment is prepared. GAMA simulation platform supports GIS models and allows specify additional parameters for GIS models [2]. GAML simulation language is structured in a way that preparing of simulation model can be done automatically.

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The Capabilities of Intelligent Intrusion Detection Techniques in Web-based Information Systems

Pjotrs Dorogovs and Andrejs Romanovs (*Riga Technical University*)

Keywords **– Information security, Intrusion detection, WEB-based system security, system modelling.**

I. Introduction

Nowadays with fast growing amount of network information systems and their integration not only into work but also into people's private life assuring security of industrial and private information assets is becoming extremely sensitive and topical issue. There is a huge number of available free-ware and paid methods of information protection from unauthorized access by unwanted individuals. Currently significant attention of researches in the field of information security is focused on using various intellectual data mining techniques for building an intellectual information security system. Such security systems roughly (for the purpose of this paper) can be divided into intrusion protection and intrusion detection systems – IPS and IDS [1].

II. Overview

In general, intrusion protection systems include any available method or recommendation that prevents attackers from gaining access to secured network, system or information asset. Most common ways to ensure high availability Intrusion protection system is usage of any kind of firewall or anti-virus software. Each type of IPS has different level of provided protection. Sometimes it's even advisable to build an IPS containing more than one security solution.

Intrusion detection systems, in turn, may be considered as a type of security assuring method as for information systems as also for computers. Such system should make a comprehensive analysis of gathered information of computer, network or information system activities to proactively identify potential security breaches that might include both attacks from inside and outside of protected perimeter. The fact that data and systems cannot always be protected from outside intruders in modern Internet environment using ordinary security mechanisms such as password and file security, leads to a range of issues.

Currently all intrusion detection systems available on the market fall into two categories – Network based systems which are placed in the network nearby system that is being monitored and that examines network traffic and Host based systems which actually run in the system being monitored and that examines activity of monitored system. Most recent type of Intrusion detection systems reside in the operating system kernel and monitor activity at the lowest available level of protected system.

In recent years a vast majority of research activities in the area of anomaly detection have been focused on studying the behaviour of programs and the creation of their profiles based on system call log files. Until now, a simple anomaly detection method based on monitoring system calls initiated by the active and privileged processes is widely used.

Profiling the behaviour of the end user is not less important aspect of data protection than the profiling the software activities. This method is effective in detecting internal attacks that constitute one-third of the corporate system security. On the other hand, taking into account the difference between the behaviours of end users, building of profiles of their activities is a difficult task comparing to building a profile of program behaviour. Hackers can even try adapting their behaviour to fool IDS systems [4].

III. WEB-based system security

For a WEB-based system displacement of Intrusion detection system is one of the vital issues to be solved to ensure security of information assets. Comparing to end-user applications where IDS is likely to be deployed on host level which is otherwise defenceless (i.e. Windows based machines running previous versions of OS are unable to create even simple logs that later can be later processed by a off-line IDS), WEB-based systems should be protected on the network level rather than on hosts. In this case Intrusion detection system will be more effective when placed in the network perimeter, i.e. just behind and/or before the firewall, on links to partners etc. Otherwise it can be placed on the corporate WAN backbone where it is possible to monitor all the traffic that attempts to enter corporate network. In special cases to ensure high-end protection of valuable information storages or processing units solution of isolation of critical infrastructure into different network segment with its own IDS is considered to be state-of-art technology in the field of information security [3].

The fundamentals for implementation strategies for intrusion detection systems to build a trustable defence system were put down in 2000. Among many other valuable issues it should be noted that implementation of firewalls between areas of the network with different requirements (i.e. between internet-intranet, between users-servers etc.), usage of network vulnerability scanners to double check firewalls and to find security holes that intruders can exploit, usage of host policy scanners to make sure they conform to accepted security practices and finally usage of symbiosis of NIDS, other packet sniffing utilities and hast-based virus scanners to flag successful intrusions, may significantly improve overall level of information security of WEB-based system [2].

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Use of Intrusion Detection System Based on Network Behavior Analysis in SCADA Networks

Aljona Velicko, Pjotrs Dorogovs and Andrejs Romanovs *(Riga Technical University)*

***Keywords* – Information security, Intrusion detection, security of SCADA network, modeling of SCADA network.**

I. Introduction

Process Control Systems (PCS) is a set of systems that remotely control and receive sensory signals. Supervisory Control and Data Acquisition System (SCADA System), usually referred as a dispatch control system, is a subset of PCS that controls systems within a big distance [1]. SCADA systems form a critical infrastructure that connects power supply equipment, water and sewage drainage systems as well as large-scale transport systems, for example, cross-border railways.

II. Overview

Nowadays the dispatch control system used in "Latvenergo" has functionality that completely satisfies proposed requirements for its use. However, the question of network security improvement always remains topical. Due to the fact that production and distribution of electric power is the main part of the state critical infrastructure, "Latvenergo" dispatch control system may be attacked by „cyber-terrorists". Such attackers use all possible and hardly available means and information sources to obtain detailed comprehension of SCADA systems, their possible vulnerability as well as defects in dispatch control systems' security of a particular company. Because of the complexity of different systems network, engineers frequently cannot prevent additional load that threatens the safety of systems. The purpose of this paper is to improve total SCADA system safety level using modern solutions of information technology.

Network security solutions are firewalls, antivirus software, Intrusion Detection Systems (IDS), Intrusion Prevention Systems (IPS), Network Behavior Analysis (NBA), and Network Behavior Anomaly Detection (NBAD) systems. IDS detects an attack of network or computer system and follows the data that streams from one computer system to another. IPS prevents attack of a computer network or computer system preventing data takeover or damages [2] (see Fig. 2). NBA system analyzes data streams during the data transfer time in computer systems and offers results of effective analysis in real-time. Network Behavior Anomaly Detection system identifies anomalies and reveals unreliable processes on the basis of information about the calculated optimal data stream during the data transfer [3].

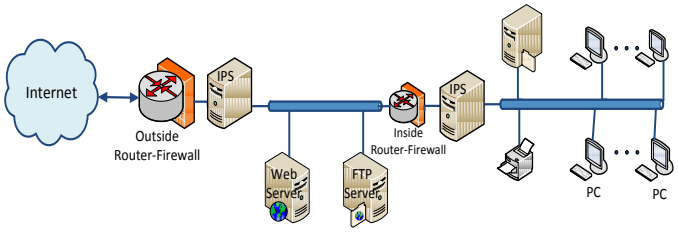

Fig. 2. Intrusion Prevention System placement.

III. Modeling of SCADA network

Nowadays "Latvenergo" does not use intrusion detection or intrusion prevention systems; however, the company shows its interest in functionality of these systems. For this reason, „Latvenergo" SCADA network is modeled using received information.

To meet the requirements, it is possible to use special network modeling software, for example, Boson Netsim, OMNeT++, OPNET Modeler or SSFNet. OMNeT++ and SSFNet are open source software, but others offer only demo-versions for free. OMNeT++ has graphical user's interface that is not available in SSFNet. That is why OMNeT++ modeling tool is chosen for the model development.

Nowadays the conceptual model of SCADA network has been produced, and on the basis of that, SCADA network model has been developed (see Fig. 4) using OMNeT++ simulation tool.

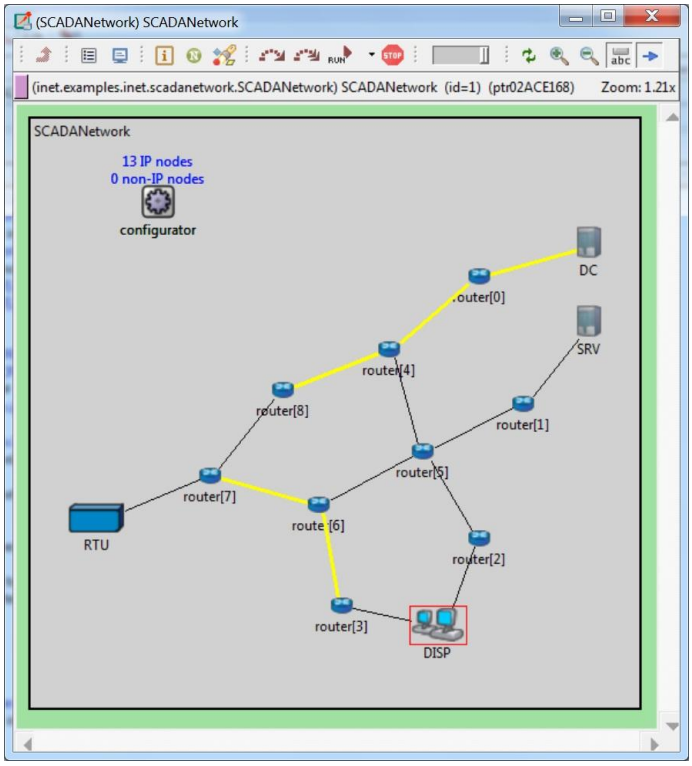

Fig. 4. The model of SCADA network.

As well as the imitation of attacks and model extension with necessary defense mechanisms have been performed. During the analysis of the results, some recommendations how to improve SCADA network safety have been suggested.

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Analysis and Modeling of Social Networks: Leaders Identification and Information Dissemination

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Keywords **– social network, modeling, social network visualization, pretopological space, leader identification.**

I. Introduction

This study addresses social network analysis, leader identification and group building around them, as well as discusses a general mathematical framework to model the group and examines the social network visualization methods. In particular, for social network modeling, the graph is used to describe the links that represent relationships or flows between the entities. Mostly individuals are listed as separate elements in different researches, but the groups are formed of several individuals in the process of interaction.

Marketing experts have assessed the role of social networks, in particular, by promoting new products. The study will be conducted within a social network model for one of the Latvian banks. On this model different scenarios will be simulated, such as new product promotion or extreme incidents that are associated with competitors negative advertising; with the aim to predict the speed of disseminating information in a social network and improve response time due to appeared incidents.

II. Social networking sites

In the existence of enormous competition, company's dialogue with the customer is extremely important. Companies are more and more interested in social networking sites to promote their products and to get feedback from their customers. It is therefore necessary to evaluate and to rank the users according to different purposes. In this study, authors propose a concept of user evaluation, which is suitable for the cases under the examination. The concept is based on the Twitter social network features, where the particular attention was paid to the determination of leaders.

III. General mathematical framework

There may be different kinds of relationships with different natures: for example, a social network can be simulated, which contains colleagues and geographical relations. It is possible to create pseudo-closure, solving the problem of modeling, for example, individuals are close to each other, if they are friends, are working together and living close by (using a given distance threshold). This concept allowed us to use a general mathematical framework, which is proposed by Vincent Levorato [1], to simulate groups in social networks, using pretopology formalism in generalization of graph theory.

IV. Social network visualization and modeling

Social network visualization [2] (Fig.1) is a field of growing interest in itself, and partly because of the variety of available methods suitable for specific use cases.

Visualization methods that are used in this study help to promote the visual exploration of data and models. Clearly, experimentation and further clarification are necessary to better assess their utility.

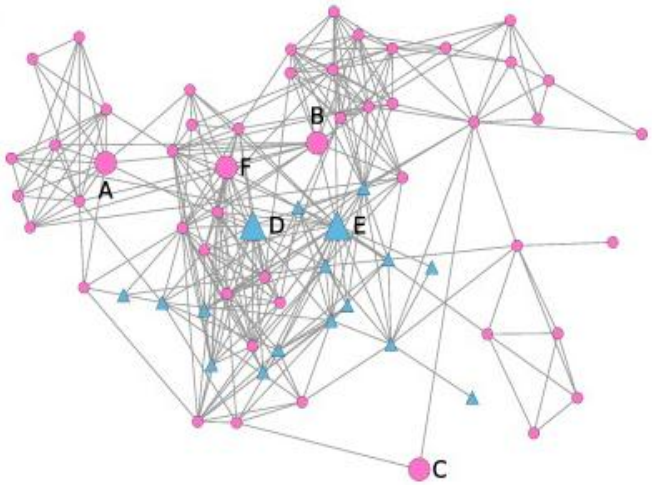

Fig. 1. Social Network Visualization. [2]

The inherent flexibility of the basic layout engine, stress reduction, may carry over related visualization problems, and it is planned to look at the exponential random graph models.

V. Conclusions

The authors will use the proposed general mathematical framework and methods of social network visualization to develop a social network model for one of the Latvian banks. On this model, different scenarios will be simulated, such as new product promotion or extreme incidents from competitors' negative advertising; with the aim to predict the speed of disseminating information and to improve response time due to appeared incidents. The authors' proposed concept of determination of leaders will be used for modeling.

A typical issue of social networks is an individual who has the capability to gather a group around him. Who is the most influential person? Knowledge about the formation of groups [3], dissemination of information, methods of group manipulating, separate group behaves, leading to total control of people's behavior and desires. Though these methods and knowledge can be used to reduce people's time wasted on social network sites. This becomes an alarming problem.

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Self-Organising Neural Network Usage for Project Risk Assessment

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***Keywords* – risk identification, project, self-organising neural network, project management.**

I. Introduction

Project risk management is an important part of each project and is the method for identification, analysing, mitigation and monitoring risks. Large organizations such as government agencies and corporations establish project risk management guidelines so that they have a standard process ready for use on any new proposal. The author of the paper offers to use self-organising neural network for risk assessment.

II. Methodology

A self-organizing map (SOM) is a type of artificial neural network that is trained using unsupervised learning to produce a low-dimensional (typically two-dimensional), discretized representation of the input space of the training samples called a map. Self-organizing maps are different from other artificial neural networks in the sense that they use a neighborhood function to preserve the topological properties of the input space The SOM [2] was originally meant for a model of brain maps, but it soon turned out to be better suited as a data-mining tool.

The usage of SOM for project risk assessment suggests selection of criteria that can indicate the importance of a risk. The author of the paper offers to use two main criteria for risk assessment: the risk likelihood and the impact level. Table 1 presents selected criteria values.

TABLE I

RISK ASSESSMENT CRITERIA VALUES

Description	Likelihood	Impact
very low	1	1
low	2	2
medium	3	3
high	4	4
very high	5	5

The method presented in this paper for risks identification is "Brainstorming". Brainstorming is a group or individual creativity techniques by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members. The author of the paper offers to use 20 risks typical for most projects. Each risk identified in project management first stage was assessed by the selected criteria.

The examined neural network contains three neurons that coincided to the three possible risk levels: high, medium and low.

The input sample (risk) in a certain way (for example, Euclidean measure) is compared with the weights of each neuron, and neuron that is closest to the input sample is declared as the winner.

Formula (4) represents the method of calculating the distance between the input sample and neuron.

$$NET = \sum_{i=1}^{m} (x_i - w_{ij})^2 \quad (4)$$

Variable *NET* is the distance between input and neuron, i- the risk index, j – neuron index, w- the weights.

III. Results

The result of self-organising neural network is shown in Fig. 3.

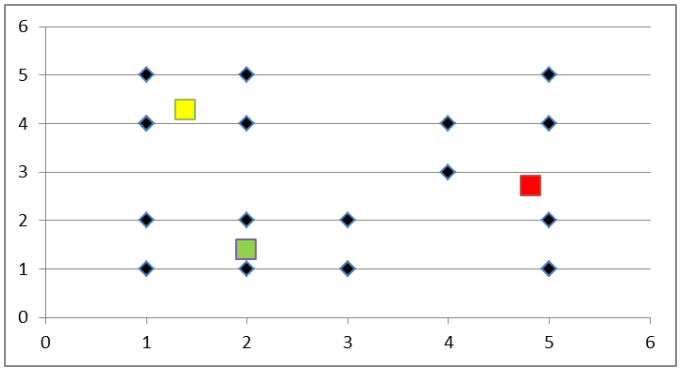

Fig. 3. Self-organising network output.

Green colour indicates neuron that coincided to low risk possibility, yellow – medium and red is regarded to high risk possibility.

IV. Conclusions

The usage of self-organising neural network helps to indicate certain amount of risk according to risk importance that is measured by its impact and likelihood. The proposed method of risk analysis can be used to indicate the importance of risks in large organizations such as government agencies and corporations because their project can contain significant amount of risks whose manual classification can take a lot of time.

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Impact of Cluster Stability on Class Decomposition in Antibody Display Data

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***Keywords* – analysis of data inner structure, clustering, cluster stability, data mining.**

I. Introduction

Bioinformatics data processing is a complicated process. This paper presents a data preprocessing step that analyzes the inner structures of a data set and that is called class decomposition. This step uses clustering (in this case applying hierarchical agglomerative clustering) to find high density areas in the classes present in data and re-labels them as subclasses. To implement class decomposition, the data is first analyzed using clustering then the clusters are evaluated and selected as subclasses. This article focuses on cluster stability evaluation to assess the characteristics of the data set and the found subclasses. The evaluation is an iterative process, making small changes to the data set in every step and reapplying cluster analysis. These small changes (removing one object from the data set repeated for 20 iterations in this case) should not have any impact on clusters if they are stable (meaning that other objects that were not removed stay in the same clusters as in the full clustering).

II. Cluster evaluation

When objects are split into groups (clusters) this division is viewed as representing the characteristics of the whole set and should not show major changes if minor changes are made in the data set. In this case the clusters are believed to be stable. Otherwise these clusters do not represent the features of the whole group. This article analyzes the stability of clusters induced in bioinformatics data sets for the reason of class decomposition using hierarchical agglomerative clustering and Ward's linkage [5]. The minor changes mentioned above are considered to be subtraction of one object of the data set – after removing one random object of the set, the division of other objects into clusters should stay the same. Of course, if there are small changes in the data, there will be changes in the clusters. These changes can be divided into two groups:

- changes in the distance at which the clusters are merged (Fig. 1a),
- changes in object allocation to clusters (Fig. 1b).

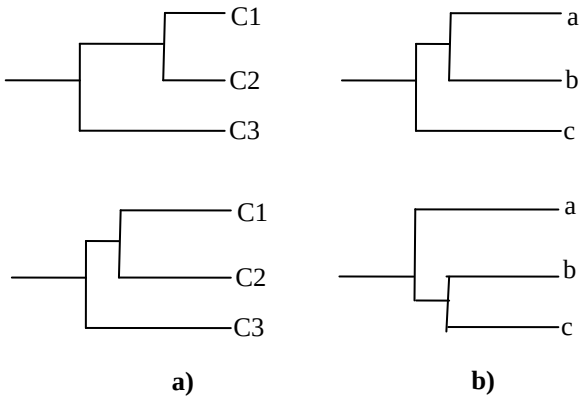

Figure 1. Changes in cluster and object allocation; top - before changes in record set, bottom - after changes.

The first type of changes are logical, whereas sum of squares changes if one object is missing, and are not as important in this study. The second type of changes is crucial to determine cluster stability in this case whereas the objects are viewed as subclasses based on their membership to a cluster. Small changes in the data set should not cause large effect (object reallocation to different clusters) in the cluster structure.

The experiments are carried out using eight bioinformatics data sets provided by Latvian Biomedical Research and Study Centre or available on the Internet.

III. Results and Discussion

Cluster stability was also tested using classification to find out if it had an impact on classification accuracy. The overall trend can be seen in Table 4 – many misplaced objects in the performed cluster stability test mean lower maximum gains in accuracy in the corresponding data sets. This means that the more stable and 'clean' clusters lead to better classification accuracy using class decomposition. If PrCa data set is removed (it has significantly higher average number of object misplacement), the correlation is -0.76 at $p<0,05$, which is statistically significant negative correlation – one of the variables grows, while other decreases, meaning that stability of clusters increases the maximum gain in classifier accuracy when clusters are used as subclasses.

TABLE IV

Gain in accuracy and cluster stability

Data set	Max gain in accuracy	Average number of misplaced objects
BrCa	15,39	0,00
GaCa	2,5	0,04
GIS	13,93	0,01
PrCa	1,0	0,33
BC1	4,77	0,01
BC2	3,12	0,02
Carc	8,33	0,00
Pr	-	0,03

IV. Conclusions

The experimental work in this study shows that cluster stability has a great impact on classifier accuracy. The more stable the clusters are, the higher the quality of data division into clusters is, which means that, when the clusters are used in classification as subclasses, the ability of a classification algorithm to discriminate between classes and subclasses grows.

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Use of BEXA Family Algorithms in Bioinformatics Data Classification

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***Keywords* – Classification algorithms, bioinformatics data, BEXA, UCI data.**

I. Introduction

This article studies the possibilities of BEXA family classification algorithms – BEXA, FuzzyBexa and FuzzyBexa II in data, especially bioinformatics data, classification. Three different types of data sets were used in the study – data sets often used in the literature (like Iris data set), UCI data repository real life data sets (like breast cancer data set) and real bioinformatics data sets that have the specific character – a large number of attributes (several thousands) and a small number of records. For the comparison of classification results experiments were carried out using all data sets and other classification algorithms. As a result, conclusions were drawn and recommendations given about the use of each algorithm of BEXA family for classification of various real data, as well as an answer is given to the question, whether the use of these algorithms is recommended for bioinformatics data.

II. Used algorithms and Data sets

A. Used algorithms

BEXA – cover procedure – iteratively examines each concept (class). The concept is examined until all positive records (instances) of the concept are covered. After adding each rule to the set all positive records covered by the rule are deleted from the set of positive instances. The best rule is found using Laplace evaluation function. Creation of specializations creates specializations for conjunctions. They are returned to the best rule searching procedure for assessment [1].

FuzzyBexa – in this algorithm the BEXA basis algorithm is fitted for fuzzy data. The highest (Cover) and middle level (searching for the best rule) procedures include membership variables (alpha). The lowest level procedure examines linguistic attribute values (the possible linguistic values of each attribute in the final fuzzy data instead of attribute values or intervals as it is in the case of BEXA) [2].

FuzzyBexa II – in this algorithm each class is not examined individually; instead it generates rules for all classes. The highest level (Cover) does not split the training set into positive and negative sets; it transfers the whole training set and the set of concepts to the middle level procedure. The middle level procedure - find best conjunction – in its turn, finds both the conditional (antedecant, IF) and the resulting (consequent, THEN) part for each rule. Respectively, the lowest level procedure that generates specializations also processes the whole training set (or its part) instead of positive and negative instances of a split data set [3].

B. Used data sets

This study uses 16 data sets that can be conditionally divided into three groups. Initially the classification algorithms are tested using popular UCI data sets like Iris data set to evaluate the result of these algorithms comparing it to other algorithms. Then a series of experiments is carried out using real natural data available in the UCI repository to assess the accuracy of the algorithms using real medium-sized data sets. The section of practical experiments is concluded with experiments that use real bioinformatics data sets. The description of the data sets is given in Table 1.

TABLE I
Used data sets

Name	Number of samples	Number of attributes	Number of classes
Iris data set (UCI)	150	4	3
Auto MPG Data Set (UCI)	398	8	2
Ionosphere Data Set (UCI)	351	34	2
Nursery Data Set (UCI)	12960	8	3
…			
GSE89 (bladder cancer)	40	5724	3
GSE1987 (lung cancer)	34	10541	3

III. Experiments

All experiments using algorithms of BEXA family were carried out in an application created using Java programming language (using Weka libraries). All experiments include evaluation using cross-validation. The experiment plan includes the data sets that were described in the previous section. To compare the results of BEXA family classification algorithms experiments were conducted using other popular algorithms and the same data sets. It is done with the aim to ascertain the competitiveness of the classification algorithms and draw the necessary conclusions, as well as answer the raised question – is the use of BEXA family classification algorithms recommended for bioinformatics data classification and whether it has potential.

IV. Conclusions

The algorithms of BEXA family can be used in bioinformatics data classification but the obtained results are not competitive when compared to other popular data mining algorithms. Additional experiments are necessary to improve classification results and assess the impact of various membership functions on the classification accuracy of BEXA family algorithms. Recommendations are given about the use of the most successful algorithm of BEXA family based on the used data set.

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Modern Approaches to Creating User Behavior Models

Pavel Osipov and Arkady Borisov (*Riga Technical University*)

***Keywords* – anomaly detection, user behavior model, Bayesian network, ontology, neural network.**

I. Introduction

This paper describes different approaches to constructing models of the electronic systems user behavior. These models effectively detect anomalous user behavior, while the conventional methods of providing security are not good enough to cope with this type of tasks. We consider three approaches: a method that uses hybrid Bayesian networks, a method based on ontology approach and the multi-agent based approach in conjunction with neural networks.

II. Described Methods

A. Multi-entity Bayesian networks

When using this approach [1], Bayesian network is represented as a probabilistic model presented as a directed graph, which allows a convenient way to display complex relationships, the local probability distributions, and quantitative information about the types and levels of relationships between user motivations. One of the major advantages of using hybrid Bayesian networks is the ability to operate parameterized structures called *multi-entity Bayesian networks* - MEBN Fragments (MFrags). Local distribution and their parameters used in MFrag were extracted from real data; it provides enough flexibility for expressive description of such complex concepts as user behavior.

To test the model, test data of 100 sessions with the system were generated for each user. The behavior of 192 users was simulated, the type of each was known in advance: normal / malicious.

The experimental results show that at the moment the system can both detect anomalous behavior, and undetect it, if the user is intentionally gradually changing his behavior for a long time.

B. Using ontologies

Using ontologies to describe a typical user behavior is now gaining popularity because of its flexibility, the quality of the proposed conceptual data management methodologies and knowledge bases, opportunities to disseminate and reuse knowledge.

In order to be able to describe the behavior of the user [2], 10 typical groups of information have been distinguished: *Identification*, *Goal*, *QCL* (Qualifications, Certifications and Licenses), *Accessibility*, *Activity*, *Competency*, *Interest*, *Affiliation*, *Security Key* and *Relationship*. Also some additional specific concepts were introduced: *Behavior*, *Type_of_Activity*, *Level_of_Activity* and *Level_of_Knowledge Sharing*. The most important group here is the *Type_of_Activity* which describes the type of user behavior in the system: if he prefers *mainly reading*, *writing*, or *lurking*. Also, each type of behavior can be classified as *very active*, *active*, *passive or active*. The third type of classification is based on an assessment of the analysis of the spread of the user's knowledge; according to that type of classification users are divided into *Unaware*, *Aware*, *Interested*, *Trial*, и *Adopters*.

The next step is to encode the ontology using a formal language; it can also be created using the ontology editor like OntoMat, OI-Modeler, KAON, or more often Protege. Then the integration of the created ontology is performed, and it is used within the overall system created.

C. Multi-agent based approach

The paper also describes another possible approach to creating a model of user behavior inside information GRID system. Current methods of providing security in this type of systems are based on public key protocols (PKI - Public Key Infrastructure). This approach ensures good conventional protocols, authorization, authentication, delegation and exchange of certificates, but is ineffective for detecting anomalous user activity.

Software agents are used to obtain the necessary information for classifier. Because of the modular structure of the system, a classifier itself can be implemented using different approaches. Its main task is to issue conclusions on the presence or absence of behavior anomalies in the current user.

Paper [3] describes the use of the classifier implemented using a neural network; for that purpose, a multilayer feedforward network was used. For each user his personal neural network was built, which classifies target user activity as a normal behavior (1) or abnormal (0).

To test the effectiveness of the system, the data base consisted of more than 34,000 records of actions performed by users was used. The final test was to use the procedure substituting the user when, after the initial use of the data about the behavior of one user, the data classifier fed the other (illegal) people. The final results has shown that the level of classification of authorized user is equal to 99.14%, while in the case of substitution, correct classification was made in 99.30% cases.

III. Conclusions

Analysis of existing approaches to building models of user behavior is important in establishing a system of similar type and purpose.

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A Comparative Study of Evolutionary Bayesian Optimization Techniques

Boris Vaskin, Yuri Chizhov and Arkady Borisov (*Riga Technical University*)

***Keywords – genetic algorithms, Bayesian belief network, Bayesian optimization algorithm, population-based incremental learning algorithm*.**

I. Introduction

This paper covers analytical comparison of Bayesian optimization with populating genetic algorithm. Bayesian probability network, that is used in task modeling, is integrated into genetic probability algorithm with an aim to record specifics of subject are using genetic algorithm. The developed software provides an opportunity to make approbation of received result. The paper contains a plan of experiments and an analysis of the results received.

II. Motivation

During the last two decades, there has been a growing interest in biologically inspired algorithms that rest on the principle of evolution [1]. This particular paper is trying to test genetic algorithms (GA) and Bayesian belief network (BBN) [3] synergism in action. It is planned to run a series of experiments on different types of GA like standard GA, population based incremental learning and Bayesian optimization algorithms (BOA) [4]. These experiments are aimed to find the differences between these algorithm types.

III. Experimental plan

First of all it is planned to perform an experiment to test the GA software using Rosenbrock's saddle function. After that the impact of the GA parameter changes (see Table I) will be tested on each algorithm using three fitness functions: Rosenbrock's saddle function, Schwefel's function and Rastrigin's function.

TABLE I

Parameters which are used to control algorithm behaviour

Parameter name	Description
Mutation probability	The numeric value between 0 and 1 which determines probability of individual mutation.
Population size	Determines the number of individuals in population.
Chromosome size	Determines the number of genes in chromosome of individual
Next generation percentage	The numeric value between 1 and 100 to determine a part of current population which will proceed to the next generation.
Cut bad individuals	Determines if individuals with worst fitness will be simply deleted from population and won't be presented in the next generation. If it's disabled, than selection will use probabilistic approach.
Use random crossover	Determines if individuals for crossover operation will be selected randomly or using probabilistic approach.
Gene parent number	Determine the number of dependent parent for gene. This parameter is used in BOA when probability matrix is constructed.

During those experiments we adjust the values of the GA parameters like mutation probability, population size, next generation percentage and monitor algorithm behavior to find a configuration which will give us the best convergence results for the specific algorithm type.

Also there were tested different approaches to select individuals for the next generation and for crossover operation. In this article we use deterministic and probabilistic approaches.

Finally conclusions about overall algorithm performance during different circumstances are made, and we to point out different algorithm advantages and disadvantages and compare them to Bayesian optimization algorithm.

IV. Software for experiments

In order to test GA behavior in different situations and with different parameters, a piece of software was developed which allowed creating and evolving populations of individuals and collecting measurement data. The software was built with Microsoft .NET Framework using Windows Presentation Foundation technologies. It's possible to manipulate a set of parameters to change the behavior of the algorithm. These parameters are described in the table below.

To make the software realization of GA more flexible, it was decided to build it using generic approach. So it's possible to use it with any type of data. The diagram of the class representing the GA realization is shown in Fig. 4 (see full version). The developer is responsible for data structure and methods to process this data, so he may be not deeply familiar with GA itself.

The software supports three types of GA: standard or classic GA realization, population based incremental learning GA realization and GA with Bayesian optimization. It's easy to switch from one GA type to another.

V. Conclusions

Our results have shown that on these specific trivial functions Bayesian optimization has no big advantage as compared to standard GA and population-based incremental learning algorithms. The overall performance of each algorithm is very similar and it's because the fitness functions aren't very difficult for the algorithms and it's easy to find a solution faster just by increasing a population size, for example. The main conclusion is that synergism of Bayesian belief network and genetic algorithm should be tested on much more complicated problems where it would be possible to define semantic dependence between genes in chromosome.

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Extraction of Interpretable Rules from Piecewise-Linear Approximation of a Nonlinear Classifier Using Clustering-Based Decomposition

Andrey Bondarenko, Vilen Jumutc (*Riga Technical University*)

Keywords - SVM, rule extraction, k-means, linear programming problem.

I. Introduction

This paper describes approach for the extraction of interpretable rules from piecewise-linear approximation of any nonlinear classifier, e.g. Support Vector Machine (SVM). We describe an approach for converting a widely acknowledged rules extraction algorithm for Linear Support Vector Machine [3] into a number of constrained linear programming (LP) problems.

II. Proposed Method

A. LP Problem

In [1] we propose an extension of the method described in [3]. Core idea is surrounding of specific space regions by convex hyperplanes obtained by the lookup of separation planes produced by linear SVM to divide two compact sets of points belonging to different classes. We utilized heuristic approach to define counts of clusters in both classes. We prove that intersection of produced hyperplanes will result in convex hyperpolytope which can be used to perform classification:

$$\wedge_{i=1}^{n}(\langle w_i, x' \rangle - b_i \geq 0) = \begin{cases} true, x' \in A_+, \\ false, x' \in A_-, \end{cases} \quad (2)$$

where *x*' is a test example, A+, A- donate positive and negative target classes and *n* is dimensions count. Having such classifier we can state LP problem for if-then rules extraction that would be able to describe classification space. If-then rules are in fact hypercuboids with edges parallel to axes, thus they can be described by upper and lower bound vertices. As we are trying to approximate hyperpolytope with inscribed hypercuboids we need to select optimization criteria, in our case it is hypercuboids of maximum volume. But due to non-uncomfortability of product based maximization criteria for LP we used a log-based form. Having that we can state optimization problem as follows:

$$\begin{aligned} &\max_{u,l} \sum_{i=1}^{n} \log(u_i - l_i), \\ &s.t.\ u_i \geq l_i\ \forall i, \\ &\langle w_j, l \rangle - b_j \geq 0\ \forall j, \\ &\langle w_j, u \rangle - b_j \geq 0\ \forall j, \end{aligned} \quad (3)$$

where w_j and b_j correspond to a norm-vector and an offset of the *j-th* decision hyperplane, *l* and *u* are given in the vector form, are indexed by *i* and represent upper and lower bounds of the hypercube with largest volume and log is a natural logarithm. It should be noted that instead of maximum volume criteria one can use point coverage maximization criteria.

B. Generalized rule extraction algorithm

The solution to the stated LP problem (Eq. 3) defines 2 vertices, namely *lower* and *upper* bounds of the found hypercuboid. Having single rule can be insufficient in terms of classification fidelity. To solve this problem one can recursively apply described algorithm to classification space regions not yet covered by found rules. Such remaining regions of interest can be defined as:

$$\begin{aligned} I_i^l &= \begin{cases} x \in R^n,\ s.t. & l_j^* < x_j \leq u_j^*\ \ \forall 1 \leq j \leq i, \\ & x_i \leq l_i^*, \end{cases} \\ I_i^u &= \begin{cases} x \in R^n,\ s.t. & l_j^* \leq x_j < u_j^*\ \ \forall 1 \leq j \leq i, \\ & x_i \geq u_i^*. \end{cases} \end{aligned} \quad (4)$$

Here *I* terms are polytope regions surrounding extracted rule for the *i*-th dimension, *l* and *u* are given in vector form and represent the lower and upper bounds (vertices) of the currently processed hypercube (rule).

III. Experiments and Conclusions

In Table 2 you can see classification results:

TABLE II
Classification accuracy (%)

Classifier	Monks-1	Monks-2	NDCC	Balance
SVM linear	65.5	67.1	73.3	93.7
SVM rbf	86.8	80.6	95.0	98.0
MSM-T	83.6	79.7	88.7	87.6
C4.5	75.7	65.1	74.0	70.8
Polytopes	99.5	80.3	93.7	97.9
Rules	96.3	74.5	89.8	96.9

The method showed good results, although it showed a high sensitivity to the selected count of clusters used for producing separation hyperplanes. It is worth mentioning that the proposed method is prone to curse of dimensionality, thus mitigation of this limitation is a prospective area for further research. More details can be found in [1] and [2].

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Representation and Analysis of Security Requirements in Business Processes

Madara Tora *(Riga Technical University)*

Keywords **– Security requirements, business process, access rights, usability.**

I. Introduction

The improvement experienced in the languages of business process modelling, especially Business Process Modeling Notation (BPMN), opens an opportunity to incorporate security requirements that allow us to improve this aspect of systems from early stages into software development. In this paper we have presented BPMN metamodel with core element and extension that allows us to incorporate security requirements into Business Process Diagram that will increase the scope of the expressive ability of business analysts. With this ARBU extension, business analysts will be able to express security requirements from their own perspective.

II. Security Requirements in BP

Adequate security requirements for any information system according to [24] must satisfy three criteria: Definition – must know what security requirements are (practical definition of security requirements); Assumptions - security requirements must take into consideration an analyst's implicit or explicit assumption that an object in the system will behave as expected; Satisfaction - must be able to determine whether the security requirements satisfy the security goals and whether the system satisfies the security requirements.

The goal of this work is to develop a method for balancing access rights permissions with usability. The main tasks are identification and definition of methods for reflecting security requirements in business processes and development of methods for analyzing these business processes with regards to security and usability problems. We developed the ARBU method for analyzing security requirements in business processes. Security extension is necessary, because standard business processes focus on functional aspects.

In ARBU, BPMN is used, because it offers a modeling technique that is quickly understood by all stakeholders, all users of business starting with business analysts and finally with people that will manage and control all designed processes. Text annotations are used as a mechanism for a modeler to provide additional text information for the reader of a BPMN Diagram. BPMN annotation supports the specification of security requirements.

Role-based access control is used in ARBU, because it is not necessary to assign each employee his basic system roles directly, it is much more logical to combine a set of them in a business role. Roles are assigned to activities, indicating that all members of the role are capable of performing the respective activity instances. For example, BPMN supports a role concept utilising lanes, which are often used for such things as internal roles (e.g., Manager, Associate) [8].

For specifying security constraints of business processes we have also included a security language for annotating process models. This paper combines security constraints, security annotations, knowledge base and creating metamodel for describing security process.

The main idea of ARBU is that a user can have one or more roles. Every user has domain knowledge, which can be collected when user starts his obligations to work or in some certain time periods. The security annotations and user-specified security requirements directly affect BPMN modeling approach (Fig. 1). This modeling framework allows reaching business goals through analysis of the organizational setting, following perspectives of different roles. The framework allows the various interacting parties to constrain the interaction by expressing security needs, which are later operationalized in security requirement.

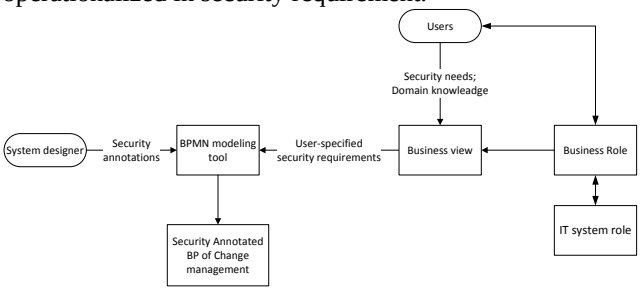

Fig. 1. ARBU approach to security-annotated BPMN.

In ARBU we present security requirements by modelling business process organizational objectives and social interactions between them. We are considering description of security needs and user-specified security requirements. As already described above, there are commitments between roles. When a security need is specified and interacts with the business view, user, under his Business role, is expected to make a commitment for security need and fulfill it. If user while he is assigned to those roles comply with their commitments, the security needs will be guaranteed. If user need to replace other users who have been assigned to the same role, then system need to check domain knowledge, and be secure that users have necessary knowledge.

III. Change Management

In the change management example, differences between three proposed levels of usability are access delimitations and permissions to systems documents. First usability level restricts any access rights to activities that are not granted to role. Second level grants access to documents that could be used in execution of activities. Third level grant access rights to activities and data objects are assigned also to roles that are involved in the execution of activities. Security requirements are included in change management business process specification. All objects in every lane must be considered for permission specification (see Table 1).

TABLE 1
SECURITY ROLE AND PERMISSION SPECIFICATION FOR CHANGE MANAGEMENT EXAMPLE

	Permissions		
Role	Object		Operations
	BP element	Description	

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Simulation-based Analysis of the Goldmine System Operation

Julija Petuhova, Anna Bogusevica and Liene Andersone (*Riga Technical University*)

***Keywords* – simulation, conceptual modelling, experimental design, optimization.**

I. INTRODUCTION

The research demonstrates the efficiency of the simulation technique application for analysis of the goldmine system operation. The goldmine system analyzed is based on truck-shovel system. The research was carried out within the modelling competition „IIE/Rockwell Student Simulation Competition". The competition is formed by international organization IIE, which has been founded in the 1948 and is dealing with education, training, research and developments in the field of industrial management. The information of the goldmine system structure and operation was given by the competition organizers. This allows to analyze system operation based on real data and to offer recommendations and solutions to increase goldmine efficiency by technical resource used optimization. A simulation model of the goldmine system is developed in the Arena simulation environment aimed to support the analysis of the truck-shovel system operation.

II. CONCEPTUAL MODELLING

In order to provide more depth understanding of the system, its conceptual model was developed (Fig.1.). The conceptual model consists of multiple components – modelling objective is to analyze the efficiency of the technical resources utilization thereby increasing the amount of the gold ore produced; key elements of the system are 3 shovels, 30 trucks; input data are empty and loaded truck speed, truck loading and discharge times, times between shovel failure and repair, working hours of the goldmine system (2 shifts per day, one shift 9 hours long, 30 days per month); the system's phases – four excavation phases; output data or parameters to be analyzed – are shovels utilization, the amount of waste and gold ore, average number of trucks according to excavation phases and average queue length at the crusher. The conceptual model could be depicted using different approaches; four most widely used approaches were applied in the paper. These are as follows: list of components, process flow diagram, business process logic flow chart and activity cycle diagram [1].

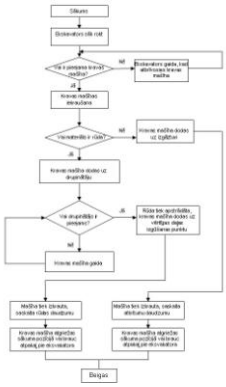

Fig. 1. Goldmine system's business process logic flow chart.

III. DESIGN AND ANALYSIS OF EXPERIMENTS

A simulation model of the goldmine system is developed using the standard edition of the Arena Professional simulation software (Fig. 2.). A dynamic, discrete-event and stochastic simulation model is created using Arena modules. To find interdependency between performance measures and experimental factors the design and performance of simulation experiments is completed. For this purpose the 2^k full factorial design and linear regression analysis is performed. The performance parameter is the amount of the produced gold ore in tons during a month's work. Four experimental factors are considered: the number of shovels, the number of trucks, the system's phase and time between shovel failures. 16 different scenarios were executed in accordance to the 2^k full factorial design. Derived multifactorial linear regression model explains 77.24 % of the changes in the amount of produced gold ore. The results of the sensitivity analysis show that the number of shovels and the number of trucks are statistically relevant experimental factors with a confidence of 95%, while the system's phase and time between shovel failures are not [2].

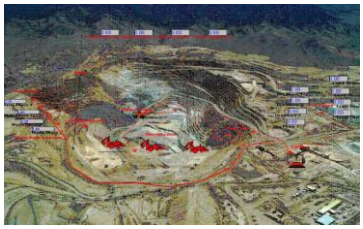

Fig. 2. The animation of the simulation model.

IV. OPTIMIZATION

The optimization of the loading-dumping operations in the goldmine system is performed. The goal of the optimization is to identify the optimal values of system parameters. An optimization model is designed according to the defined optimization problem statement. A built-in optimization tool OptQuest for Arena is used for optimization implementation. Various meta-heuristics algorithms are applied to search of an optimum solution e.g., scatter search, neural networks, tabu search, etc. Based on the optimization results analysis the following recommendations are provided: the number of trucks should be reduced to 18 while the number of shovels remains the same and the number of crushers should be increased to 3. 495 000 tons of gold ore is produced after setting the optimal system parameters during the period of 30 days [3].

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Applying Building Block Selection in Linear Genetic Programming to Solve Classification Tasks

Sergejs Provorovs, Irina Provorova and Arkady Borisov (*Riga Technical University*)

Keywords **– Linear genetic programming, genetic programming, data mining, evolutionary algorithms.**

I. Introduction

This work presents an analysis of the use of linear genetic programming to solve classification tasks using good building block selection. Usually classification tasks have data sets containing a large number of attributes and records, and more than two classes that will be processed using created classification rules. As a result, by using classical method to classify a large number of records, a high classification error value will be obtained. The linear genetic programming is a new direction of evolution algorithms that is not widely researched and its application areas are not well defined.

II. Motivation

In recent years different types of genetic programming (GP) have emerged. They all follow the basic idea of GP to automatically evolve computer programs. Three basic forms of representation may be distinguished for genetic programs. Besides the traditional tree representations, these are linear and graph representations [1].

Linear genetic programming (LGP) is a GP variant that evolves sequences of instructions from an imperative programming language or from machine language. LGP programs are represented as instruction sequences that when executed give us the solution to our problem. These programs are composed from instruction of the used programming language and it call for *chromosomes* and the instructions of program call for *genes* of chromosomes (see Fig. 1).

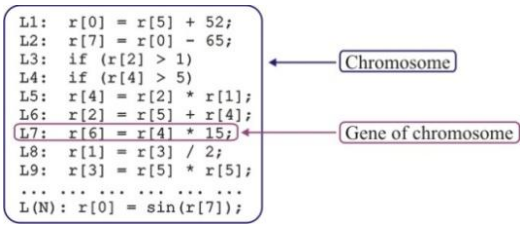

Fig. 1. Chromosome and genes in LGP.

A. Schema of chromosomes in LGP

Schema of chromosome in LGP (see Fig. 2) is a group of genes (instructions) with particular values. If chromosomes are "*N*" genes long, and a schema is "*n*" genes long, then *N-n* chromosomes share this schema [3].

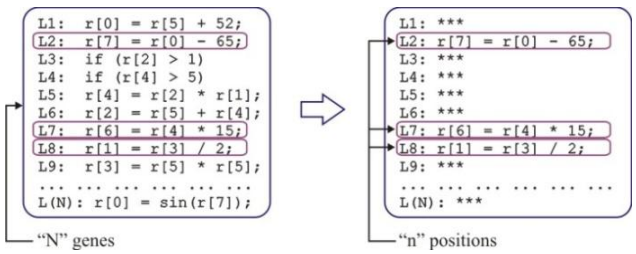

Fig. 2. Schema in LGP.

The schema is "good" if a chromosome contains it, then there is a high probability that the chromosome has high fitness.

B. "Building block" in LGP

A "Building block" in LGP is a schema (see Fig. 3): short (few genes) or compact (adjacent genes) [3].

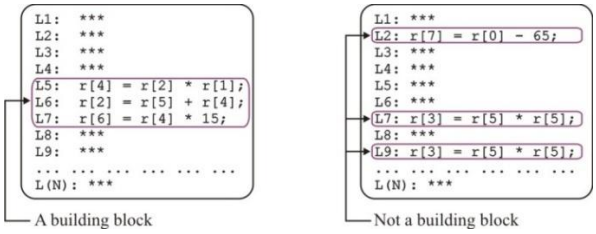

Fig. 3. Building block in LGP.

The building block is "good" if, on average, chromosomes with this building block are "better" than those without it.

III. General Strategy

Selection: Favour the proliferation of supposedly good building blocks by cloning good chromosomes more frequently than bad ones.

Recombination: Make it possible the good building blocks from different chromosomes to meet in a new chromosome.

IV. Experiments

The experiments were made using databases from „UCI Machine Learning Repository" [2]. The cross-validation was used in each experiment. Special software was used for carrying out these experiments, as well as two programs written were developed additionally. The estimation of selected good building block influence on LGP algorithm is based on comparison with the LGP classification result without it, namely - the classification error.

V. Results

The obtained results show that using in LGP the building block selection to solve classification tasks helps to accelerate to create and evolve a "good" program (regression function) and helps to improve the classification result, namely, providing the reduction of classification error (the classification error was reduced on average by 7.31%).

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Intermodal System of Public Transport: A Survey

Alona Petrova and Julija Petuhova (*Riga Technical University*)

***Keywords* – public transport, intermodal system, simulation.**

I. Introduction

The research demonstrates the efficiency of the intermodal system of public transport. Public transportation services are vital for civic life. Public transportation services are integral to societies. Countries need effective public transport services for transit users, apparent or latent, who need and value different modes of public transport. Urban public transport systems are more attractive for commuters and more economically viable for operators if they offer the option to travel from any point in the city to any other point. This can be achieved through the expansion of network as well as through intermodal connections. The goal is to create a plan for a new transportation center and gateway for Riga City and the region that promotes mobility, enhances the image of public transportation and creates a catalyst for economic development.

II. Intermodal Passenger Transport

To promote public transport network, provision of intermodal facilities is essential. Public transport is generally able to work more efficiently if there is a good network and connections with other modes are provided. This is because public transport usually requires access transport from users' origination and egress transport to their final destination. Therefore intermodal facilities can provide substantial benefits in time savings as well as comfort. The following facilities should be examined together with the public transport network plan [1]:

- bus stops (with seat, shelter, and information board);
- bus terminal (for transfer between urban and intercity buses);
- intermodal facilities at existing on proposed MRT stations;
- paratransit facilities;
- pedestrian facilities around bus stops and terminals.

The "Push and Pull" approach emphasizes that urban transport measures must persuade users into using public transport and non-motorized transport, while developing strategies to "push them out" of automobiles and similar transport modes. To achieve the "pull" component, one must provide good quality of service in public transport, develop infrastructure for public transport and non-motorized transport and, in general, develop policies that improve conditions for the use of these modes [2].

To arrive at a situation where people are "pushed from cars", policies must be in place to discourage their use by eliminating fuel subsidies, creating charges to automobile ownership and use, and, in general, creating policies that increase the cost of using these modes while using the revenue from those charges to enhance sustainable urban transport modes. This approach is generally used by transport economists as it follows a rationale of "price-driven-behavior".

III. Concept of Trunk and Feeder System

Intermodal transportation systems are designed to allow passengers to easily incorporate more than one form of transport into a journey from point A to point B. Line consolidation through straightening and 'trunking' should improve operational efficiencies by reducing route length and service duplication, while offering a more coherent legible service to network users. Service efficiencies gained this way can then enable spare resources to be redeployed elsewhere on the network. The concept of a Trunk and Feeder System is shown graphically in Fig. 1.

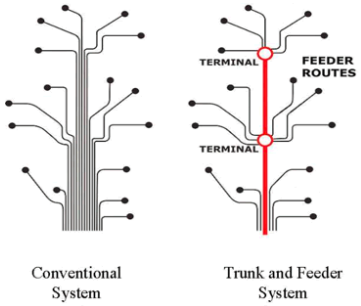

Fig. 1. The concept of Trunk and Feeder System.

IV. Modelling and Simulation

Modelling and simulation methods are essential elements in the design and operation of transportation systems. Traffic simulation microscopic models simulate the behavior of individual vehicles within a predefined road network and are used to predict the likely impact of changes in traffic patterns resulting from the proposed commercial developments or road schemes. They are aiming to facilitate transportation consultants, municipalities, government transportation authorities and public transportation companies. Traffic simulation software modelers combine in a single package multiple traffic flow mathematical models and therefore make it possible to combine the current knowledge on traffic theory when analyzing a traffic congestion problem.

V. Benefits

The study is innovative from the perspective of the approach and possible implementation in Latvia. It could help the nation carve out a long-term strategy of establishing viable public transport modes or alternatives e.g. Mass Rapid Transit, Light Rail Transit, and subterranean /general railways in the country, which could extend the domain of economic benefits from the common man to those in businesses and industries.

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The Problem of Efficiency Measurement and Its Solutions

Tatyana Arshinova (*Riga Technical University*)

Keywords **– Efficiency measurement, Stochastic Frontier Approach (SFA), Data Envelopment Analysis Approach (DEA), Decision Making Unit (DMU), Returns to Scale (RTS).**

I. Introduction

The interest to the problem of efficiency measurement has significantly increased in the last decade. Frontier analysis methods are considered to be among sophisticated tools for performance measurement that allows the investigation of complex multidimensional production processes. The aim of the scientific paper is to stimulate the empirical development of performance evaluation.

II. Methodology of Frontier Data Analysis

According to the methodology of methods' of frontier data analysis, the efficiency score of investigated Decision Making Units (DMUs) is calculated as a distance from the point that defines the production process of a DMU to the certain efficiency frontier. Entities that are functionating on the efficiency frontier are considered to be absolutely technically efficient; inefficiency of other DMU's is increasing together with extension of the distance to the efficiency frontier. The value of efficiency score is fluctuating from zero to one.

Methods of frontier analysis may be divided into two groups: parametric (Stochastic Frontier Approach (SFA), Distribution-Free Approach (DFA), Thick Frontier Approach (TFA)) and non-parametric (Data Envelopment Analysis (DEA), Free Disposal Hull (FDH)) methods.

III. Parametric Frontier Methods

In accordance with parametric approaches, the efficiency frontier is constructed on the basis of econometric modelling, usually in the form of Cobb-Douglas (log-linear) production function. Econometric analyses include two error components: an error term that captures inefficiency (u_i) and a random error (v_i). Parametric methods have significant advantages – they provide the possibilities to use panel data, to distinguish the random noise from inefficiency and to calculate the standard error of efficiency measurement results'. Nevertheless, the stochastic approaches of performance measurement presume the comparison of investigated DMUs' efficiency to the theoretically developed benchmark frontier, therefore the optimal combinations of inputs' and outputs' sometimes are not achieveable practically. The application of parametric methods' also requires observance of the restrictions imposed on the distributional assumptions on the inefficiencies and random error.

IV. Non-parametric Frontier Methods

In contrast to the econometric approaches, non-parametric methods are based on the hypothesis that the efficiency frontier is generated from the empirical results' of the most efficient DMU's i.e. benchmarks' that „float" on the piecewise linear frontier. The level of technical efficiency of these DMU's is 100%. However, the level of allocative efficiency that defines the optimality of output and input proportions' may have different values even among absolutely technically efficient DMU's. While mathematical, non-parametric methods require few assumptions when specifying the best-practice frontier, they generally do not account for random errors.

The main principles of Data Envelopment Analysis, using the efficiency frontier estimation approach, were firstly stated in the scientific paper of M.J. Farrell "The Measurement of Productive Efficiency" in 1957. M.J. Farrell assumed that the efficiency of an organization consists of two components: technical efficiency, which reflects the ability of a Decision Making Unit (DMU) to obtain maximal output from a given set of inputs and allocative efficiency, which reflects the ability of a DMU to use the inputs in optimal proportions. The definition of the DMU in context of DEA is flexible; it is concerning all entities that are using multiple inputs in the production process of outputs. As an original non-parametric approach of efficiency measurement, Data Envelopment Analysis (DEA) has been introduced by Charnes, Cooper and Rhodes (CCR) in 1978. They provided the formulation of linear programs to measure the productive efficiency (CCR efficiency) of a Decision Making Unit (DMU) relative to a set of referent DMUs. Banker, Charnes and Cooper (BCC) (1984) showed that the CCR efficiency measure can be regarded as the product of a technical efficiency (BCC efficiency) measure and a scale efficiency measure. Related to the latter measure is the economic notion of returns to scale. BCC also provided a modification of the CCR linear programming formulation (via the addition of a convexity constraint) to estimate technical efficiency and the returns to scale. Since DEA in its present form was first introduced in 1978, it has been widely applied to modelling of operational processes for performance evaluations. DEA's empirical orientation and the absence of the need for the numerous a priori assumptions that accompany other approaches (such as standard forms of statistical regression analysis) have resulted in its use in a number of studies involving efficient frontier estimation in the governmental and in the private sector.

Using parametric and non-parametric frontier analysis techniques, the author will develop the efficiency measurement methodology.

Figures, tables and equations will be included into the final version of the scientific paper.

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Power and Electrical Engineering

Power Engineering

The Effect of Non-uniformity in Meshed Networks

Josifs Survilo (*Riga Technical University*)

Keywords **– circulating current, meshed network, non-uniform network, power losses.**

I. Introduction

The drawback of non-uniform networks (X/R≠const) appears when the network is meshed (has loops) [1], [1]: extra losses caused by circulating current (CC) appear; in some branches currents are considerably increased. A ringed network (which has one loop) is considered in [3] where the shortcomings were apprehended as well as ways to eliminate them. The task complicates when there are more loops. Then it is impossible to do without matrix algebra. The losses due to non-uniformity can be found by subtracting the losses in uniform grid from those in non-uniform one. However it could be necessary to locate the problem in the network and now more sophisticated method should be applied.

II. Considered network

The fragment of network in Kurzeme (west Latvia) is considered. The main energy flow is directed to Klaipeda. Branch impedances and loads are given in table 1.

Node matrix $\boldsymbol{M}$ reflects n=17 branches and k=14-1=13 nodes (Fig. 2). Of all 14 nodes one is balancing. Circuit diagram contains r=4 independent loops represented by matrix $\boldsymbol{N}$. Branch impedances are represented by **Z**-matrix. On the basis of these matrices, the square matrix $\boldsymbol{A_Z}$ and inverse matrix $\boldsymbol{B_Z}$ are obtained [4] (f.v.):

$$\boldsymbol{A_Z} = \begin{bmatrix} \boldsymbol{M} \\ \boldsymbol{NZ} \end{bmatrix} \tag{1}$$

TABLE 1

Branch Impedances and Loads

Desig-nation	Impedance (Ω)	Desig-nation	Load (MW)
Z_1	0.42+2.62i	J_1	-275.6
Z_2	0.16+5.29i	J_2	-4.1
Z_3	6.38+12.88i	J_3	0
Z_4	6.38+12.88	J_4	-3.8
Z_5	2.05+2.64i	J_5	0
Z_6	2.05+2.64i	J_6	-1.2
Z_7	6.42+13i	J_7	0
Z_8	17.8+36i	J_8	-12.7
Z_9	12.1+24.44i	J_9	-14
Z_{10}	0.36+0.72i	J_{10}	-2.8
Z_{11}	0.16+0.31i	J_{11}	-22
Z_{12}	0.15+0.3i	J_{12}	-9.2
Z_{13}	1.18+1.52i	J_{13}	0

$$\boldsymbol{B_Z}=\boldsymbol{A_Z}^{-1} \tag{2}$$

CC is found by means of CC matrix $\boldsymbol{\Delta B}$

$$\boldsymbol{I_{ci}} = \boldsymbol{\Delta B}\, \boldsymbol{J}, \tag{7}$$

To eliminate CC, the opposing voltages E can be found:

TABLE 5

True Extra Losses in Meshed Network

Table 2	Sample 1	73.88 kW
	Sample 3	548.26 kW
Table 3	Sample 1	11.25 kW
	Sample 3	971.9 kW
Table 4	Sample 3	234.02 kW
	Sample 8	2.43 kW

$$\begin{bmatrix} E_1 \\ \dots \\ E_r \end{bmatrix} = \boldsymbol{\Delta B_E}^{-1} \begin{bmatrix} -I_{ci1} \\ \dots\dots \\ -I_{cir} \end{bmatrix} \tag{14}$$

III. Characteristic of meshed non-uniform network

To foresee the possible extra losses in the network, the non-uniformity factor K_{nu} can be found which equals to extra losses, when the network is loaded by loads equal to unity.

IV. Consideration of network versions

More calculations were made to see how extra losses and K_{nu} change. The results are presented in table 2 - with changed branch impedances with the same loads; table 3 – with changed branch impedances according to table 2 and with changed loads but the same for each case; table 4 – with changed branch impedances and changed for each case load.

IV. Using the scaling factors

Proceeding with calculations, vector $\boldsymbol{J}$ of node loads was written according to table 1 in MW which in calculations was considered as current in Amperes. The results A were obtained. To have the true results A_{tr}, it is necessary to apply scaling factors K:

$$A_{tr} = AK\,. \tag{20}$$

Some true results are given in table 5.

VI. Conclusions

1. In meshed non-uniform networks, CC exist in all branches. CC in branches pertaining to both adjacent loops are combined of CC in these loops.

2. Extra power loss in the network is equal to the sum of extra losses in each branch which are equal to squared CC module multiplied by resistance of the branch.

7. Judging by the results, the extra losses are small but with changed input data they can greatly increase.

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Environmental Aspects and Operation Mode of Small Hydropower

Josifs Survilo (*Riga Technical University*)

Keywords **– dam, efficiency, environment, small hydro.**

I. Introduction

With expensive fuel it is necessary to pay attention to renewable sources of energy. Now we have to use also small rivers for electric energy production. However building the dams harms the environment. A lot of ponds appear and the rivers are partitioned. Safety aspect also comes into force [1].

II. The Ways of Utilizing the Water Energy

To avoid these shortcomings, it should be tried to avoid the use of dams. This can be done with water wheels which utilize the power of water stream but their efficiency is so small that one can not count on them. Otherwise it is necessary to create the water pressure. In order to turn a turbine, pile-up of the water is needed.

Let us recall the basic relations.

Power P generated by hydro:

$$P = \eta \Delta p_e \Phi , \tag{2}$$

where η is an efficiency factor; Δp_e is pressure drop for generation of electricity; Φ is rate of water flow to a turbine.

$$p = \Delta p_e + \Delta p_p , \tag{3}$$

where p, Δp_p are total pressure, its drop on the way to turbine.

$$\Delta p_e = kp , \tag{4}$$

where k shows the share of useful water pressure.

Overall efficiency factor η_{oa} can be defined by:

$$\eta_{oa} = k\eta . \tag{6}$$

III. Penstock Instead of Dam

It should be recommended to use the penstock (pipe) at places where river has large slope. The bulk of water inside pipe is directed to the turbine and a small part of it – by its natural course. The water flowing in the pipe is subjected to resistance R_h against its flow. The water flow in completely filled pipe can be of two ways: laminar and turbulent [2]. In larger velocities it is turbulent; in small ones it is laminar.

Laminar flow can not be reckoned with. It requires very large pipe diameters.

Turbulent flow is described by Darcy – Weisbach [3] equation:

$$h_p = f \frac{Lv^2}{2gD_p}, \tag{17}$$

where h_p is head loss for water flow in the pipe; f is Moody friction factor; g is free fall acceleration; v is average velocity of water; D_p and L are pipe internal diameter and length.

Flow rate can be determined (ρ – water density) so:

$$\Phi = \pi \sqrt{\frac{D_p{}^5 \Delta p_p}{8 f \rho L}} = \pi \sqrt{\frac{D_p{}^5}{8 f \rho L \Delta p_p}} \Delta p_p , \tag{20}$$

Resistance to turbulent water flow is:

$$R_h = \frac{1}{\pi} \sqrt{\frac{8 f \rho L \Delta p_p}{D_p{}^5}} = \frac{2 f \rho L v}{\pi D_p{}^3} . \tag{21}$$

If we want to have a given water flow in a pipe by some pressure Δp_p than internal pipe diameter should be:

$$D_p = \sqrt[5]{\frac{8 f \rho L \Phi^2}{\pi^2 (1-k) p}} . \tag{22}$$

Generated power is:

$$P = \eta \pi k p \sqrt{\frac{D_p{}^5 (1-k) p}{8 f \rho L}} = \eta \pi \sqrt{\frac{D_p{}^5 p^3}{8 f \rho L}} \sqrt{k^2 - k^3} . \tag{23}$$

Maximum power, using pipe of diameter D_p and sufficient river flow, sets in by $k = 2/3$, and then it is:

$$P_{\max} = 0.4275 \eta \sqrt{\frac{D_p{}^5}{f \rho L}} \sqrt{p^3} . \tag{25}$$

The overall efficiency factor is $\eta_{oa} = (2/3)\eta$.

If maximum power P_{max} is given, the diameter must be:

$$D_p = 1{,}4048 \sqrt[5]{\frac{f \rho L P_{\max}{}^2}{\eta^2 p^3}} . \tag{28}$$

The water flow in a river is unstable [4] (f.v.) and now electricity generation is tied to river flow. Since such a hydro must be connected to a grid and operation mode is that of generation in the rhythm of the river.

The pipe must be permanently filled with water, by smaller water flow rate h_p decreases and useful factor k grows.

The slope of river can be artificially increased.

IV. Conclusions

1. Building the small hydro using the pipe instead of dam satisfies environmental aspects.

2. Theoretically such hydropower using the pipe instead of dam is possible on other rivers, however practically the expenses on pipe should be taken into account.

3. Efficiency of pipe hydro is smaller than the dam hydro since part of water pressure is lost in the pipe.

6. Pipe hydropower must be connected to a grid and its operation should be in the rhythm of river flow.

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Evaluation of Customer Costs of Reliability with Time-variable Loads and Outage Costs

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Keywords **– Life Cycle Analysis (LCA), reliability, power supply**.

I. Introduction

Reliability of power supply is one the main parameters describing power system operation. Optimal power supply reliability level contributes to economically efficient work of power system that includes expenses of system operators and customer costs. It is quite hard to evaluate customer costs of reliability (CCR) and make decision on appropriate amount of investments in grid.

To evaluate CCR, information about power supply interruption costs, as well as amount of interrupted power and energy not supplied should be known.

Further there is discussed problem of CCR identification using time variable loads of customers instead of more traditional usage of average loads.

II. Formulation of Problem

In the most cases analysis of CCR and energy not supplied (ENS) is performed using average loads. In such case energy consumption is replaced by average load of load point during some long period of time – season, like in [4] (f.v.), year, like in [5] (f.v.) or other time period, like in [6] (f.v.). For calculation of ENS average load of year/season/other period is multiplexed with average power supply interruption time of customers.

Comparing high cost periods indicated in [1] – [3] with interrupted load and ENS of the two sectors, we can conclude that costs of Commerce and Services have god correlation with load values. In this case average load can be used for identification of CCR.

In case of Industry sector we cannot see the same correlation between high costs and periods with the biggest values of ENS and loads. Such situation can be explained by the effect of technological process in industry. In such case usage of average load value for calculation of CCR can lead to large scale errors, because even in Latvia, where Industry sector is assumed to be relatively small, it makes more than 25% of all electrical energy consumption [7] (F.V.).

To make calculation of CCR more precise, time-variable loads should be used in calculations.

III. Approach for Evaluation of Customer Costs of Reliability

Flowchart, developed by authors of the paper, given in Fig.5 illustrates structure of proposed approach for evaluation of CCR that is based on evaluation of effect of interruptions occurring at distribution network level.

To calculate CCR for the regime *re*, ENS and interrupted load for each hour of a 24 hour (a day) period are calculated. CCR is calculated based on the information of each hour`s ENS and interrupted load. CCR is formed by costs caused by short (< 3 min.) and long (> 3min.) power supply interruptions and can be calculated using (1):

$$CCR = CCR_s + CCR_l \text{ ,} \quad (1)$$

Where

CCR_s – customer costs of reliability caused by short (< 3 min.) power supply interruptions [monetary units].

CCR_l - customer costs of reliability caused by long (> 3 min.) power supply interruptions [monetary units].

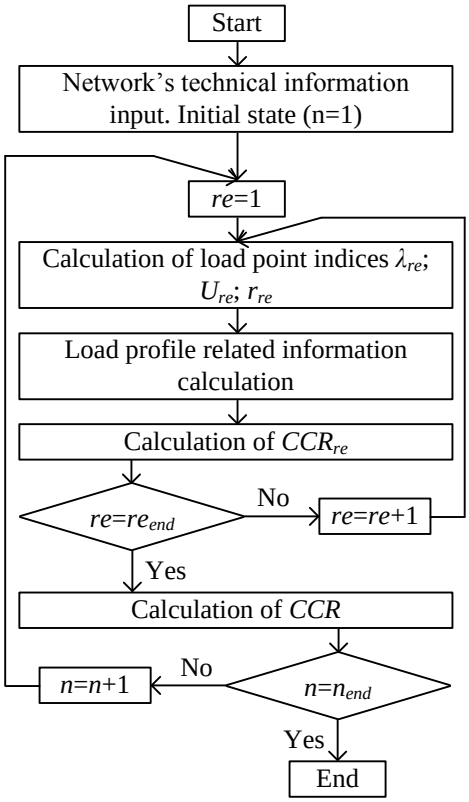

Fig. 5. CCR calculation flowchart.

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Assessment of Wind Production Impacts to a Power System and Market Formation in Baltic (Digest)

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Irina Oleinikova (*IPE*) and Gatis Junghans (*AS "Latvenergo"*)

***Keywords* – Distributed power, Modeling, System integration, Wind energy.**

I. Introduction

Numbers of wind power projects in Baltic region was proposed in last period. Integration of wind generation into power production mix has significant impact to the power system (PS) operation as well as to the electricity market.

The aim of study was the assessment of wind production impacts related with considerable wind installation in future, developing of methods and algorithms enable simulations from wind conditions to final impact on a system. In a paper algorithms and methodology for estimation of those impacts including model which is capable to generate wind production curve assuming real wind conditions in a region are proposed.

II. Wind Generation Modelling

Wind power and thus its modeling is significantly different from the other power technologies. Generation has specific characteristics, including variability and geographical distribution. The methodology and model presented in further part integrates specific features of large-scale wind generation deployment and regional wind conditions.

The resulting production curve is labeled as "raw" production curve with relatively high volatility of production. Averaging of the wind speed has partial impact to the shape of output production curve, so dynamics of variations has been decreased. However, in order to achieve characteristics observed and measured in real conditions, incorporation of so-called large-scale deployment smoothing effect (LSDSE) of wind production is performed in the next step. The results of applied smoothing are shown in figure 4.

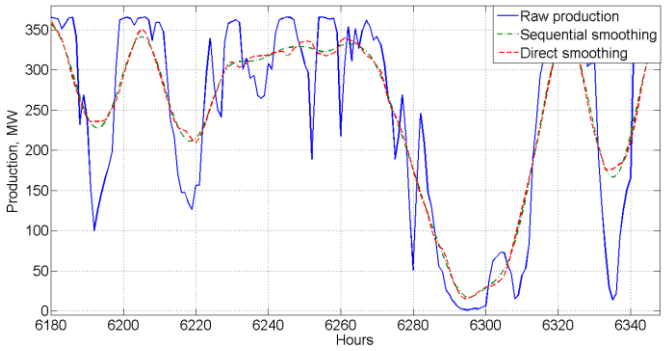

Fig. 4. Example of one week smoothed wind production.

III. Results of Regional Wind Production Modeling

The deliverables obtained from simulation of the wind production are presented in this part of article and contains raw and smoothed production curve in Baltic 2020 scenario; monthly diversity of wind generation and duration curves with different smoothing approaches for 2011, 2016, 2020 scenarios; capacity and load factor estimation as well as comparison of the annual Baltic wind production obtained by model and expected values in NREAPs 2011-2020.

TABLE III. Simulated and Expected Wind Production

Year	Results MWh	NREAPs MWh	Year	Results MWh	NREAPs MWh
2011	942476	901000	**2016**	2632868	2385000
2012	1399022	1095000	**2017**	2850606	2853000
2013	1640172	1579000	**2018**	2979375	3087000
2014	1914100	1843000	**2019**	3389096	3251000
2015	2061600	2133000	**2020**	3637270	3697000

IV. Impacts of the Wind Development to a Power System and Electricity Market

Engagement wind production into estimated Baltic merit-order generation at the basis of SRMC extended with transmission capacities for winter conditions in 2020 scenario are shown in Fig. 10. Level of load in the system represents estimated minimal, average and maximal load during January.

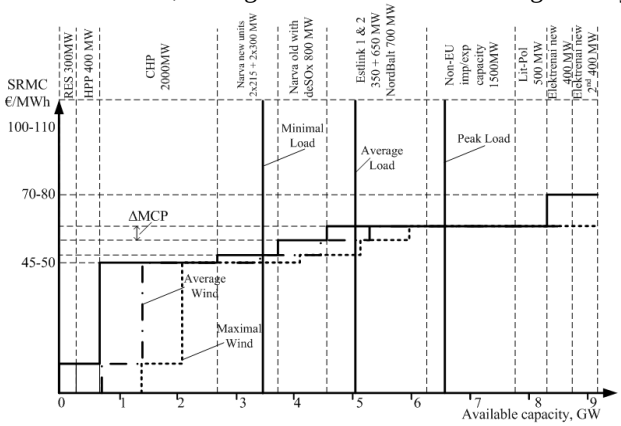

Fig. 10. System price formation in winter scenario 2020.

V. Conclusions

Results obtained by model are comparable with targets published in NERAPs, level of system penetration by wind in compliance with methodology and evaluation criteria shows that for all assumed scenarios are values within acceptable range. Integration of wind production will reduce need of most expensive conventional plants which can lead to lower average prices for electricity. Should be noticed that expansion of power production capacities with low marginal costs of production might have also negative impact to the conventional generators, mostly caused by decrease of their load factors, hence, reducing ability sufficiently cover total production costs.

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Evaluation of the Profitability of High Temperature Low Sag Conductors

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Keywords **– Efficiency, estimation technique, power transmission, supply quality, transmission of electrical energy.**

II. Introduction

Since an expansion of the transmission grid will be required, it is necessary to utilize the existing infrastructure of the transmission grid with maximum extension of new technologies into the existing power line systems with less economic investment and a high level of technical security. The use of High-Temperature Low Sag (HTLS) conductors is an important method for improving and upgrading the existing transmission network nowadays. For the comparative assessment, conductors of the conventional core design and HTLS conductors [1], [2] are presented.

IV. A Comparative Assessment of the Examined Conductors

The comparative evaluation of the selected conductors was based on technical and economic aspects.

Concerning the technical comparison, it was divided according to two main criteria:

1) mechanical limitations – mechanical tension, conductor sag and the permissible span; in this case, the special program "SAPR LEP 2011" was used [3] (see Fig. 3, 4 (f.v.), 5 (f.v.), 6 (f.v.), 7);

2) thermal limitations – the capacity of the line and the permissible conductor temperature (see Table II (f.v.)).

Firstly, the mechanical comparative evaluation will be discussed.

Fig. 3 shows that the mechanical tension of the examined conductor types in a line for the heat-up mode at +35°C is higher for the ACCC and ACCR conductors as compared with the traditional type conductors, in this case AS and ACSR.

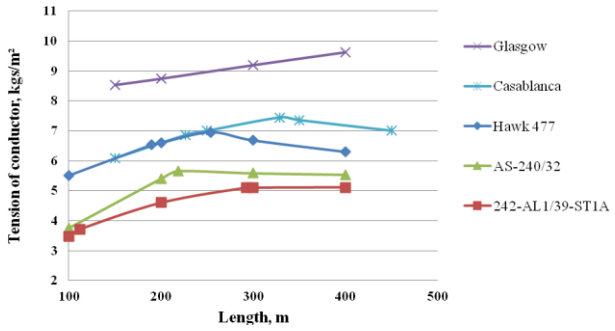
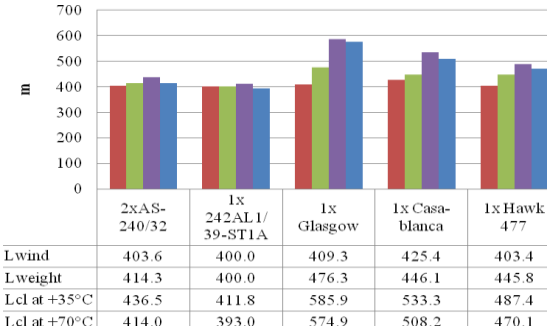


Fig. 3. The tension-length relationship in a conductor heat-up mode at +35°C of the different types of conductor of a line LN-266

As far as the conductor sag is considered, it can be concluded that for the heat-up mode at +35°C the largest sag occurs in conductors of conventional core designs like AS and ACSR compared with the HTLS conductors like ACCR and ACCC (see Fig. 5 (f.v.)).

Fig. 7 presents simulation results regarding the permissible spans of the examined conductors, which show that the wind spans (L_{wind}) are the decisive spans of all the described conductors.



	2xAS-240/32	1x 242AL1/39-ST1A	1x Glasgow	1x Casa-blanca	1x Hawk 477
Lwind	403.6	400.0	409.3	425.4	403.4
Lweight	414.3	400.0	476.3	446.1	445.8
Lcl at +35°C	436.5	411.8	585.9	533.3	487.4
Lcl at +70°C	414.0	393.0	574.9	508.2	470.1

Fig. 7. The allowable wind (L_{wind}), weight (L_{weight}) and clearance (L_{cl}) spans of the different types of conductor of a line LN-266

Secondly, the thermal comparative evaluation will be reviewed.

Table II (f.v.) shows that the HTLS conductors like ACCC and ACCR have the highest permissible conductor temperature compared with the ACSR and AS conductor. Therefore, the higher the permissible conductor temperature, the higher the capacity that can be transmitted over a particular overhead line.

The economic comparison is based on the quantity of tension and intermediate towers as well as on the total amount of required material and equipment (see Fig. 8 (f.v.)). Therefore, an approximate calculation of the total investments (C_Σ) consists of five main parts and is determined by the following formula:

$$C_\Sigma = C_c + C_s + C_f + C_{str} + C_{\Sigma i}\ , \qquad (2)$$

where C_c – the cost of a conductor, r.v.; C_s – the cost of a tower, r.v.; C_f – the cost of a foundation, r.v.; C_{str} – the cost of a string, r.v.; $C_{\Sigma i}$ – the total installation costs, r.v.

V. Conclusions

The comparative evaluation of different types of conductor showed the profitability of replacing a conductor of the conventional core design with a HTLS conductor by technical and economic criteria. Besides, the application of HTLS conductors could be more productive, if the high price of the ACCC and ACCR conductor types will be reduced. At the same time, it can be one of the reasonable methods for increasing the limited capacity of the existing overhead lines.

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Estimation of asset insulation condition by the Monte Carlo method

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Keywords – PARTIAL discharge, reliability, prognosis, insulation.

I. Introduction

Disturbances of an electrical supply usually are caused by unpredicted failures of electrical equipment. Main reasons for failures are too fast degradation of insulation, network grounding method, installation and used material quality. All mentioned causes are bonded and can't be observed independently outside of this context. Pinpointing of potential failure is onerous by fact that power supply lines are built or rebuilt as cable line in recent years and there are very least options for maintenance personnel to make a visual inspection and assess the condition of the insulation since cable lines are buried underground.

II. Overvoltage in the distribution network of Latvia

Historically medium voltage distribution network was developed as isolated neutral system. One of the benefits of this type of grounding is that it is possible to operate the network during sustained 1 phase ground fault. It shall be kept in mind that during ground faults voltage in undamaged phases increase up to line voltage as well as insulation is unfavorably heated due to increased currents.

A. Distribution network grounding methods

In mixed (cable and overhead) 20kV network with ground fault up to $I_c \leq 20A$ isolated neutral system is preferred which doesn't have a physical connection to the ground, see Fig. 2. (f.v.)

In case when 20kV network ground fault exceeds $I_c > 20A$ ground fault compensation system is introduced, see Fig. 3. (f.v.) in order to limit the ground fault current below acceptable 20A.

Normally network with explicit cable lines is grounded through the low ohmic resistance creating low ohmic grounded neutral system to prevent large ground fault impact on the electrical equipment reliability and electrical safety, see Fig. 4. (f.v.). Low ohmic grounded system limits the fault current up to 1000A or even less and allows reliable and selective protection tripping at the beginning of the fault.

Spread of the network grounding methods for all 357 feeding substation bus bar sections in Latvia at the 1st of January 2012 is shown in the table I.

TABLE I

AMOUNT OF BUSBARS AND ITS GROUNDING METHOD

Busbar amount, n	Voltage level, kV	Neutral grounding method
124	20	isolated
72	20	compensated
42	10	isolated
19	10	compensated
59	10	low ohmic
41	6	isolated

C. Surge values in context of neutral grounding

At the ground fault experiments in the network with isolated neutral it was discovered that overvoltage during transient process might be as high as 3.5 times the nominal phase voltage [1], which is dangerous value for insulation and sometimes leads to breakdown.

Same experiments in compensated network showed that overvoltage during ground fault transient process doesn't exceed 2,2 times the nominal phase voltage [1].

Overvoltage value depend on the fault resistance during the ground fault either it is purely metallic or intermittent arc.

V. Calculation of PD occurrence possibility

Accordingly to inside the company regulation expected indoor switchgear lifetime is 40 years [3]. Monitoring of PD will be done 20 times every 2 years during asset lifetime. It is estimated that one termination (PD measurement) out of 60 terminations will be with damaged insulation and shall be fixed immediately.

Raw data for Monte Carlo calculation:

– 1 out of 60 terminations is dangerous and insulation degradation process is ongoing that might lead to failure;

– 20 consecutive measurements with interval of 2 years shall pass the PD measurement test;

– There is 50 % probability every PD measurement time that termination is potentially dangerous and will fail sooner than its estimated lifetime as expected;

– Probability shall be calculated with 99% confidence.

Calculation model is set up in the MS Excel software.

For the row of 20 measurements accidental value is selected each time out of 60 variations where one PD measurement outcome is not acceptable, see table II.

TABLE II

RESULTS OF THE 20 MEASUREMENTS FOR 40 YEARS OF EXPECTED ASSET LIFETIME

Measure-ment No. 1	Measure-ment No. 2	Measure-ment No. 3	Measure-ment No. n	Measure-ment No. 20
valid	valid	valid	invalid	valid

It shall be 3583 simulation run to achieve desired precision with same raw data at the input. To find the final value calculation algorithm is run after implementing 3583 simulations.

Second and more accurate calculation gives that it is possible to say with 99% confidence that in 72-74% of PD measurement cases 1 out of 60 terminations in 20 consecutive measurements will be failed or even might cause large scale accident in the network.

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The Stipulation for Orthogonality of the Nodal and Extra Currents

Josifs Survilo (*Riga Technical University – RTU*), Dmitrijs Antonovs (*RTU*) and Edite Biela (*RTU*)

Keywords **– circulating current, closed grids, homogenous network, loop current, non-uniform grid, power losses.**

I. Introduction

In closed non-uniform grids, there exist not only power losses caused by load currents but the losses generated by grid non-uniformity (X/R≠const) and foreign emf in the grid loops (if such there are). This question is considered in [1], [2] for two-terminal lines. For closed grids, it is considered in [3], [4]. But not all influencing factors were considered and there was no general consideration made. In short, the rules must be elucidated by which the total power losses can be eliminated on losses caused by various factors (i.e. when they are orthogonal).

II. Two terminal line

For two terminal line, it is shown that total losses are the sum of load losses in uniform line and losses caused by non-uniformity and extra losses. The total power losses are:

$$\Delta P_{J+E} = \Delta P_J + \Delta P_E = \\ = \Delta P_E + \frac{R_1 J^2 |Z_2|^2}{|\dot{Z}_1 + Z_2|^2} + \frac{R_2 J^2 |\dot{Z}_1|^2}{|\dot{Z}_1 + \dot{Z}_2|^2} + \Sigma R \cdot I_{ex}{}^2. \quad (6)$$

III. Closed Grids

Closed grids contain more than one loop. As an example, the non-uniform grid is shown in Fig. 2.

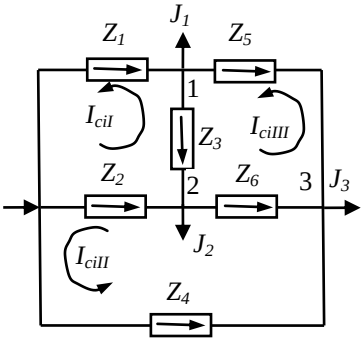

Fig. 2. Non-uniform closed network with three loops

In Fig. 2, there are depicted three independent loops $Z_1 – Z_2 – Z_3$; $Z_2 – Z_4 – Z_6$ and $Z_5 – Z_3 – Z_6$ with loop (circulating) currents (CC) $\dot{I}_{ciI}$; $\dot{I}_{ciII}$ and $\dot{I}_{ciIII}$. To eliminate CC, it is necessary to insert in these loops opposing voltage $\dot{U}_1$; $\dot{U}_2$ and $\dot{U}_3$. So far it is clearly expounded in [8] (where symbol U is replaced by symbol E).

The input current vectors are: node current input vector J_j consisting of load currents J_1, J_2, J_3; foreign emf input vector J_f consisting of inserted in loops foreign emf E_{f1}; E_{f2}; E_{f3} and vector J_{jf} (see (11):

$$J_j=[J_1; J_2; J_3; 0; 0; 0]; \; J_f=[0; 0; 0; E_{f1}; E_{f2}; E_{f3}]; \\ J_{jf}=[J_1; J_2; J_3; E_{f1}; E_{f2}; E_{f3}]. \quad (11)$$

Further, the following quantities must be calculated: branch current vector I_j excited by node loads J; circulating current vector I_{ci}; equalizing current vector I_{eq}; extra current vector I_{ex}; summary branch current vector I_{jf}; branch current vector I_h excited by node loads J in uniform grid; losses ΔP_j caused by load currents in non-uniform grid; losses ΔP_{ci} caused by CC; losses ΔP_{ex} caused by extra currents; losses ΔP_{jf} caused by summary branch currents; losses ΔP_h caused by load currents in uniform grid:

$$I_j=B_z*J_j; \; I_{ci}=\Delta B*J_j; \; I_{eq}=B_z*J_f; \; I_{ex}=I_{ci}+I_{eq}; \; I_{jf}=B*J_{jf}; \; I_h=B_h*J_j; \\ \Delta P_j=I_j{}'*R*I_j; \; \Delta P_{ci}=I_{ci}{}'*R*I_{ci}; \; \Delta P_{ex}=I_{ex}{}'*R*I_{ex}; \; \Delta P_{jf}=I_{jf}{}'*R*I_{jf}; \\ \Delta P_h=I_h{}'*R_b*I_h, \quad (13)$$

It is found that losses from summary branch currents are:

$$\Delta P_{jf}=\Delta P_h+\Delta P_{ex}, \quad (14)$$

which means that load currents in uniform grid and extra currents are orthogonal. Formula (14) has been proved in full version and confirmed by calculations.

IV. Determination of extra losses from incorrect transformer ratios

Expounded above was used for Kurzeme Ring losses calculation.

The KR model consists of 38 nodes, 50 branches (transformers, transmission lines and cables) and they make in common 13 loops, all data of 330 kV elements were reduced to 110 kV voltage.

The results of calculations in MW for one phase are the following:

total losses for one phase are ΔP_{jf} = 1.989; load losses in non-uniform grid ΔP_j = 1.839; load losses in uniform grid ΔP_h=1.793; losses caused by transformer ratio difference ΔP_f=0.150; CC losses ΔP_{ci} = 0.046; extra losses 0.196.

V. Conclusions

1. Closed grids inherit main properties of two-terminal line.

2. The orthogonality of load currents and extra currents means that power loss from joint action of these currents is equal to the sum of power losses by separate action of these currents.

3. Extra currents in initial grids are orthogonal to load currents in uniform grid.

8. Decomposition of power losses makes it possible to establish the cause of power losses.

9. Different transformation ratios in high voltage closed networks can increase the losses.

10. The obtained theoretical results applied to the network of Kurzeme Ring showed that extra losses are not considerable as compared with load losses in uniform grid by actual load flows.

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Development of an algorithm and software "MVES-TV 2012" for touch voltage evaluation in MV networks

Ilze Priedite-Razgale (*Institute of Physical Energetics, Riga Technical University - RTU*) and
Janis Rozenkrons (*RTU*)

***Keywords* – Distribution of electrical energy, safety, software.**

I. Introduction

The major consideration why substation is so well-grounded is personnel protection. Equipment protection is just one of the other reasons.

A continuous current of 0.15 A flowing through the trunk part of the body is almost always fatal. In assessment of touch voltage in case of one phase earth fault for the medium voltage networks, it is important to understand the electrical characteristics of the most important part of the circuit, the human body. [1]

The earth potential rise of an earthing system may be calculated from available data (impedance to earth of existing earthing systems, switchgear and network schemes etc.). For the calculation all earth electrodes and other earthing systems, which are reliably connected to the relevant earthing system with sufficient current carrying capacity, may be considered

II. Algorithm for evaluation of touch voltage in MV networks with compensated neutral earthing

In evaluation of touch voltage it should be taken into account earth fault current value at substation, resistance to earth at substation, earth electrode impedance at substation, number of substations and type of cable. In Fig.8 is shown algorithm for evaluation of touch voltage in MV networks with compensated neutral earthing. [2],[3]

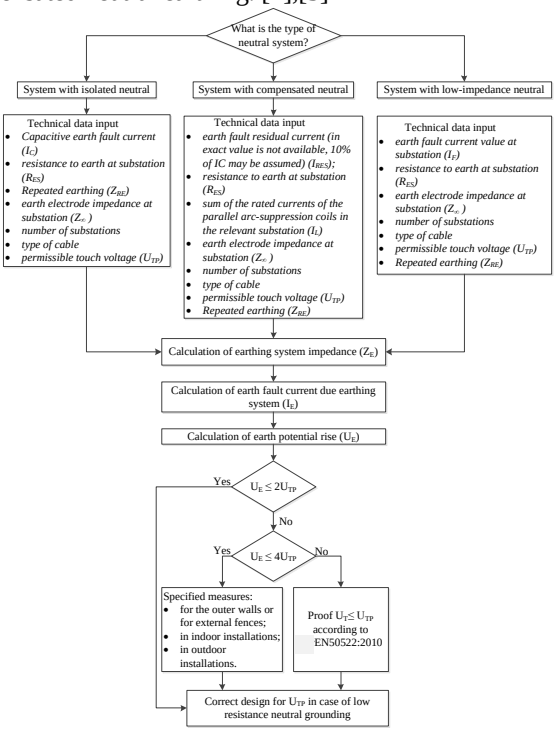

Fig.8. Algorithm for evaluation of impedance to earth at substation in MV networks with low resistance and compensated neutral earthing

III. Software "MVES-TV 2012" Test

Software "MVES-TV 2012" developed by the authors was tested. The results are shown in Fig.9 and Fig.10. It is easy verify results, if use equations (2), (3), (4) and (5).

In Fig. 9 example of evaluation in case of cable lines is shown. In this case touch voltage value does not exceed permissible touch voltage.

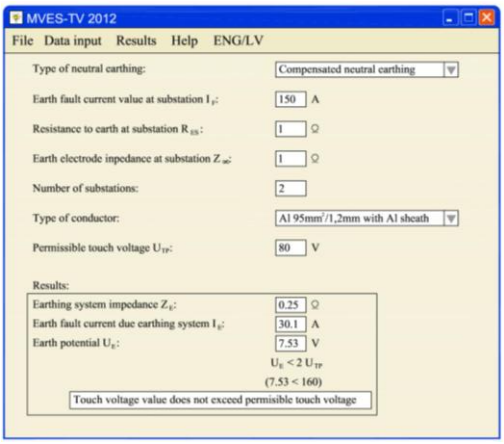

Fig.9. MVES-TV 2012 evaluation in case of cable lines

IV. Conclusions

An algorithm for evaluation of touch voltage in medium voltage networks with different type of neutral earthing in paper was made. Proposed algorithm takes into account power line type (overhead line, underground cable line), earth fault value, number of substations, etc.

Based on this algorithm, new software "MVES-TV 2012" (Medium Voltage Electrical System Touch Voltage) was developed by the authors of this paper. Evaluation with this software ensures the safety of human life in any switchgear place to which persons have legitimate accesses.

This software can be useful for distribution network exploiting engineers when trying to evaluate of permissible touch voltage in medium voltage networks with different type of neutral earthing.

With this software it will be easily and quickly to evaluate of permissible touch voltage in medium voltage networks with different type neutral earthing

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Power and Electrical Engineering

Electrical Machines and Drives, Robotics

Load Compensation in Mechatronic System with Observer

Aleksey Kolganov (*Ivanovo Power State University - IPSU*), Sergey Lebedev (*IPSU*) and Mikhail Kulenko (*IPSU)*

Keywords **– Control of drive, estimation technique, mechatronics, motion control, simulation.**

I. Introduction

The important factor of influence on characteristics of mechatronic modules in positioning systems is kinematic and dynamic connections between axes as variable loads of the complex form. The compensating connection on disturbances with load observers [1] allows using combined control as ensuring control of dynamic processes on disturbance.

II. Structure of Mechatronic System with Load Compensation

The combined control system (Fig. 1) consists of the astatic position regulator (*APR*) for maintenance of regulation quality on control and zero static error on disturbance; the load observer (*LO*) for making a compensation unit (*CU*) to compensate disturbances of the arbitrary form; the electromagnetic torque loop (*ETL*) for setting in motion a mechanic in dependence on the signal for position (q_r), feedback (q), speed ($\dot{q}$) and an estimation ($\hat{Q}_L$) the *LO*.

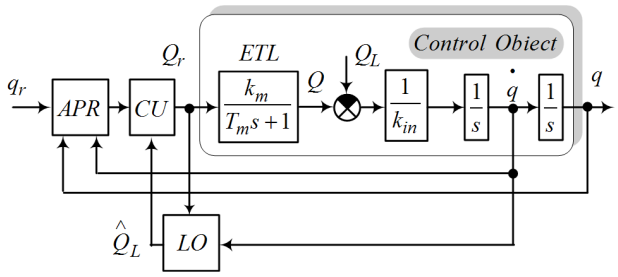

Fig. 1. Structure of the system with combined control and load compensation.

IV. Astatic Position Regulator Synthesis

The synthesis of a closed loop of position regulating for an astatic position regulator in the form of modified PID controller with the compensation filter of nulls of a closed-loop transfer function (Fig. 3) is executed for the given passband ($\omega_0 = 2\pi f_{pr}$). The controller parameters can be evaluated according to binomial distribution (Newton binom), Butterworth or Bessel polynomial distribution.

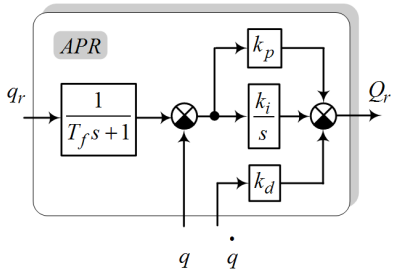

Fig. 3. Astatic position regulator structure.

Simulation results (Fig. 4) (f.v.) analysis shows that adjusted on Bessel polynomial astatic system has the best performance. Along with the best response time on reference signal, advantage in speed performance and a minimum dynamic error on disturbance is attained.

V. Load Observer and Compensation Unit Synthesis

Usage of astatic state observers [2] as a load observers is offered. In accordance with (8) (f.v.) the load observer structure (Fig. 6) is obtained.

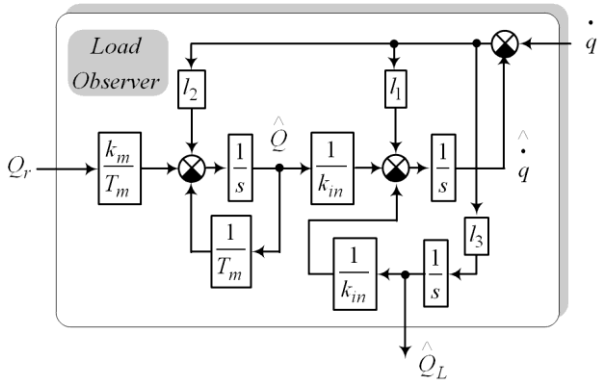

Fig. 6. Load observer structure.

VI. Astatic and Combined Systems Research

The load form can be arbitrary enough in real mechatronic systems, so the systems response at the zero reference signal for positioning was researched (Fig. 9).

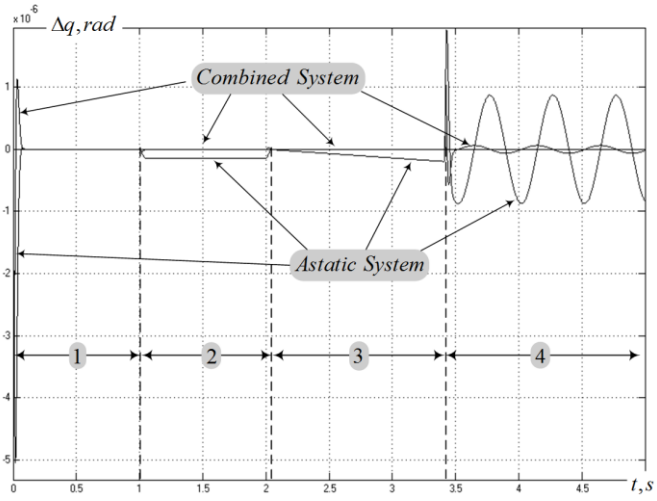

Fig. 9. Influence on an error value of different forms disturbances: 1 – constant load value; 2 – linear increasing of load; 3 – variation according to parabolic law; 4 – harmonic load variation with constant amplitude and frequency.

VII. Conclusion

The results are obtained show the proposed structures of combined control systems with astatic regulator and the 1st order astatic load observer can be extended to mechatronic systems of different configuration and application.

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The Re-examination to Adjustment the Rotor Magnetic Field Observer in the Induction Motor

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Alexander Smirnov (*IPSU)* and Georgy Bouldukan (*IPSU)*

Keywords **– Electrical drive, asynchronous motor, simulation, optimal control.**

I. Introduction

The most qualitative induction motor control can be obtained when using torque vector control system. Apart from the type of the used observer for ensuring the integrity of the controlling system motor parameter estimation is needed. They are rotor characteristic time *Tr* and stator-rotor mutual inductance L_{12}.

Among analyzed induction motor parameters identification methods ones suggested in [1], [2] suit better for practical application.

However these approaches, in spite of the relative simplicity, have a number of disadvantages. This paper presents a development of an adjustment technology for the rotor magnetic field observer in the induction motor, suitable for industrial applications.

II. The Research of the Imrecission Influence in Rotor Characteristic Time Estimation on The System Characteristics

For determination of the imprecision influence in rotor characteristic time value *Tr* on the system characteristics the investigation of the mathematical model of the vector torque loop was carried out in Simulink. The obtained simulation results are given in Fig. 1.

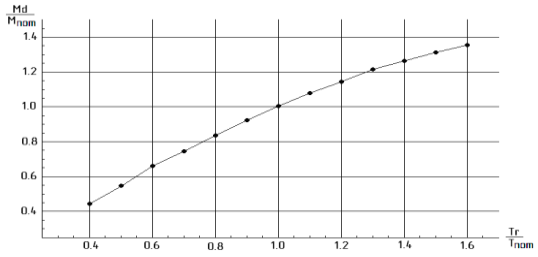

Fig. 1. The characteristic curve of the torque according to the *Tr* valuation inclination.

The given characteristic curve shows that rotor stream phase observer alignment error greatly affects the torque value, gained by the motor at the same stator current and primary voltage.

The reason of the dependence of the induction motor torque from the *Tr* valuation inclination is the presence of the cross coupling between magnetizing and active stator current components.

On the basis of the obtained results it is possible it is possible to estimate the value of cross coupling between the channels of the active and magnetic current component by the magnetic flux and induction motor torque measurement.

The induction motor torque correspondence with the active and magnetizing currents is described by the formula:

$$M_D = C_M(I_{MAG}) \cdot I_{MAG} \cdot I_{ACT}. \qquad (1)$$

However, the given formula is the mathematical description of the fact that when there is the constancy of the magnetizing current, apart from nonlinearity of the magnetization curve, velocity, time and environments in the linear zone the motor torque must be a linear function with the specification on active current:

As the valuation of the dynamic motor torque it is suggested to use rotor acceleration: So, the basic criterion of the quality of the rotor flow observer adjustment it is reputed to be the acceleration constancy, which is time independent and assignment to the active current, at the electric drive acceleration at no-load run.

The developed adjustment technique of the characteristic time was checked experimentally on the electric drive with a capacity of 4 kW. The results curves are shown on Fig. 6 and Fig.8.

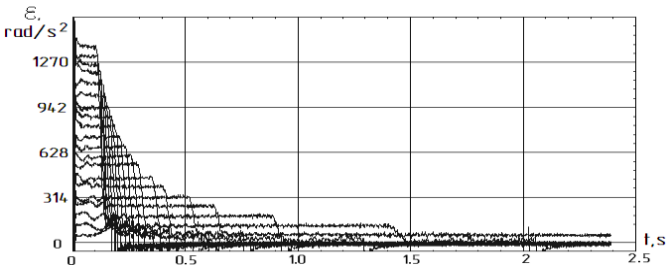

Fig. 6. The acceleration transient process at optimum estimation of *Tr*.

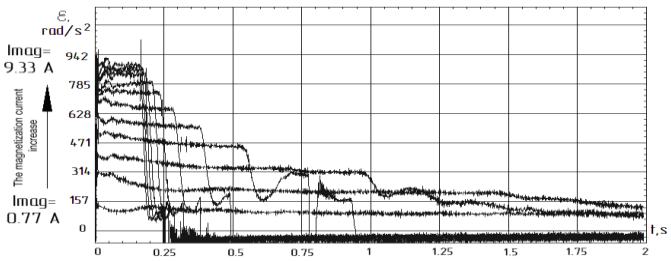

Fig. 8. The acceleration transient process at the observer adjustment correction.

III. Conclusions

The method of the observer adjustment that uses the acceleration constancy at the constant value of the active and magnetizing stator current components is suggested. The main advantages of the described method are the lack of the necessity of extra measuring devices and the prior data for the motor parameters. The chosen factor of adjustment quality is general and does not depend on the structure and specific model of rotor magnetic flow observer.

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Improving of Dynamic Control Quality of Manipulator Robots

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Keywords **– Robotics, control methods for electrical systems, modeling.**

I. Introduction

Significant influence on manipulator behavior is rendered by its kinematic and dynamic configurations [1]. Kinematic characteristics of manipulator robot define method of calculating of reference. Manipulator robot dynamics have significant influence on its behavior both during movement process and at static state.

II. Designing of manipulator robot control system structure

While developing manipulator robot control system its main primary features shall be defined. Overall structure of control system that includes dynamic factors influence is pictured at Fig. 1.

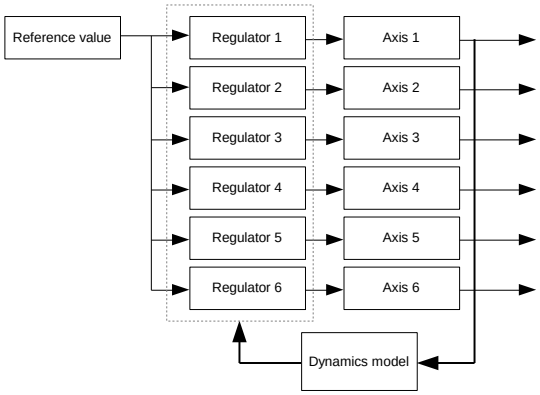

Fig. 1. Manipulator robot control system structure

Since axes represent interconnected system their regulator shall work synchronously in order to precisely follow reference value [2]. Also it should be taken into account that they should consider influence of mechanical torques calculated at the dynamics model block.

The dynamics model block is needed to calculate actual values of torques at manipulator link connections. Required data on axes' state are received from separate control channels feedback. Calculated values are transmitted to regulators where they are used to compensate internal disturbances from manipulator movements.

III. Dynamic model optimization

Dynamics model block is intended to calculate torque values at specific time. It can be done using Lagrange-Euler method described by equation (1).

Since torqueses generated at different joints have different effect on manipulator's dynamics in the large, those of them that have insignificant influence on its behavior can be omitted from calculations.

Using method described at [3] we can reduce amount of calculations by removing summands that have least influence on result.

Suggested control system structure allows designing manipulator robot control system that takes into consideration its dynamic characteristics thus improving control factor of merit. Optimizations of calculations allow implementing this control system with the limited amount of calculation resources.

IV. Analysis of dynamics model influence of control factor of merit

Overall factor of merit was chosen as a quadratic criterion that equals to sum of squares of dynamic positioning errors in specific time.

$$\varepsilon(t) = \sum_{i=1}^{3} \varepsilon_i^2(t), \qquad \varepsilon_{cm} = \lim_{t\to\infty} \varepsilon(t). \tag{4}$$

Positioning error for model with compensating dynamics model is lesser than without it (Fig. 5, f.v.). This confirms assumption that including of dynamics model block improves overall control factor of merit.

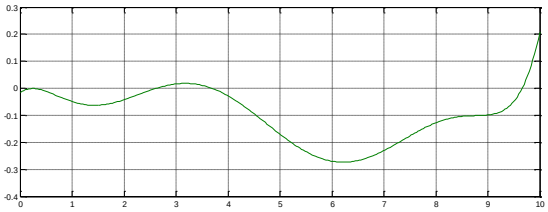

Fig. 6. Quadratic positioning error for optimized dynamics model

Optimizing of calculations leads to some decreasing of positioning precision (Fig. 6) comparing to full model, it stays more precise comparing to the model that doesn't use dynamics compensation at all.

V. Conclusion

Performed analysis has shown that considering dynamic factors while designing control system allows achieving better control factor of merit. At the same time implementing of full dynamics model proved inefficient due to requirement of substantial calculations.

Despite of including dynamics model into control system structure leading to its complication, achievable improvement of factor of merit allows compensating additional costs on its design and implementation.

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Start-up and Reverse Analysis of Induction Motor Model in Pump Regime

Guntis Orlovskis (*Riga Technical University – RTU*) and Karlis Ketners (*RTU*)

Keywords **– Electrical machine, induction motor, modeling, simulation.**

I. Introduction

Nowadays pump drive systems are sometimes used as renewable energy sources. For example, produced energy from wind generator is supplied to pump. After that the pump transports water to reservoir that is located at high place. At the end the stored water is derived to hydro generator. In this case the cost of kilowatt per hour is lower. It means that this type of accumulated energy system will develop more in coming future [1].

II. Induction Motor Model

Nowadays one of the most efficient transition processes under research can be achieved using mathematical analyses. Many authors pointed out that not always mathematical model includes all system elements and load variations. Therefore authors with the help of voltage and frequency control methods can make induction motor (IM) performances more efficient. Slip optimization reduces power loses, stator current and consumed power [2].

A. Mathematical Model in MATLAB Simulink

Using program MATLAB Simulink a simple mathematical model was made. It consists of induction motor standard voltage equations and function of pump performance. The objective is to make function which can predict the efficiency of drive process.

B. Mathematical Model for Pump

From Fig. 1 we can see that in several mathematical programs for pump accelerations process transitions use a squared function of torque-speed characteristic. But in real processes it can be otherwise.

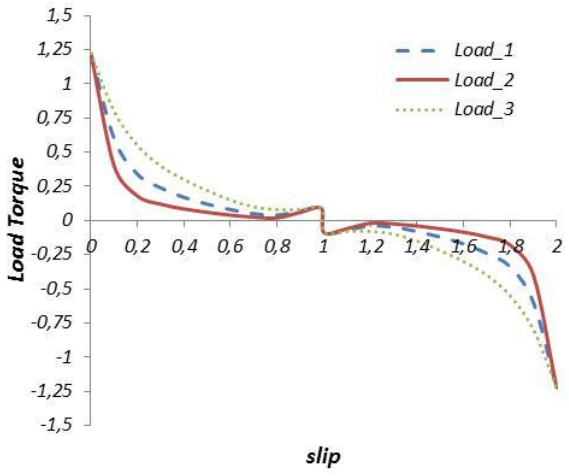

Fig. 1. Function of torque-speed characteristic for IM.

During IM research three kinds of pump characteristics there were chosen (Fig 3). As it is seen at starting moment load torque value is small but after acceleration it increased till nominal.

III. Experimental Stand

For the research the induction motor test workbench from company LEROY SOMMER was used (Fig. 5). It consists of researched motor, parallel connected powder break, torque sensor (SCAIME), and tachogenerator. IM rated data: Pn=0.3kW, Un=400V, In=1.33A, fn=50Hz, Tn=2Nm.

IV. Results of Simulation

Reactive static load torque was chosen for IM model. It means, in motor mode reactive torque is opposing rotor motion. This process does not depend on rotor motive direction. Therefore, after stator windings are switched to contrary side it is required to change load torque value.

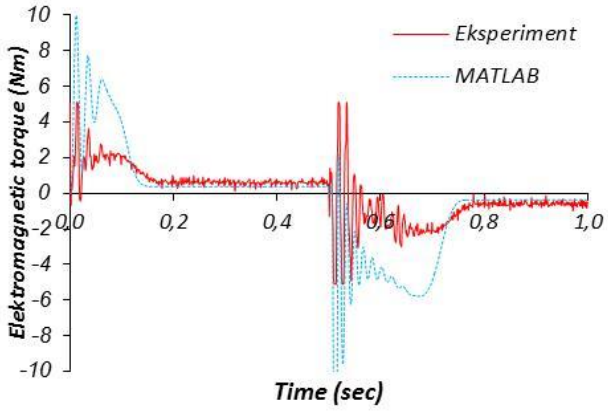

Fig. 2. Comparison between Electromagnetic torque in start-up and reverse transition process.

From Fig. 2 we concluded that in modeling IM transition process it is not necessary to take into account only constant load values. Start-up process can take longer time for acceleration if load torque remains constant. IM electromagnetic torque ripples in start-up process can be even 10 times more than nominal.

V. Conclusion

Created IM mathematical model is very practical in treating the transients and control of symmetrical IMs fed from symmetrical voltage power grids or from PWM converters. In working process algorithm or in other words approximation for torque-slip characteristics was developed. Summing up this developed function can be used to describe ventilator and pump transition processes and to get more accurate simulation results as well.

References

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Detection of Induction Motor Broken Bars in Grid and Frequency Converter Supply

Toomas Vaimann (*Tallinn University of Technology – TUT*), Anouar Belahcen (*TUT, Aalto University – AU*), Javier Martinez (*AU*) and Aleksander Kilk (*TUT*)

***Keywords* – Broken rotor bars, diagnostics, frequency converter, grid supply, induction machines, Park's vector.**

I. Introduction

Induction machines are used widely in different applications and quite often in critical duty cycles, where different failures may pose vast economical and safety risks both for people and surroundings. Different failures can occur in electrical drives and one of the most common faults is the breaking of the rotor bars.

This paper describes an experimental study where broken rotor bars diagnostics of induction motor is performed on a machine that is supplied directly from grid and also a machine that is driven though a frequency converter.

II. Analysis and Discussion

Park's vector approach is an easy way to decide if the motor is healthy or not [1]. It means that the phase currents (i_a, i_b, i_c) are to be transformed into current alpha and beta components (i_α, i_β) and placed on d-axis and q-axis respectively.

Exactly the same transformation can be used to transform the three-phase voltage into a two-dimensional system.

A. Grid Operation (Motor 1)

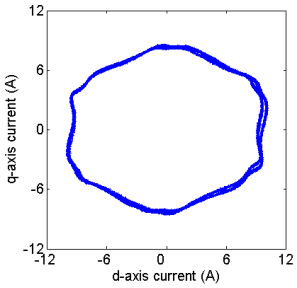

Fig. 2. Stator current Park's vector pattern of healthy motor at no load conditions (Motor 1).

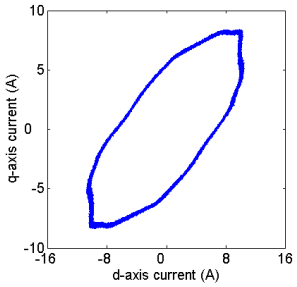

Fig. 3. Stator current Park's vector pattern of faulty motor at no load conditions (Motor 1).

As seen in these figures, the healthy motor figure is indeed in a more or less circular shape and the faulty one more close to an ellipse as described in the literature concerning this method [2].

B. Frequency Converter Operation (Motor 2)

Frequency converters, due to slightly time-varying supply frequency, induce additional harmonics to the current spectrum of the machines, which reduces or even hinders the sideband frequencies that are used as fault indicators. Also they create more noise in the signals, which makes detection of the fault more complicated.

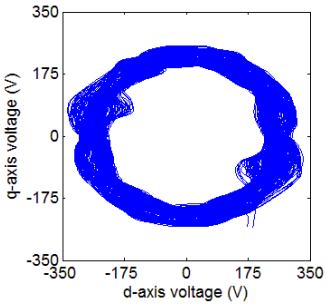

Fig. 14. Stator voltage Park's vector pattern of healthy motor at no load conditions (Motor 2).

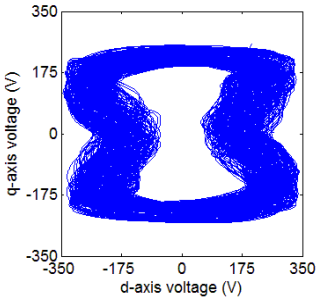

Fig. 15. Stator voltage Park's vector pattern of faulty motor at no load conditions (Motor 2).

The changes are clearly visible, which means that analysis of stator voltage in case of broken bars of the frequency converter driven induction motor can be used more effectively for determination of the rotor fault than the analysis of stator current.

III. Conclusion and Future Work

Park's vector approach can be very effectively used for transformation of three-phase voltage. For diagnostic purposes this might be a better use of the method, as in the case of voltage, load conditions, as well as deviations of supply voltage do not have as high effect on the outcomes as in the case of current.

Further study in the field is needed to find more accurate and effective solutions to detect faults in machines driven through frequency converters. Furthermore, investigation is needed for better understanding the impact of frequency converters to the Park's vector pattern of stator voltage.

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Multi-Domain Model for the Evaluation of Large Scale Robotic Applications within Production

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Keywords **– Robotics, Industrial application, Simulation, Energy Efficiency**

I. Introduction

In this paper, a multi-domain model for automated evaluation of large scale robot production lines is presented. The model allows to determine the energy consumption of the robotic applications from the given robot programs. It is an enabler, to select the optimal DC bus energy buffer depending on robot program [1] or to compare optimized trajectories [2].

The developed modeling tool-chain is based on a robot controller software interpreter, internal path planner, RCS-module, kinematic and dynamic sub-models and an electrical drive sub-model. The according block diagram is shown in Fig.1.

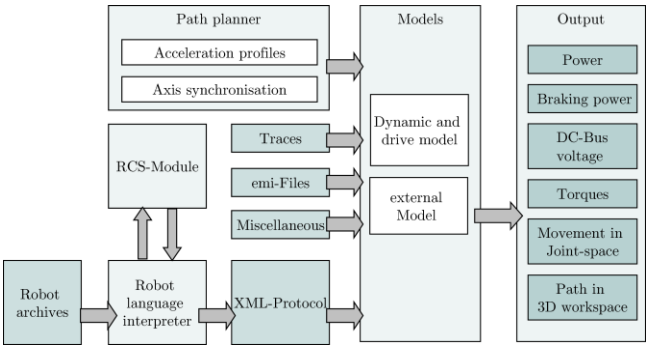

Fig. 1. Modeling tool-chain of a robot system

II. Robot System Modeling

A. Rigid body kinematics and dynamics

The geometric model of a manipulator was developed as shown in Fig.2. Joints $A1 \ldots A6$ and frames $o_1 \ldots o_6$ are assigned to according links, whereas o_0 is the base frame. The geometric model delivers kinematic transformations from joint to workspace and vice versa.

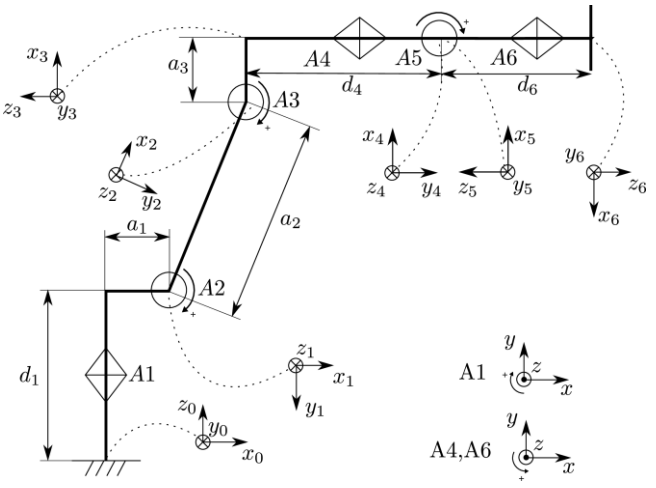

Fig. 2. Manipulator's geometric model

For energy consumption modelling an inverse dynamic model is used. The vector of manipulator axes' torques is expressed in form

$$\boldsymbol{\tau} = D(\boldsymbol{q})\ddot{\boldsymbol{q}} + C(\boldsymbol{q},\dot{\boldsymbol{q}})\dot{\boldsymbol{q}} + F(\dot{\boldsymbol{q}}) + g(\dot{\boldsymbol{q}}) + E(\dot{\boldsymbol{q}}), \quad (6)$$

where $D(\boldsymbol{q})$ is a manipulator's inertia matrix, $C(\boldsymbol{q},\dot{\boldsymbol{q}})$ is a matrix of centripetal and Coriolis forces, $F(\dot{\boldsymbol{q}})$ is a torque caused by viscous and Coulumb friction, and $g(\dot{\boldsymbol{q}})$ is a vector of gravitational torques. $E(\dot{\boldsymbol{q}})$ represents external forces that act on manipulator like weight balancer of the axis 2, but $\boldsymbol{q}$ is a vector of axes' positions. The Eq.6 is solved using Newton-Euler Recursive approach.

B. Electrical drive model

The calculation of the power exchange in within the DC bus is based on iterative calculation of energy sinks and sources over an integration step. The resulting DC bus voltage is

$$u_{dc} = \sqrt{\frac{2(w_{C,act} + w_{ac} - w_m - w_{ch} - w_{inv})}{C_{dc}}}, \quad (28)$$

where C_{dc} is the DC-bus capacitance; $w_{C,act}$ is the energy in C_{dc} of previous/initial integration step; w_{ac} is an energy required from the AC network; w_m is the mechanical energy requirement derived from dynamic model considering motor losses; w_{ch} energy on brake chopper, but w_{inv} represents the inverter losses.

C. Experimental model validation

The explicit model validation has been done by comparing tolerances of the geometric model, resulting motor torques, DC-Bus voltage and AC power with the measurements. Numerical results of KUKA KR210-2 manipulator's dynamic model with KRC2 controller show a maximal error below 2%, whereas geometric model has a maximum error of 0.017mm.

III. Conclusions

Model validation results present accuracy within 2% of the dynamic model that is crucial for minimum-effort trajectory generation.

The modelling chain allows an automated analysis of the effect of the extended DC bus buffer for a particular robotic application. The developed multi-domain model can be used as for research and development as for energy determination of robotic applications without explicit knowledge in robotics.

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Electromechanical Battery Mass Minimization, Taking into Account its Electrical Machines Rotor Energy

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Keywords **– Design, electrical generator, energy storage, flywheel system.**

I. Introduction

Energy can be accumulated in different ways, each of them has advantages and disadvantages, and it is possible to store energy in the rotating mass.

II. Electromechanical Battery

Electromechanical battery store energy in the kinetic form, the storage applications battery is a rotating disk – flywheel. There are various flywheel designs, as well as a wide range of materials. For the charging the flywheel with energy and for discharging process is necessary to use electrical machine, in the charging process this machine is working in motor mode, and in the discharge process, it serves as a generator.

Some flywheel energy storage application consists of one electrical machine, which is integrated in to the flywheel or on the contrary, flywheel is into the electrical machine [1]. Sometimes there is possible to use standard electrical machine with flywheel on the common shaft [2], or with specially designed electrical machine [3], in the first variant maximal rotor stored energy can be calculated, in second variant it is necessary to search electrical machine and flywheel stored energy ratio, it is a goal of this paper.

III. Rotor Energy

The main component of different types of electromechanical battery EMB is electrical machine, common equation of battery mass (2)

$$m_{EMB} = m_{SP} + m_{MA}, \qquad (2)$$

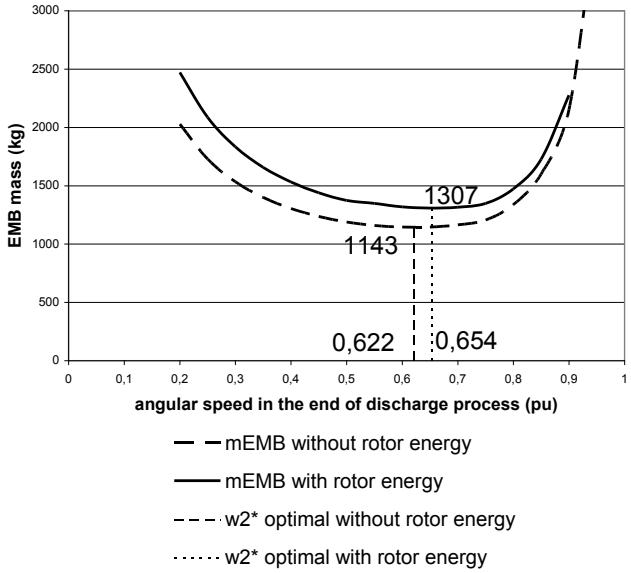
where m_{EMB} – mass of EMB, kg, m_{SP} – flywheel mass, kg, m_{MA} – electrical machines mass, kg [5]- in the full version (f.v.). Flywheel mass equation (3),

$$m_{SP} = \frac{4W}{\eta_{izl}\left(R_{SP}\omega_1\right)^2\left(1-\omega_{2*}^2\right)}, \qquad (3)$$

where W – quantity of energy, J, that can be taken (or loaded) from the spinning disk, if the relative minimal rotation speed in the end of the discharge process is ω_{2*}, η_{izl} - efficiency coefficient of discharge process, R_{SP} – flywheel radius, m, ω_1 - maximal angular velocity of EMB, $\omega_{2*} = \omega_2 / \omega_1 = (\omega_1 - \Delta\omega)/\omega_1$. The mass of electrical machine is calculated using classical design equations, and as example will be described synchronous machine with electromagnetic excitation. This type of electrical machines can provide voltage regulation in the discharge mode, when angular velocity drops down, by increasing excitation current the output voltage can be closely to nominal value. To find mass of electrical machine is necessary to find D_1 internal stator diameter and l_1 stator length, the main relationship between machines dimensions, and electrical and magnetic parameters can be expressed through Arnolds machinery constant, it is using simple calculation method, without rotor stored energy.

Kinetic energy stored in electrical machine rotor - W_{rot}, depends on discharge process power, process duration, and quantity of energy, to determine W_{rot} is necessary to find electrical machine geometrical dimensions going through accurate and standard design calculation process, this is second calculation method. There group of limiting factors through calculation process are stator and rotor yoke flux density, stator tooth flow density, l_1, D_1 and their ratio λ. To calculate all design combinations and variants of electrical machine, a calculation program was created.

From two calculation methods comparison analysis (Fig.4), it is clear that rotor energy do not give positive result.



Simple calculation equations (3), (4)-in (f.v.), (5)-in (f.v.) calculated optimal ω_{2*} not equal to the optimal ω_{2*} calculated through the accurate design process. As the positive result of taking into account the electrical machine rotor kinetic energy, is that ω_{2*} is increased, it means that it will be reduced excitation system, which is designed for minimal angular velocity, in the end of the discharge process.

Taking into account W_{rot}, we can increase minimal rotations speed and in this way to reduce electrical machine mass and increase flywheel mass (2), it provides EMB cost reduction.

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Estimation of Traction Drive Test Bench with Energy Storage System Operation in Regenerative Braking Mode

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Leonards Latkovskis (*Institute of Physical Energetics*)

Keywords **– Electrical drive, energy storage, supercapacitor.**

I. Introduction

Feature of hybrid energy storage systems (ESS) (Fig. 1.) (f.v.) is the combination of different type storage devices. For ESS research the stationary test bench is necessary, because the full-scale experiments disturb the scheduled traffic, and therefore could be run only in the off-peak time or using special test tracks. Use of the laboratory test bench with power scale 3-5 kW allows to reduce number of real vehicle test runs. Besides, the high power and high voltage transport systems are unsafe and inconvenient for educational purposes and scientific research.

The main idea of the article is estimation of the traction drive test bench with ESS overall performance in the regenerative braking mode by means of Matlab/Simulink model [1]. Capacity of the used in the test bench supercapacitor is too high in relation to the traction power therefore in the article results of the ESS scaling are presented.

II. Test Bench Scheme and Parameters

A. Test Bench Scheme and Motor Parameters

The tramcar drive is replaced by a traction drive model which contains an equivalent independent excitation DC motor.

The traction DC motor is mechanically coupled to the asynchronous machine which together with the frequency converter forms a load simulator [2].

B. Hybrid Energy Storage System

The hybrid energy storage system of the test bench includes the supercapacitor Maxwell BMOD0063-P125-B01 with the 125 VDC rated voltage and capacity 63 F and the accumulator battery consisting of eight elements Panasonic LC-RA1212PG with the 12 VDC rated voltage of one element.

III. Test Bench Scaling

A. Traction Drive Model Scaling

The traction drive model scaling is made on the basis of Tatra T3M tramcar parameters (f.v.).

B. ESS Scaling

The size of vehicle ESS may be determined by two parameters: energy capacity $E_{ESS,vehicle}$ and power capability (at discharged state) $P_{ESS,vehicle}$. As the time scale used is 1:1 [2], the relevant bench ESS parameters are calculated as in (11) – (14) (f.v.).

If the minimum voltage is calculated at chosen $I_{SC,max}$

$$V_{SC,\min} = \frac{P_{ESS,bench}}{I_{SC,\max}}, \qquad (15)$$

then the maximum voltage is

$$V_{SC,\max} = \sqrt{\frac{2 \cdot E_{ESS,bench}}{C} + V_{SC,\min}^2}\ . \qquad (16)$$

Calculated value $V_{SC,max}$ should be less than maximum allowed voltage for supercapacitor bank.

IV. ESS Operation in Regenerative Braking Mode

In the braking mode the traction drive of the vehicle operates as a generator. Energy E_{br} which is generated by the motor in this case [3] can be expressed as

$$E_{br} \approx K_1 \cdot E_{Kinetic}, \qquad (17)$$

where K_1 is factor which depends on the internal losses of a vehicle, power auxiliaries etc.; $E_{Kinetic}$ is the vehicle kinetic energy. The value of K_1 varies in range 0.5-0.6.

V. Simulation Results

The Matlab/Simulink simulations is made in the overhead feeding mode at various initial voltages $V_{SC,0}$ of the supercapacitor: $V_{SCmin} < V_{SC,0} < V_{SCmax}$; $V_{SC,0} < V_{SCmin}$; $V_{SC,0} > V_{SCmax}$. Acceleration, freewheeling and braking modes in time scale 1:1 were simulated. The most admissible armature current I_{arm} = 40 A and power scale factor k_P = 85.5 are used.

VI. Conclusions

Correct operation of the test bench depends on the correct scaling therefore within this article scale factors are calculated, and working range of supercapacitor voltage is set.

Scaling of the energy storage system allows choosing optimum parameters for the supercapacitor to provide effective braking energy saving at minimum price and sizes.

According to scale, the working voltage range of the supercapacitor used in experiments is calculated.

In the case when value of the supercapacitor initial voltage is in working range limits, the energy storage system allows the braking energy saving and partial providing the traction motor with energy in the acceleration mode.

It is necessary to consider possible decrease in ESS effectiveness if initial voltage of the supercapacitor is too close to the working range limits.

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Methods for Predicting Remaining Service Life of Power Transformers and Their Components

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Keywords **– Maintenance, power transformer, prognosis, reliability.**

I. Introduction

Prediction of a fault and remaining service life is the most important information for maintenance engineering group to avoid system outages.

Four different methods are comprised in this paper that allows estimating remaining service life of power transformer. However it has to be noted that development of such prediction for power transformer requires direct cooperation with diagnostics, which provides information on faults.

II. An Overview and Practical Application of Approaches of Remaining Service Life Prediction

The main objective of this paper is to analyze methods for determining remaining lifetime, considering the aspect whether information provided by diagnostic tests used for power transformers in Latvia is sufficient.

TABLE III

Main Disadvantages of Methods of Remaining Service Life Prediction

A Direct evaluation of degree of polymerization (DP)	- Requires opening transformer tank for determining value of DP; - Involves the use of the empirical coefficient; - Fails to analyze a single component of a transformer.
B Indirect evaluation of DP	- Discrepancy in formulas relating furans and DP; - Fails to analyze a single component of a transformer.
C Hot spot temperature	- Relevant ageing factors are not considered; - Involves the use of the empirical coefficients; - Measuring is difficult; - Fails to analyze a single component of a transformer.
D Analysis of maintenance data	- Requires statistical data from the beginning of the transformer operation that can not be obtained later on, if not recorded in time.

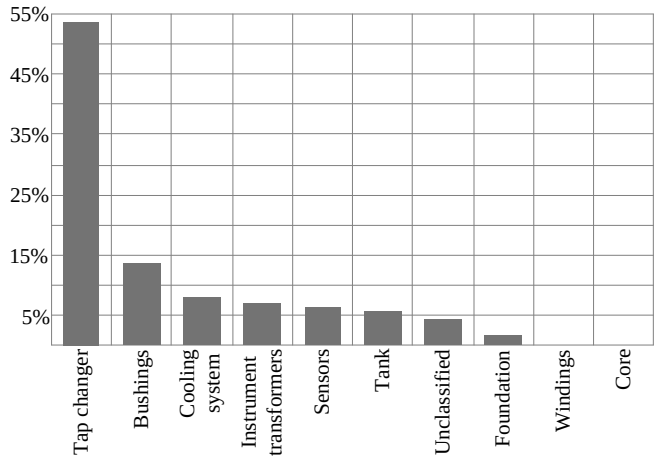

Fig. 3. Classification of faults (by Nordel method)

Fig. 3 shows distribution of the faults depending on location that is obtained by applying Nordel classification method of faults [1] to statistical data on faults of power transformers in Latvian transmission network.

The research based on statistical data about faults of power transformers allows concluding that for power transformers in Latvia the technical condition of the individual components determines overall remaining service life at a large extent. Tap changer, cooling system, and bushings are components with the highest contribution of faults and in coming years such faults can be expected repeatedly.

Therefore the method that includes Weibull distribution [2] is suitable for analysis of situation in Latvian power network.

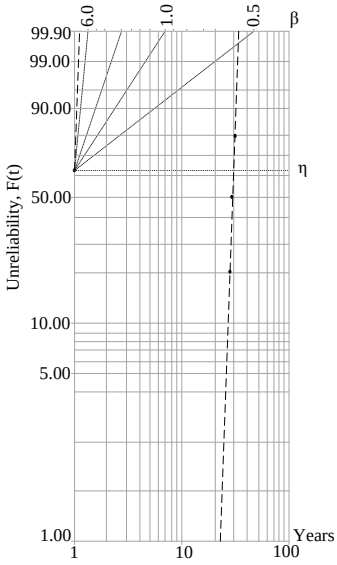

Fig. 4 Weibull cumulative distribution functions for the tap changers of transformer T3

Charts (as shown for example in Fig. 4.) allow evaluating the technical condition of the component and its mean service life.

III. Conclusions

The Weibull analysis method is the most suitable in Latvian situation. The necessary maintenance data of the transformer can be obtained by using condition based maintenance strategy; also this method does not require additional and complex diagnostic tests.

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The Formula Synthesis of The Maximal Mechanical Torque on The Volume for a Cylindrical Magnetic Coupler

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Vladislav Pugachov (*Institute of Physical Energetics*)

***Keywords* – Design, finite element analysis, formula synthesis, magnetic device, magnetic field.**

I. Introduction

A magnetic coupler (MC) is a mechanism that is used to transfer the mechanical torque without contact of both half couplings, using attraction and repulsion forces from permanent magnets placed on the half couplings.

Main design parameters for a cylindrical MC in cross-section are given in Fig. 1. Three more parameters are used as design parameters: the axial length *l*, the pole pair number *p* and the proportionality coefficient β.

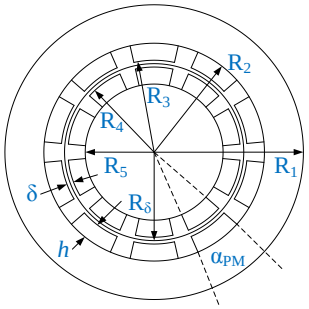

Fig. 1. Dimensions of cylindrical magnetic coupler in a cross-section.
R_1-R_5 – radiuses; R_δ – radius of airgap's middle circle ; δ - airgap; h – PMs height; α_{PM} – angle of PM.

In this paper an experiment plan was made, obtaining multivariate experimental data [1], which were analyzed and from which formulas were synthesized. The most suitable formula from the synthesized data was chosen and the formula was tested on variants that are between the variants of experiment plan.

From experiments there such variables were analyzed: permanent magnets' height *h* (with values in millimetres – 6, 6.5, 7, 7.5, and 8), proportionality coefficient β (with values – 0.7, 0.8, and 0.9) and axial length *l* (with values in millimetres – 30, 32, 34, 36, 38). The goal function is a division of maximal mechanical torque on the volume.

II. The Formula Synthesis

The program for formula synthesis was written by *Dr.sc.eng*. Oskars Onzevs. The formula synthesis was based on regression models [2].

III. Synthesis For Chosen Independent Variables

First synthesis for three variables: proportionality coefficient β, axial length *l* and PM's height *h* was made. When the relevance for $M_{max}/V = f(\beta, l, h)$ was studied the axial length was not an independent variable. That shows up also in the synthesized formulas, where just independent variables: coefficient β and PM's height *h* were used. It one formula (f.v. 9) was chosen out of five to compare with results, when in the program data by two variables are given. The graphs for this formula and real experiment's data at different PMs' height (6, 6.5, 7, 7.5 and 8 mm) by coefficients β = 0.7, β = 0.8 and β = 0.9 show that the difference for all coefficient cases is enough high, calculating in percentage – middle difference is for 20%. That is not acceptable. Further synthesis by two independent variables was made. From six given formula variants one was chosen (f.v. 10) to describe the goal function – maximal mechanical torque on volume (f.v. Fig. 6). For this formula the difference from experiment data is till ten per cents, however the middle value of error is just four per cents, which is acceptable.

Also for control parameters – yoke height h_{yoke}, maximal magnetic flux density in inner half coupling $B_{max\ in}$ and in outer half coupling $B_{max\ out}$ – formulas were synthesized, from which one was chosen and the results were compared to the experimental data. The formulas gave linear relevance, what is similar to yoke height h_{yoke}, but not similar for the magnetic flux densities.

IV. Testing The Chosen Formulas

There were thirteen additional experiments made to check, how the formulas behave for variants, which are between the given ones. The additional variants were made in such principle:

1) The proportionality coefficients β were left as given for synthesis and just the permanent magnets' height *h* was changed;
2) The PM's heights *h* were left as given for synthesis and changed just with the proportionality coefficient β;
3) Both variables in values, which were not given by synthesis, were changed.

V. Conclusions

From experimental data one can observe, that the highest value of main function – maximal mechanical torque on volume – is proportionally coefficient equal β = 0.7, by more higher permanent magnets (*h* = 8 mm) and, of course, by longest axial length *l*. These three variables are independent for researching the value of maximal torque, but, when it is researched the relevance for M_{max}/V, the axial length *l* is not independent, because it is included in the volume calculation.

Giving data for two independent variables from the six synthesized formulas one can choose a formula, which describes the relevance very well, $M_{max}=f(h, \beta)$.

The research and formula synthesis must be continued.

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Power and Electrical Engineering

Power Electronic Converters and Applications

Assessment of Autonomous Power Supply System for Light Sensor of Illumination Measurement Testbench

Olegs Tetervenoks (*Riga Technical University - RTU*), Ilya Galkin (*RTU*) and
Jelena Armas (*Tallinn University of Technology*)

***Keywords* – wireless sensors, lighting, measurement, energy storage, supercapacitor.**

I. Introduction

The choice of energy source of autonomous power supply of wireless node becomes a serious problem when the system has a large number of wireless nodes. Rechargeable batteries are a convenient solution for wireless devices. They allow achieving great duration of operation [1]. At the same time batteries have disadvantages such as long charging time and limited lifetime.

Supercapacitor as an energy source for wireless sensor nodes in general case was discussed in [2], but this article is focused on the specific application of supercapacitor in wireless node of illumination measurement testbench.

II. Light Sensor Energy Consumption

The structure of wireless light sensor of illumination measurement testbench is shown in Fig. 2. Energy consumptions of each individual element of light sensor are summarized in Table I.

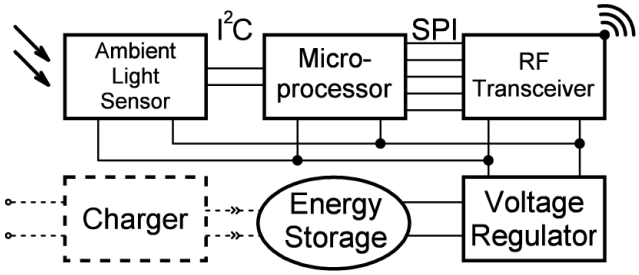

Fig.2. Block diagram of light sensor

TABLE I

Energy Consumption of Different Nodes at Different Operation Modes

Node	Active mode		Low power mode or power down	
	Typ	***Max***	***Typ***	***Max***
Ambient light sensor	0.24mA	0.6mA	3.2µA	15µA
Transceiver	19mA	23mA	2µA	–
Microprocessor	340µA	550µA	41µA	120µA

It is seen in this table, that RF transceiver is largest energy consumer of sensor. Microprocessor program must be prepared so that the RF transceiver is used as less as possible. Also during inactivity of sensor all nodes should fall into low-power modes.

III. Electrochemical Double-Layer Capacitor as a Storage of Energy

B. Capacitor Charging Process

It is necessary to limit charging current to protect charger from overload. There are two protection types of charger: limiting of capacitor charging current and limiting of input current of charger. The last one allows accelerating energy accumulation process (Fig. 9) at higher charger input voltages.

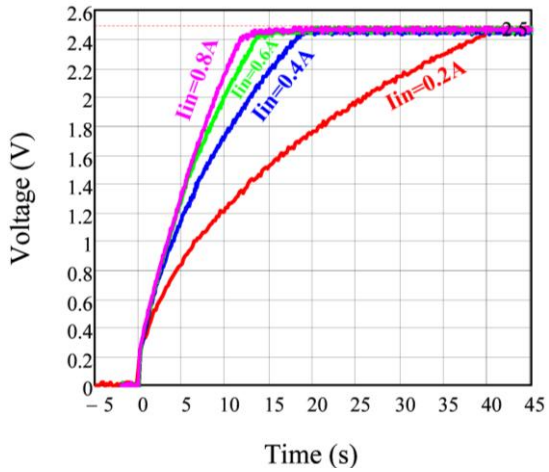

Fig. 9. 10F supercapacitor charging time at constant charger input current.

A. Duration of Operation

Operation time was calculated and measured for 10F supercapacitor with 2.5 V nominal voltage. Table III summarizes the operation time of the light sensor at different conditions.

TABLE III

Comparison of Duration of Operation at Different Conditions

Conditions			Calculated	Measured
Duration of operation	Not optimized	Boost	5min, 2s	5min,18s
		SEPIC	4min, 17s	4min, 46s
	Optimized	Boost	1h, 10min	1h, 15min
		SEPIC	1h, 2min	1h, 3min

VI. Conclusions

The evaluation of results has shown that the main criterion for improving energy efficiency and increasing the operating time of the wireless node powered from supercapacitor is the optimal algorithm of the device (microprocessor program), which involves minimal use of the RF transceiver.

Through the use of supercapacitor charging time of energy storage of the testbench light sensor prototype was reduced to 15-20 seconds (Fig. 9.) The optimized software allowed increasing operation time to 1 hour and 15 minutes (Table III).

Assessment of relative costs (Table IV) also showed that use of the ultracapacitors as energy storage for wireless device is economically profitable.

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Simulation Study of Different Modulation Techniques for Three-Level Quasi-Z-Source Inverter

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Oleksandr Husev (*Chernihiv State Technological University*), Dmitri Vinnikov (*Tallinn University of Technology*)

Keywords **– Modulation strategy, multilevel converters, renewable energy systems, simulation.**

I. Introduction

The shoot-through switching state only possible when the output voltage is in the zero state ($U_{AB} = 0$) of 3L-NPC qZSI [1][2] demands approaches to modulation techniques in order to combine the boost factor, lower input current ripple and more capacitor voltage balance with the best possible output voltage quality using this topology.

This paper is devoted to the simulation of different shoot-through sinusoidal PWM techniques for the 3L-NPC qZSI because traditional shoot-through PWM techniques used for this converter present some problems, such as larger size of the passive elements, more input current ripple, capacitor voltage disbalance and higher THD when the desired output voltage frequency is 50 Hz.

II. New Improved Shoot-Through Modulation Techniques for a 3L-NPC qZSI

A. Technique 1

Fig. 4 shows a sketch of the proposed technique.

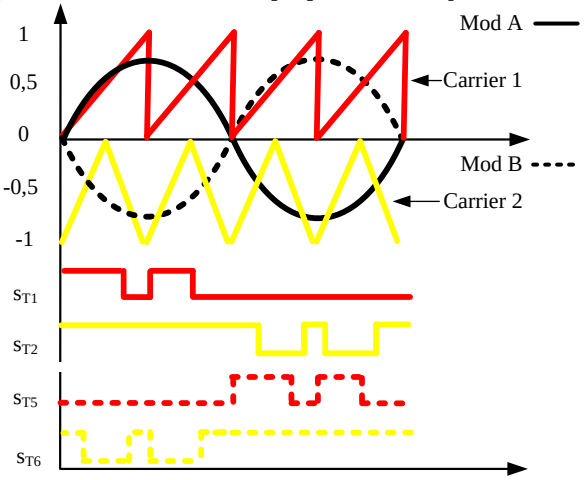

Fig. 4. Sketch of the proposed modulation technique 1.

In order to modify the shoot-through duty cycle (D_S), the shoot-through factor ($F_{s\text{-}t}$) is defined.

B. Technique 2

Fig. 8 shows a sketch of the proposed second technique.

C. Technique 3

Technique 2 has been modified to compensate the decreased average voltage U_{AB} when the shoot-through states are applied (average voltage in the leg A (U_{A0}) is decreased during the positive semi-cycle and increased during the negative semi-cycle when the shoot-through states are applied). Leg B must compensate this situation through the change of the voltage U_{B0} and Fig. 9 shows how we can obtain this compensation. This compensation is produced through $carrier_3$ $carrier_4$ and displacements.

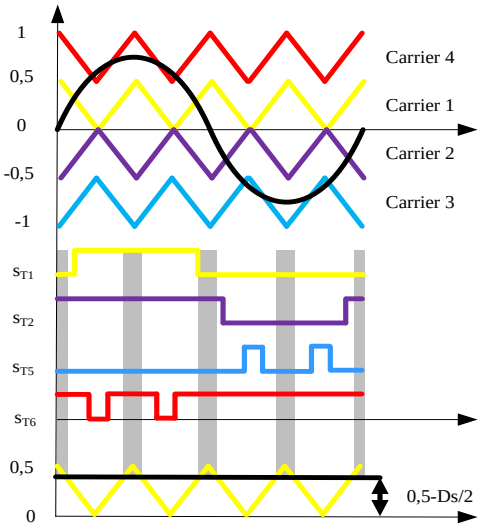

Fig. 8. Sketch of the proposed modulation technique 2.

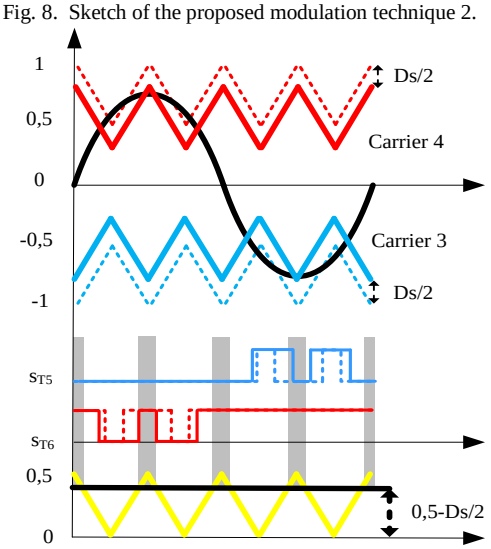

Fig. 9. Sketch of the proposed modulation technique 3.

III. Conclusions

In order to verify the proposed techniques a comprehensive simulation study was performed in SimPowerSystems of Matlab/Simulink. The study was based on four characteristics: output voltage quality, boost factor, input current ripple, and disbalance of the capacitor voltage. Modulation technique 3 showed the best performance and behaviour because the shoot-through states are uniformly distributed and with constant width during the whole output voltage and the average output voltage is compensated.

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Multiport DC/DC Converters for Renewable Energy Systems: General Topologies and Control Methods

Anna Andrijanovits (*Tallinn University of Technology*)

Keywords **– energy storage, converter circuit, renewable energy systems.**

I. Introduction

Hybrid power sources are becoming more and more popular. Renewable energy resources have additional advantages of zero fuel costs and reduced environmental impact. One of the most significant challenges is the intermittent nature of many renewable energy resources. To overcome these problems it is appropriate to implement hydrogen-based long-term energy storage within the renewable energy system (RES). Such systems consist of an electrolyzer, a hydrogen storage system and a fuel cell. Typically, the electrolyzer and the fuel cell are connected to the RES via separate interface converters. To reduce the power losses the multiport interface converter could be implemented, as shown in Fig. 1.

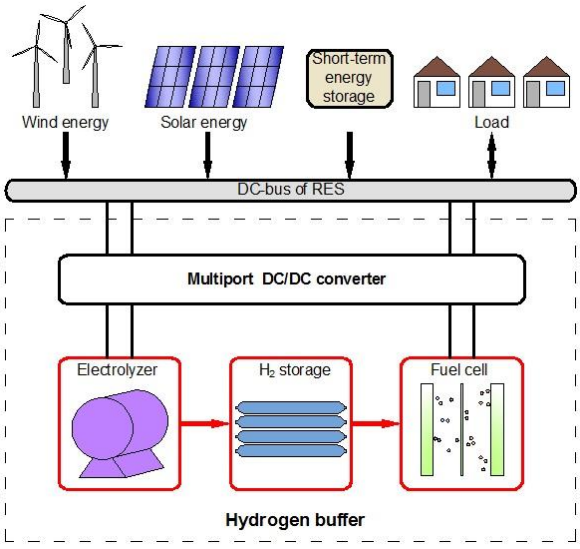

Fig. 1. Principle of a multiport interface converter.

Bidirectional power flow capability to interconnect the ports is a key feature of the multi-port DC/DC converter. However, a multiport converter is a complex unit and there are more design challenges, e.g. the control system [1], [2].

II. Galvanic Isolation of Ports

In recent years, multiport DC/DC converters have attracted increased research interest and many different topologies have been proposed. These topologies can be classified into three groups: non-isolated, partially isolated and fully isolated multiport topologies.

III. General Topologies

The basic circuit topologies used to construct a multiport converter are as follows: single-phase and poly-phase. The general switching cells are classified in Fig. 5. A detailed description of more popular switching cell topologies was presented in [1].

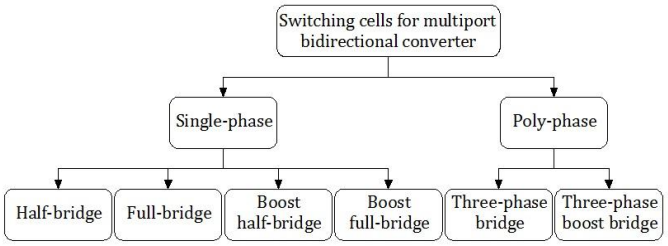

Fig. 5. General classification of bidirectional switching cells.

IV. General Principle of Energy Flow Control in Multiport Converters

A classification of different control methods suitable for a multiport DC/DC converter is shown in Fig 7.

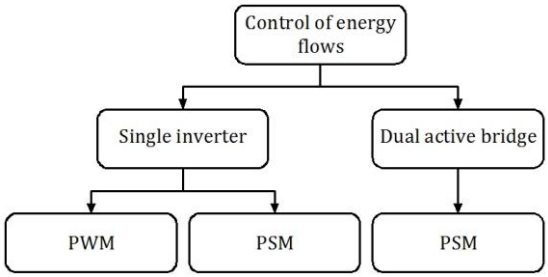

Fig. 7. Classification of basic energy flow control methods in multiport converters.

In general, the control methods can be classified into the single inverter control and the dual active bridge (DAB) control. Single inverter control is mostly used in unidirectional systems, where the power flow is controlled by the duty cycle variation of the inverter switches. Output port is typically the diode rectifier. It is the simplest method requiring a smaller number of control channels than the dual active bridge, where the input and output inverters are operating synchronously.

VI. Conclusions

This paper presents galvanic isolation topologies for multiport DC/DC converter applications. For the multiport applications, the described cell topologies provide a general method to integrate multiple sources provided by their flexibility and diversity in structure. The resulting multiport converter features a simple topology, minimum conversion steps, low cost and compact packaging.

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Use of Passive Cell Balancing for Electric Vehicle Battery Pack

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Keywords **– Automotive electronics, Battery Management Systems (BMS), design.**

I. Introduction

Electric vehicles (EV) with advanced battery chemistries such as lithium iron phosphate require adequate battery management systems (BMS). One of the most basic and important BMS tasks is the cell voltage balancing. Imbalance of cells in battery systems is very important matter in the battery system life and performance.

Over the years quite a lot of cell balancing/equalization methods and topologies have been proposed in [1,2] and reviewed in [1,2]. The aim of this paper was to select and elaborate a quick cell balancing solution for a kart lithium-ion battery pack.

II. Kart Battery Pack

Proposed charging system to be used for electric kart is lithium iron phosphate (LFP) battery charging. Typical nominal voltage of a single LFP cell is 3.2V. The absolute maximum voltage for each cell is 4V. Common practice is to use 3.8V per cell for battery charging. LFP cell minimum operating voltage is 2.8V.

IV. The Elaborated Cell Balancing Module

Schematic of the proposed individual cell balancer is shown in Fig. 1.

Board terminals CN1 and CN2 are meant to be connected directly to the battery terminals. Texas Instruments MSP430G2153 value line microcontroller was used.

Resistor divider is used to measure cell voltage. Resistors R1 to R6 are used to shunt a cell and discharge it. Switch VT1 is used to turn-on shunting.

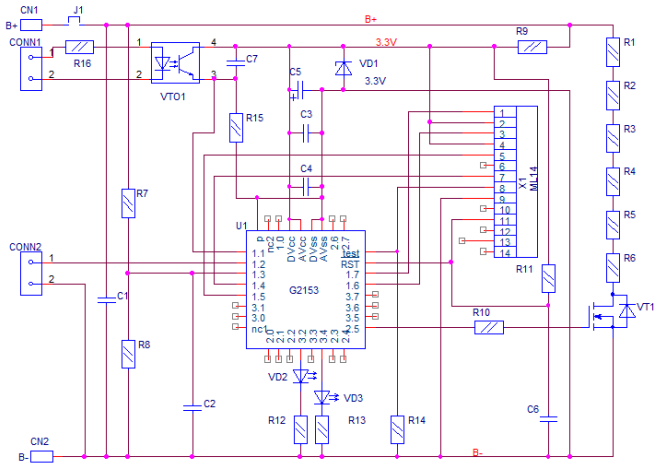

Fig. 1. Schematic of cell balancer module.

Optocoupler is used to isolate RX line, TX line is directly connected to the microcontroller.

V. Control Implementation

Microcontroller code is optimized to consume as little power as possible since the source is a battery cell.

ADC module wais used to measure cell voltage. Obtained values were used to produce average cell voltage value. If this value exceeds certain set higher or lower cut-off values program turns on one of the status indication LEDs. If battery cell voltage has reached full charge green LED is lit and MOSFET is turned on to discharge particular cell and allow other cells to reach the same value. If lower voltage value is reached, only red LED is lit.

UART communication was implemented. Initially UART module is set in RX mode to wait for incoming data. A communication subroutine is activated once data is received. Received data is stored in memory and cell balancer sends its own data to the next balancer. Stored received data will be sent in the next transmit round. Data form all cell balancers is passed further to the main controller in daisy-chain manner. Data transfer is finished once main controller receives back the same command it initially sent to the first cell balancer of the communication ring.

All data was transferred one byte at a time, which presented a problem on how to distinguish command byte from data bytes. To select appropriate unique command byte all possible data byte values had to be analyzed. It can be noticed that least significant byte can take values from 0 to 139 and from 154 to 255. This leaves out a free region from 140 to 153. Generally any of these free values could be used as command bytes, but for increased confidence the middle value of 146 was used as command byte by the higher controller.

VI. Conclusions

Passive cell balancing is a viable option when a battery pack has to be developed as fast as possible with small costs. This method gives good cell equalization speed with satisfactory energy efficiency. However active balancing can perform better in all parameters except price and development time.

One of the directions of development is to design a battery pack front end that monitors overall pack voltage and current. It can be used as part of battery state measure device to measure SoC, SoH and other parameters. Front end can be implemented with low loss circuit breaker to disconnect battery from load if certain overload or deep discharge situations are detected.

Main future task is to fully develop the higher controller or control panel. As both names impose this BMS part is used to control and collect data from individual cell balancers and front end. It can give commands to balancers and use their information to calculate different battery pack parameters.

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New DC/DC Converter for Electrolyser Interfacing with Stand-Alone Renewable Energy System

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Keywords **– Distributed power, energy storage, ZCS converters, ZVS converters.**

I. Introduction

Use of alternative energy sources is an urgent issue today. However, renewable energy sources are difficult to use due to their stochastic variability. The concept of hydrogen use needs to be introduced to stabilize unregulated renewable energy generation [1]. Fig. 1 shows a hydrogen-based energy storage system or a hydrogen buffer (HB).

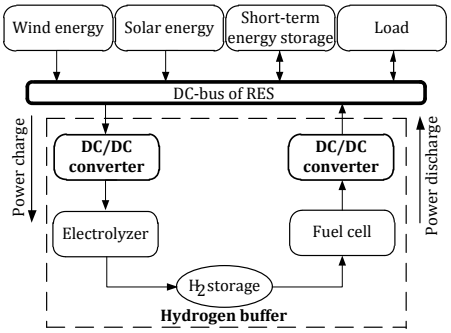


Fig. 1. Energy exchange processes in the hydrogen buffer connected to a stand-alone renewable energy system.

This paper presents a new galvanically isolated step-down DC/DC converter for electrolyzer integration with renewable energy systems (Fig. 2). The converter has a half-bridge inverter on its primary side, high-frequency step-down transformer and a full-bridge phase-shifted active rectifier based on reverse blocking (RB) switches on the secondary side.

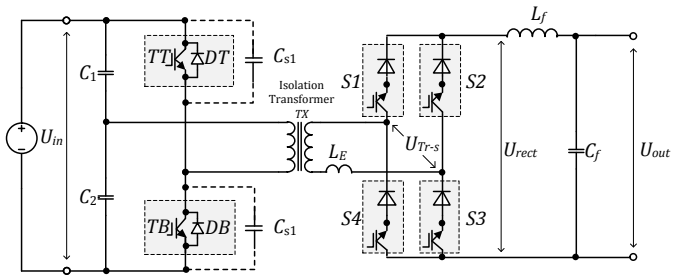


Fig. 2. Investigated half-bridge converter circuit with controlled RB switches at the secondary side.

II. Step-Down DC/DC Converter with a Full-Bridge Phase-Shifted Active Rectifier

The phase-shifted synchronous rectifier concept is a well-known method to reduce the ringing, increase the efficiency and achieve ZVS (zero voltage switching) of converter switches. The other advantages are the possibility of using non-dissipative capacitive snubbers in the inverter and constant frequency operation, allowing for simple control of the converter. Generally, these converters comprise a half- or a full-bridge inverter, a high-frequency transformer and a rectifier. The rectifier part could be classified as: full-bridge, central-tapped and current-doubler.

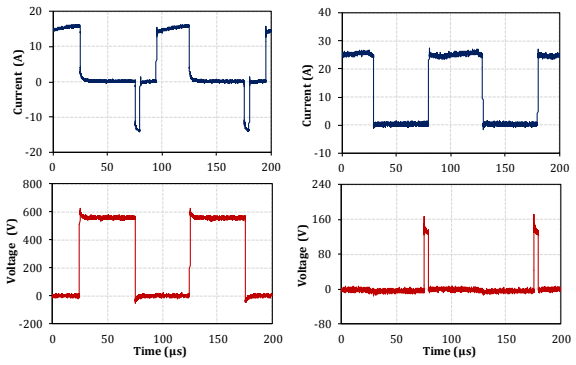
III. Operating Principle

To overcome the disadvantages of a conventional phase-shifted synchronous rectifier, the control algorithm of the rectifier switches could be modified, at the same time keeping the advantages of the reference phase-shifted control algorithm [2]. The proposed algorithm provides phase-shifted control whereas practically no energy is returned into the power supply. This is achieved by introducing two additional switching states of the rectifier switches.

V. Simulation and Experimental Results

In order to verify the theoretical approach the proposed converter was simulated using PSIM software. To experimentally validate a theoretical background a small-scale prototype with the output power of 1 kW was assembled. The main parameters and components are presented in Table I.

The experimental waveforms are presented in Fig. 8. As shown, the test results completely correspond to the theoretically predicted waveforms.



(a) (b)

Fig. 8. Experimental voltage and current waveforms of the TT IGBT module (a); S1 transistor (b) (Uin=350 V; fsw=10 kHz, 800 W load).

VI. Conclusions

This paper presents a novel galvanically isolated step-down DC/DC converter for electrolyzer integration with stand-alone renewable energy systems. The design of the converter with several recommendations and guidelines are outlined. To validate the topology, the simulation and experimental results are presented and discussed. According to the results, the presented step-down DC/DC converter topology with a phase-shifted active rectifier could be one of the most promising candidates for high-power conversion systems due to its reduced switching losses and a wide regulation range.

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Loss distribution of Resonant DC/DC Converter for 5KW Fuel Cell Application

Aleksandrs Andreiciks (*Riga Technical University - RTU*), Ingars Steiks (*RTU*) and Oskars Krievs (*RTU*)

***Keywords* – Fuel cell system, resonant converter.**

I. Introduction

The research of renewable energy resources, as well as the hydrogen energy has gained a growing interest in the recent years. In order to utilize the electrical energy which is produced by the fuel cells, characterized by slow dynamic response, low output voltage and large voltage variations, static power converters are researched widely throughout the world. [1]. Detailed simulation study of the most appropriate resonant converter has been carried out to be used for 5kW proton exchange membrane (PEM) fuel cell. The proposed 5kW LLC resonant converter is designed for boosting from the low input voltage ($25V_{dc}$-$48V_{dc}$) to high output voltage ($400V_{dc}$). For the purpose to increase the overall efficiency of the system it was decided to use several converters in parallel.

II. LLC Resonant converter

LLC converter displays many advantages over other resonant converter topologies; it can regulate the output over wide line and load variations with a relatively small variation of switching frequency, it can achieve zero voltage switching (ZVS) over the entire operating range, and all essential parasitic elements, including junction capacitances of all semi-conductor devices and the leakage inductance of the transformer, are utilized to achieve soft-switching [2].

III. Design example

The design goal of LLC resonant converter is to achieve minimum losses with the capability to achieve required maximum gain to ensure wide range of operation. The resonant components including Lr, Cr, and Lm are the major challenge in design considerations. A laboratory prototype with 1250W rated power was built to verify the effectiveness of the proposed converter. Since the selected series resonant frequency fr is 60kHz, we can obtain the required series inductance.

$$L_r = \frac{Z_o}{2\pi f_r} = \frac{0.042}{2\pi \times 60000} = 0.11\mu H \,. \qquad (11)$$

the series resonant capacitance of C_r is given as:

$$C_r = \frac{1}{2\pi f_r Z_o} = \frac{1}{2\pi \times 60000 \times 0.042} = 63\mu F \,. \qquad (12)$$

and the maximum magnetizing inductance L_m can then be estimated by:

$$L_m = \frac{nV_o T_S t_{d,\min}}{8C_o V_{DC}} \le \frac{\eta T_S t_{d,\min}}{16C_o} \,. \qquad (13)$$

The dead time between two gate drives is defined as 200ns. A power MOSFET IXFN230N10 is employed as switch, with C_{oos1}=C_{oos2}=C_o=5600pF. The magnetizing inductance was $L_m \le 21\mu H$.

IV. Simulations

To describe the operation of the LLC resonant converter for fuel cell application, simulation results were obtained using PLECS simulation software. As it can be seen from the simulation, the converter operates as desired, providing 100 V output voltage at rated input and load condition.

V. Loss Distribution

The losses in LLC resonant converter are investigated and simulation is carried out based on PLECS simulation software. Losses dissipated in the power devices are considered temperature independent during the loss simulation. The power losses consist of conduction losses and switching losses.

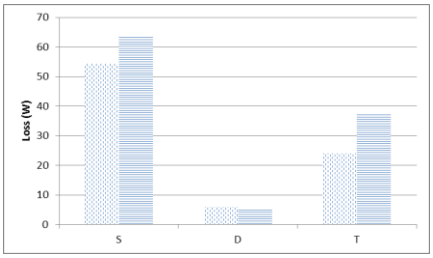

Fig. 5. Calculated and simulated loss dissipation on power MOSFETs (S), diodes rectifier (D), transformer (T)

VI. Experimental tests

Experimental testing of one LLC converter was carried out as well. The testing was performed using two 12V 50Ah car batteries in series as the input voltage source and connecting the LLC resonant converter to a resistive load. The converter was tested at constant frequency at variation of the load.

VII. Conclusions

In this paper, the design considerations for LLC resonant converter for fuel cell application are explored. The analyzed converter offers many advantages over other resonant converter topologies; it can control the output over wide line and load variations with a relatively small variation of switching frequency, it can achieve zero voltage switching over the entire operating range and all essential parasitic elements, including junction capacitances of all semi-conductor devices and the leakage inductance of the transformer, are utilized to achieve soft-switching. condition of ZVS state for primary MOSFET switches and ZCS state for secondary diodes.

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Conductor Design Optimization of Half-Bridge Power Module Utilizing FEM Calculation Software

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Keywords **– Bus bar, design, EMC/EMI, simulation, voltage source inverters (VSI).**

I. Introduction

A variety of converters for different applications often includes the same repetitive stage – couple of series connected transistors and associated capacitors – transistor half-bridge. That is why the idea to build power electronic converters of the half-bridge modules seems quite obvious [1]. The operation parameters of such modules are better if the parasitic inductance of commutation loops is lower. In particular it: 1) reduces switching times, commutation losses and size of the cooling system; 2) allows increasing commutation frequency and reducing size of necessary passive components. Such reduction of the inductance can be achieved with implementation of the bus-bars [2] and [3].

II. Current Paths in Half-Bridge Module

There are two states of the half-bridge module: 1) active state, when current path is provided by one of the transistors of the module; 2) freewheeling state when the current path is provided by a diode. The operation of particular transistors and diodes depend on the polarity of the load current. The current paths of the half-bridge module for positive direction of the output current are shown in Fig. 1. In the active state the path includes internal and wiring inductance of the conducting transistor ($L_{\sigma T1}$), of the upper, energy supplying, capacitor ($L_{\sigma C1}$) and of DC bus connections ($L_{\sigma W1}$). When the transistor VT1 turns off current changes in this loop leads to significant overvoltage. The freewheeling path includes internal and wiring inductance of the conducting diode ($L_{\sigma D2}$), of the lower, energy absorbing, capacitor ($L_{\sigma C2}$) and of DC bus connections ($L_{\sigma W2}$). When the TV1 turns on, these inductances slow down the switching and leads to higher commutation losses.

IV. Possible Designs of Conductor System

This configuration of the half-bridge module illustrates the principle of current path symmetry and the distance reduction between critical points. It consists only of basic elements of the half-bridge – two capacitors and two transistors. The main drawbacks of this design are inconvenient layout and height. It is also clear that the capacitance between the conductive planes is minimal.

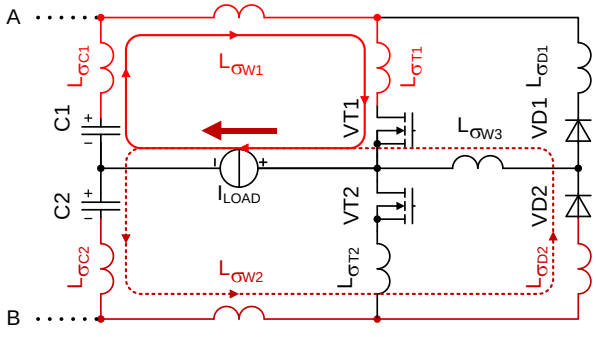


Fig. 1. Active (red-solid line) and freewheeling (brown dotted line) current paths in half-bridge power module for positive output current.

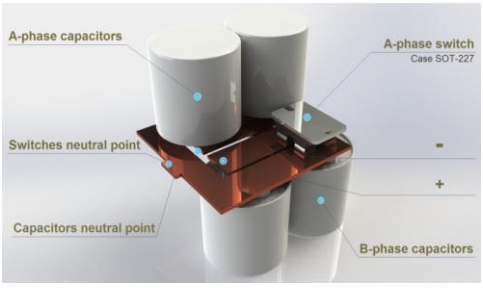
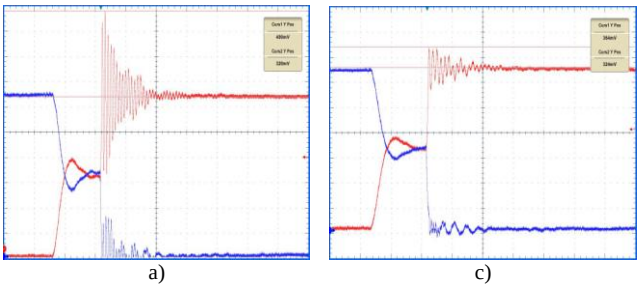


Fig. 3. General view of module with split capacitors.

In order to overcome these drawbacks one more design has been proposed. In this we design the necessary capacitance is achieved with multiple capacitors (Fig. 3).

VI. Experimental Testing

Three prototypes of converters (without bus-bars, with non-symmetrical and symmetrical bus-bars) have been experimentally tested. The overvoltage in the first case is 53.1% that is an obviously unacceptable result (Fig. 8-a). The third tested prototype with symmetrical bus-bars produces the results given in Fig. 8-c. Although the present prototype does not exactly match the first design (Fig. 2) it produces overvoltage is 12.3%.



a) c)

Fig. 8. Oscillograms of commutation transients (time scale 200 ns/div, voltage scale 25 V/div): a) without bus-bars; c) with symmetrical bus-bars.

VII. Summary and Conclusions

In this research with a help of FEM calculation software JMAG a bus-bars principle has been applied to the design of conductor system of a half-bridge power module. Several constructions of bus-bars has been proposed, calculated and verified through simulation and experimentally. The overall conclusion that has been made says that the bus-bar principle can be successfully utilized in the module and can significantly (by 12%) reduce commutation overvoltage.

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Enhancement of Street Lighting Infrastructure with DC link

Alexander Suzdalenko (*Riga Technical University – RTU*) and Ilya Galkin (*RTU*)

***Keywords* – Lighting, DC power supply, photovoltaic.**

I. Introduction

The artificial lighting is one of major electrical energy consumer, which shares about fifth part of the global electricity market.

For this reason enhancement of street lighting infrastructure is an important task, leading to minimization of global energy demand and reduction of municipal expenditures on illumination of public places and streets.

II. Expenditures Dynamics

The electricity price in Europe is rising rapidly. In the year 2015 the price per electricity is expecting to be about 0.15 EUR/kW·h [1], influencing the rise of expenditures for municipal organization, paying bills for lighting. On the other hand, prices per LED lighting are getting lower, while its efficiency is improving.

Thus it is reasonable to analyze the use of LED in street lighting making prognoses for price per light in 2015.

The Department of Energy USA (DoE) has launched the project entitled CALiPER (Commercially Available LED Product Evaluation and Reporting) aimed to benchmarking of commercially available SSL products, providing detailed test results and real parameter comparison with those, mentioned in specification.

At the given time experts from DoE prognoses, that SSL technology remains development and by year 2015 commercially available LED luminaries with efficacy of 138 lm/W will appear on the market (see Fig.5 in f.v.) [2].

The "cost of light" is calculated (see Table I) by using following formula [3]:

$$C_{light} = \left(\frac{1000}{\Phi_{lm}}\right) \cdot \left(\frac{C_{inst} + C_{lamp}}{T_{lamp}} + P_{lamp} \cdot C_{electricicity}\right),$$

where C_{light} is price per light [EUR/Mlm·h], Φ_{lm} - luminous flux [lm], C_{inst} – installation cost (50 EUR), C_{lamp} - lamp's cost [EUR], P_{lamp} - lamp's wattage [W], $C_{electricicity}$ - price per electricity [EUR/kW·h].

III. Advantages of DC link for Street Lighting Infrastructure

Concerning advantages that have been drawn in previous chapter, it may be assumed that SSL is going to be replacement technology in the lighting sphere in the nearest future. Another assumption can be drawn on base of the fact, that LEDs are DC load, what for street lighting grid could be supplied with DC voltage.

In this case configuration of LED luminary could be as it is drawn below (see Fig.4).

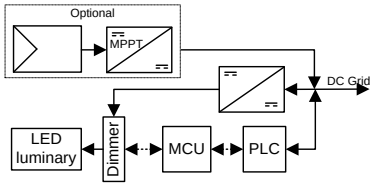

Fig. 1 Configuration of street lighting unit.

It could greatly reduce the elements count in the luminary's power supply unit (PSU) (see Table II in f.v.), because it contain only primary DC/DC converter adjusting grids DC voltage to admissible value, which further is regulated by dimmer, which is controlled by microcontroller unit, which communicates over power lines.

V. Conclusions

As the electricity price is rapidly rising, the total cost of consumed energy by luminaries during its lifetime is getting more noticeable in contrast to initial expenditures. The prognosis for year 2015 is drawn, approximating the electricity price and LEDs parameters. The use of DC link as interface in street lighting infrastructure is described as preferable, due to a lot of advantages, concerning simple connection of RESs to the DC grid, improving total efficiency of the street lighting, more reliable communication.

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TABLE I

Price per Light Comparison for SSL and HPS Lighting Technologies Concerning 2015 Year's Prices and LED Efficacy Prognoses

Type of lamp	*Lamp cost (2012/2015) [EUR]	Lifetime [h]	Lumenous flux (2012/2015) [lm]	Wattage [W]	Efficacy (2012/2015) [lm/W]	Price per light (2012) [EUR/Mlm*h]	Price per light (2015) [EUR/Mlm*h]
150 W Na (HLF-175MH150HPS)	71.14	24000	16000	186	86	1.483	1.744
2*80 W LED (LEDFFLA80392)	2*450/2*350	50000	2*5600/2*11040	2*80	70/138	1.823	1.088
400 W Na (RAB MEGS400SFQT)	229.80	24000	50000	464	108	1.183	1.392

Buck-Boost DC-DC Converter for Wind and Hydrogen Based Autonomous Energy Supply System

Pavels Suskis (*Riga Technical University - RTU*) and Ivars Rankis (*RTU*)

Keywords **– Converter circuit, DC power supply, Industrial application, Modeling, Power supply, Semiconductor device, Wind energy.**

I. Introduction

This paper is related to one of proposed circuit types to gain buck-boost conversion for voltage regulation of wind generator. Output voltage of generator is varying from 0 to 650 V on the other hand it should feed 540 V dc-bus of system. The voltage is supplemented by hydrogen electrolyze tank and fuel cell as output energy storage and stabilization device. Mentioned system is a renewable autonomous power source for industrial and household.

III. Step-Up/Step-Down Converter Operating Principle

In order to reduce element number, eliminate voltage polarity of the input and the output voltages and simplify voltage step-up/step-down converter circuit the converter topology shown in figure Fig. 5 is proposed. The proposed circuit topology is based on Step-Up DC/DC Converter with a Commutating LC-Filter [1] circuit topology, but has several advantages over classic boost and buck boost converters [2] and [3].

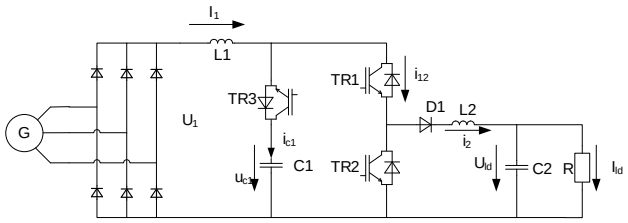

Fig. 5. Circuit diagram of proposed converter equipped by generator.

The circuit of the converter is combination of buck and boost converter. When the circuit is operating in the step-down mode transistor TR1 is controlled by the PWM signal and the transistor TR2 is off. In this case transistor TR3 is constantly in saturated switching state and commutated LC-filter is operating only as a standard LC-filter. The output voltage in this case is just a part of input voltage chopped by transistor TR2. When the converter is operating in step-up mode the transistor TR1 is in the conduction mode continuously and the transistor TR2 is controlled by PWM signal. The control signal of TR3 is opposite to the TR2 control signal. When both transistors TR1 and TR2 are in conduction mode the short-through operation takes place and input inductor L1 gets energized through semiconductor switches and then when voltage is boosted it gets transferred to the load joint. The proposed scheme is able to operate in the boost regime in discontinuous current mode only.

The equations of the load current and voltage for the voltage step-down regime are:

$$I_{ld} = \frac{I_{2\max}}{2} = \frac{(U_1 - U_{ld})D_1}{2L_2 f}. \quad (5)$$

and

$$U_{ld} = \frac{U_{in} D_1^2 R}{4 f L_2}\left(\sqrt{1+\frac{8 f L_2}{D_1^2 R}} - 1\right). \quad (8)$$

The boundary duty ratio of the step-down regime of the converter is calculated by formula:

$$D_{1b} = 1 - \frac{2 f L_2}{R}. \quad (14)$$

The equations of the load current and voltage for the voltage step-up regime are:

$$I_{ld} = \frac{I_{2\max}}{2} = \frac{(U_b - U_{ld})D_1}{2L_2 f}. \quad (6)$$

and

$$U_{ld} = U_1 \frac{\sqrt{R^2(1-D_2)^2 + 8L_2 fR} - R(1-D_2)}{4L_2 f}. \quad (8)$$

The critical duty ratio for voltage boost operation is:

$$D_{2b} = \frac{2 f L_2}{R}. \quad (9)$$

The proposed converter is not able step-up voltage if the duty cycle is below the value calculated by equation (2).

The calculations of the paper are verified by simulation and smaller power range real model of the converter.

V. Conclusions

Proposed scheme of DC-DC voltage converter is very close to combination of classical Buck and Boost converter but allows obtain same polarity voltage as for source. Voltage Boost regime is possible only at discontinuous current mode of load junction inductance current and its value, converter operation frequency and load resistance have strong effect on voltage conversion ratio. The load resistance of converter should be adjusted corresponding to minimum input voltage and maximum boundary duty ratio. The paper contains output characteristics of converter obtained by analytic calculations. This way of calculations sets primary significance of the choice of the load joint inductance, while input inductance is less important. The paper contains comprehensive materials on expecting output characteristics of the system.

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Implementation Possibilities of SMD Capacitors for High Power Applications

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Keywords **– Passive component integration, switched-mode power supply, power conditioning, voltage source converter.**

I. Introduction

Capacitors are one of the basic passive elements that significantly affect power density in power electronics [1].

Implementation and comparison of different types of SMD capacitors available in the market for a 1 kW quasi-Z-source inverter (qZSI) based step-up converter (Fig.1) is proposed.

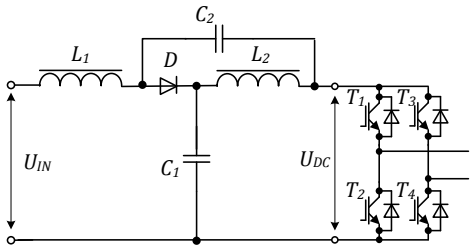


Fig. 1. General circuit diagram used in the experiments.

II. Idea of Experiment

The circuit diagram in Fig.1 consists of a VSI coupled with a qZS-network (C_1, C_2, L_1, L_2, D). The operation of could be roughly explained by two main power conversion states: voltage boost and power transfer [1].

If the input voltage is equal or higher than the desired DC-link voltage, the converter works in the non-shoot-through mode. If the input voltage drops below the predefined DC-link voltage level, the converter starts to operate in the shoot-through mode. During the shoot-through states the upper and lower switches of one or both phase legs are conducting (i.e., both devices are conducting) [2]. The DC-link voltage across the inverter bridge is the sum of both capacitor voltages, expressed as

$$u_{DC} = U_{C1} + U_{C2} = \frac{1}{1-2\cdot D_S}\cdot U_{IN}\,. \qquad (5)$$

During the active state, both of the capacitors are connected in series and limit the voltage ripple on the DC-link [3].

Table I shows general operation and component ratings of the proposed DC/DC converter.

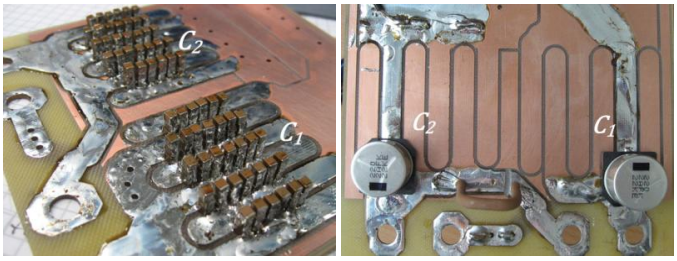
According to operation voltage range (100 V) ceramic capacitor "Murata" (GRM32ER72A225K) with a capacitance of 2.2 µF and Aluminum electrolytic capacitor from "Panasonic" (EEEFK2A221AM) with a capacitance of 220 µF were selected for further study. To obtain 1,4% voltage ripple across DC-link the capacity of one capacitor should be 220 µF. Since the capacitance of a ceramic capacitor is 2.2 µF, they were soldered 100 in parallel to obtain 220 µF.

TABLE I

General Operation and Component Ratings

Parameter	Value
Minimal input voltage, $U_{IN(min)}$	40 V
Nominal input voltage, $U_{IN\ (nom)}$	80 V
Desired DC-link voltage, U_{DC}	80 V
System power rating, P	1000 W
Operation frequency of a qZS-network, f_{qZS}	60000 Hz
Desired voltage ripple across the DC-link	1.4 %
Inductance of inductors L_1, L_2	50µH

Fig. 2*a* presents a PCB where 200 SMD capacitors are soldered to obtain the capacitance of 220 µF per each qZSI capacitor (C_1 and C_2). Fig. 2*b* presents a PCB where two 220 µF electrolytic capacitors (C_1 and C_2) are used.



(a) (b)

Fig. 2. Capacitances C_1 and C_2 that consist of 200 SMD capacitors (a) and electrolytic capacitors (b).

III. Analysis of Experimental Results

Fig. 9 presents experimental and theoretical voltage ripple on the DC-link in whole operation range of input voltage U_{IN}.

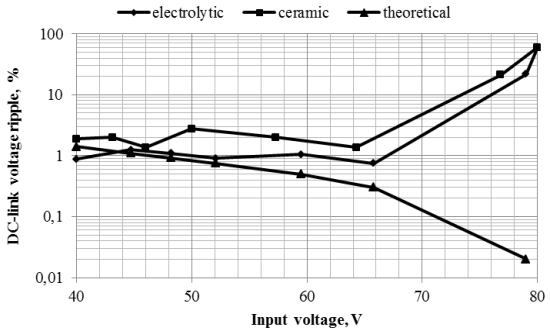


Fig. 9. Dependence of capacitor voltage ripple on the input voltage.

IV. Conclusions

Experimental operation waveforms in both input voltage extremes showed that no significant visual differences exist in the performance of the two types of capacitors.

Differences in voltage ripple were found between the electrolytic and ceramic capacitor, especially in the capacitor C_2 case. This fact could be caused by high temperature on the electrolytic capacitors when the voltage ripple damping capability decreases. The heat reduction could be achieved by selecting capacitors with smaller impedance and higher permissible ripple current.

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Choice of the Optimal Power of Distributed Lighting System Unit

Olegs Tetervenoks (*Riga Technical University*)

Keywords **– Distributed power, efficiency, lighting.**

I. Introduction

This paper considers several aspects of the efficiency of lighting systems based on LEDs. The main idea is to deliver necessary illumination defined by standard to the task area and surrounding areas keeping input electrical power as less as possible.

First of all illumination distribution calculations should be done. Rare articles related with the LED light distribution calculations [1] have focused on the modeling of single LED illumination distribution or calculations of scenes with defined light fixtures in Dialux program. In this paper light distribution model is aimed at finding minimum acceptable parameters of uniformity.

Also one of the most serious challenges is the choice of optimal input electrical power of single LED (unit). Better efficiency can be achieved by reducing input electrical power of LED. At the same time, the initial costs of system increases by the need to use more LEDs.

II. Calculations of Light Distribution

A. Standard Requirements

EN 12464-1:2002 standard is used as the reference for calculations in this paper.

B. Numerical Calculations of Light Distribution

Input electrical power of LED has not direct influence on its light distribution. However LEDs can be placed at different distances and mounting heights. Maximal allowable distance between LEDs depending on mounting height can be calculated to meet standard requirements (Fig. 5).

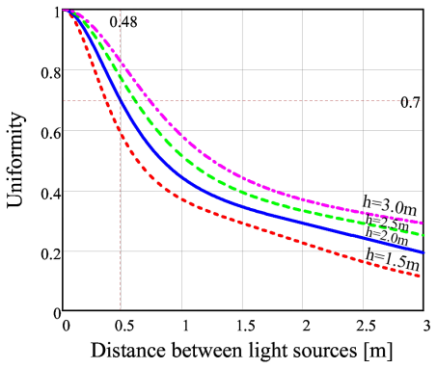

Fig. 1. Dependency of uniformity of 9 bare W724C0 LEDs from distance between LEDs and mounting height (distance between projections of lateral light sources and task area border is equal to half of distance between light sources).

V. Assessment of Relative Costs

Evaluation of relative costs is the best way to find optimal input electrical power. Relative costs [€/(klm·h)] of lighting system can be found from the expression:

$$Costs = \frac{Price_{unit} \cdot n + Life \cdot P_{total} \cdot Price_{electricity}}{n \cdot Light_{total} \cdot Life}, \qquad (13)$$

where

$Price_{unit}$ – is the price of single LED [€];

n – is the number of LEDs utilized in lighting system;

$Life$ – is the life time of LED [h];

P_{total} – is the total input electrical power of n LEDs [kW];

$Price_{electricity}$ – is the price of electricity [€/kWh];

$Light_{total}$ – is the total amount of produced light [klm].

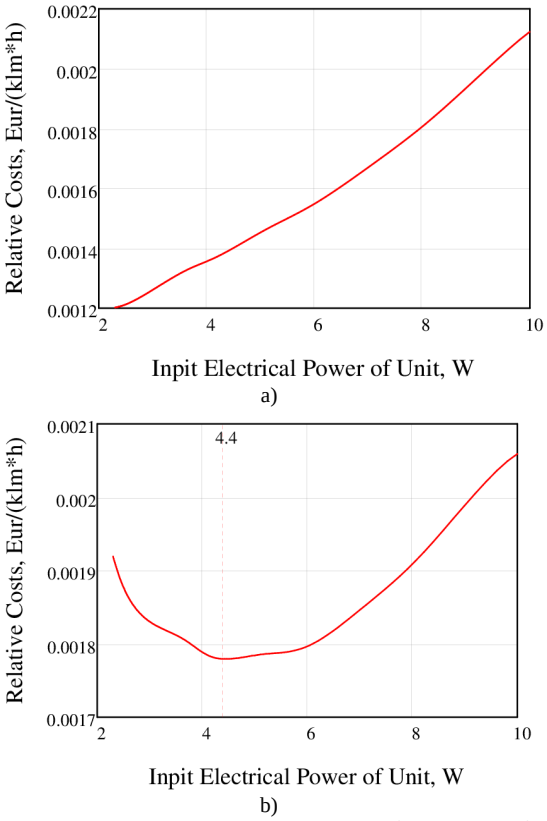

Fig. 10. Relative costs vs. input electrical power of single LED for Seoul Semiconductor W724C0 (9x9m task area): a) without taking into account reliability of power supply; b) power supply life time – 30000 hours.

VI. Conclusions

Parameters such as light source mounting height, distance between light sources and spatial distribution of luminous intensity affect uniformity. They have not direct influence on input electrical power of LED.

The results obtained in this article (Fig. 10) show that the best way to evaluate optimal input electrical power of LED is the assessment of relative costs. Also they show that the major parameter in these calculations is power supply reliability.

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Enhancement of Dimmable LED Drivers Utilizing Discontinuous Conduction Mode

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***Keywords* – Lighting, regulation, electronic ballast, switched-mode power supply, DC power supply.**

I. Introduction

The most advantageous – fluent (or amplitude) mode light regulation is often provided by an electronic LED ballast (driver) operating in continuous conduction mode (CCM). Quite rare reports dealing with discontinuous conduction mode (DCM) usually focus on grid interfacing problems 0 or on the weight/size optimization 0 of LED drivers. The main aim of the presented research is to determine the controllability parameters of the converter in DCM mode and to compare them with those in CCM and to find the impact of the conduction mode on the losses and efficiency.

II. Controllability in DCM and CCM

The controllability of an LED driver is understood as a set of parameters 0 that reflects its capability to control LED current and which are mostly found form the regulation curve of the driver (current vs. duty cycle). At the same time the current is defined by the working point of the driver found as an intersection of its V-A curve and those of LEDs. The generalized idea of this research is to move the boundary line between CCM and DCM so that VA-curve of LEDs is mostly located in DCM operation region of the driver. Then the same values of current require lower duty cycles that make the span of duty cycles wider and control of the driver – easier (Fig. 1.).

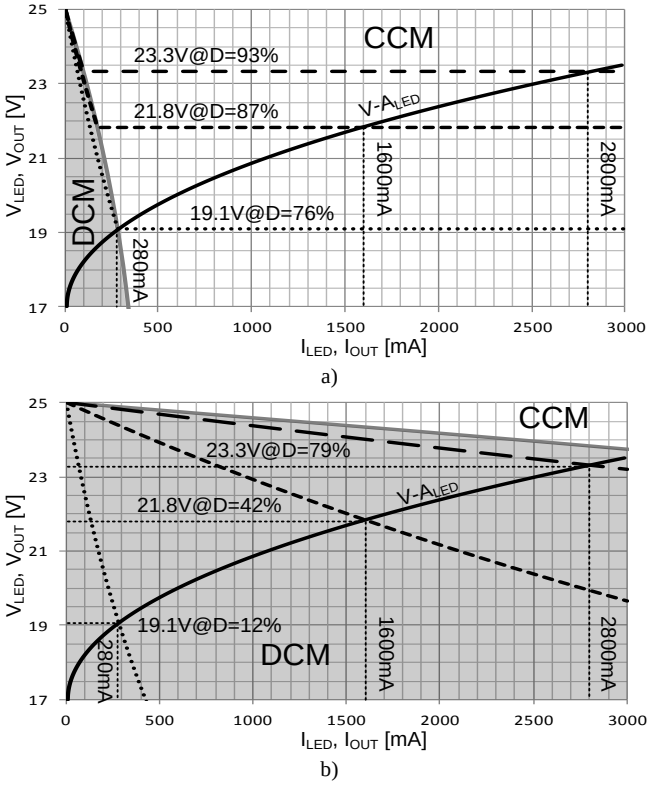

Fig. 1. Calculated operation VA curves of buck LED driver (V_{IN}=25 V, load – 7xW724C 23.2 V x 2.8 A ≈ 70 W): a) completely in continuous conduction mode; b) completely in discontinuous conduction mode.

TABLE I

Simulated parameters of controllability of LED lamp

L, µH	G_{LEDmin}	G_{LEDmax}	RG	NL, %	G_a
1	0.53	1.61	3.03	13.2	1.15
2	0.66	1.25	1.90	6.48	0.94
4	0.73	0.87	1.18	2.10	0.77
10	0.51	0.58	1.13	0.44	0.53
50	0.22	0.24	1.10	0.46	0.23
250	1.20	5.37	4.48	17.7	2.97

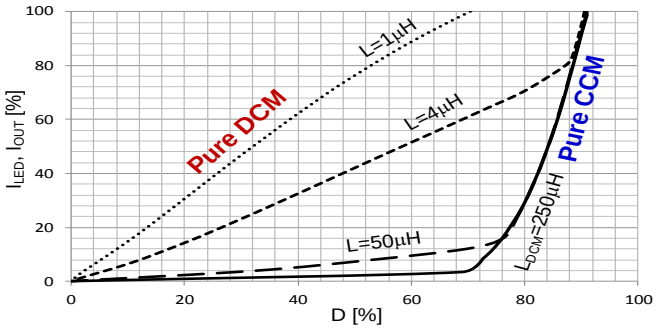

Fig. 3. Measured regulation curves of LED lamp taken in CCM and DCM.

B. Mathematical Model and Simulation of Buck LED Driver

The PSpice simulated controllability parameters of a buck type LED driver at different values of the inductance are presented in Table I. They confirm that the proposed idea of DCM utilization for better controllability seems quite realistic. The lower is inductance the better regulation can be achieved.

C. Experiments and Analysis

The experimentally achieved regulation curves are given in Fig. 3. This figure shows good correspondence of simulated and measured results that also confirm the proposed idea.

IV. Conclusions

In this paper the operation of LED drivers in DCM have been discussed. The results of simulation and experiments gave opportunity to compare the controllability of buck LEDs driver with different values of inductance. Obviously, smaller inductance leads to DCM. In this mode the dynamic range of relative light output is closer to 1. It can be summarized that from the point of controllability the DCM is preferable. However, the controllability is not the only criterion.

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Power and Electrical Engineering

Process Control

A Risk Based Modeling of Interdependencies in Critical Infrastructures through UML

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***Keywords* – Emergency power, measurement, modelling, power supply.**

I. Introduction

In this work an approach that allows monitoring critical infrastructures by considering the state of the services as well as the states of interdependent services is presented. This can be achieved by abstracting data gathered from the CI to a common set of parameters that can be shared with interdependent infrastructures [1]. We also propose an extension to the Unified Modeling Language (UML) in order to define a model for research of CI dependences.

II. Methodology

The goal of the presented approach is to address the challenge of monitoring of the state of critical infrastructures and their interdependent services. Our hypothesis is, that it is possible to reduce the complexity of a service through abstraction to a common (risk related) set of parameters.

The four modeling steps are detailed as follows:

- Service components and risk assessment;
- Measurement aggregation;
- Services interdependencies linking
- CI interdependencies modeling using UML

III. Water Service Provider Case Study

A. Situation Description

The reference scenario is composed of a high level representation of water utility (Talsi Water), which presents interdependencies with energy provider (Latvenergo CI) and a telecommunication provider (GSM Operator CI). This scenario is demonstrated as an example for validating the risk based methodology.

As it is shown in Fig. 1, Talsi Water CI provides water supply, billing and customer care services. Water supply services utilize infrastructure components, for example, water pumps, SCADA, water meters and sensors – transmitters, data transmission gateways and data centre equipment (servers, data bases etc.) [2]. Data transmission gateway infrastructure relies completely on GPRS service provider. The part of the infrastructure components is shared among services, for example, data bases and servers.

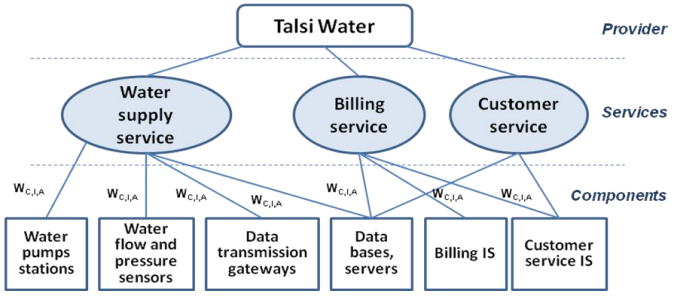

Fig. 1. Talsi Water services decomposition.

B. Interdependencies modeling with UML

The ontology proposed in Fig. 2 was created in order to study CI interdependencies of the particular city, but can be readily adapted to other cases, taking into account the specifics of each city.

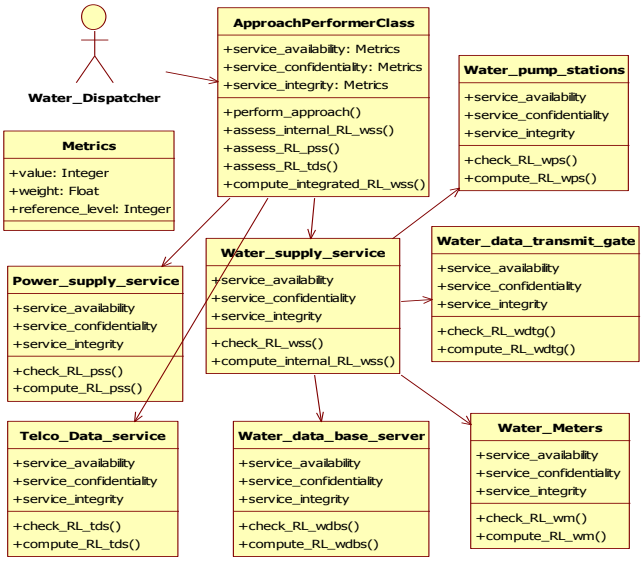

Fig. 2. Interdependencies Class diagram.

V. Discussions and Future Work

In this work we employed an idea to abstract and to decompose services to a small set of common parameters; therefore three parameters were chosen to evaluate the state of services of different CI (confidentiality, integrity and availability). The main advantage is that the model is that it is easily extensible for including additional parameters and ubiquitous for heterogeneous CI. Another benefit of the CI security model for businesses is the ability to compare different types of infrastructure using common risk related parameters.

In this paper authors used the modeling notation offered by UML and the idea of information abstraction in models defined at different levels of abstraction proposed by the MDA approach. The developed model is completely platform independent.

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Speech Control Systems for Electrical Technologies

Peter Apse-Apsitis (*Riga Technical University – RTU*), Ansis Avotins (*RTU*) and Leonids Ribickis (*RTU)*

***Keywords* – Converter control, education tool, lighting, motion control, robotics.**

I. Introduction

Voice recognition started about 100 years ago, when first telephone was designed and developed, nowadays speech recognition must recognize individual human voice and speech and digitally transfer it as written word. Usually both tasks are very close and there are no strict borders between voice and speech recognition software or hardware.

In the field of electrical technologies, voice command controls are not widely used, mainly for special systems or special needs. In the same time it could be an attractive idea to use voice commands as possible control method for educational purposes or other existing devices and applications, like, three-wheel robot FESTO Robotino, where speech control system [1] contains several Windows operating system based software modules, and was complicated and not enough reliable, or DC drive or even use it for LED lighting and indoor illumination control.

II. Structure of Systems

The functional diagram of this control system is shown in Fig.1. System includes microphone, computer (Apple) running OS X 10.6 operating system, Dragon Dictate speech recognition software and FileMaker Pro 12 database software. It is also easy to use other Apple products, like iPhone in wireless microphone mode.

Speech recognition software Dragon Dictate converts spoken word into characters in FileMaker database text field. Then text field content is filtered, analyzed and converted as commands by FileMaker database software.

After analyzing process, commands are sent as a request to Arduino Ethernet module (board) via Internet. Arduino Board acts as Web server with fixed IP address. As it is connected to Arduino microprocessor board, the requests from FileMaker to Web server then are transformed to electric drives, control systems, actuators or other device control signals.

For example, spoken words “light 50” are converted to digital command to set LED lighting illumination to 50%. More complicated commands, like “100 steps forward, speed 50 second”, can be done, where mentioned command forces the step motor to perform 100 steps in forward direction with speed 50 steps per second.

Command structure still must be pre-defined and stored in FileMaker database, in this way each user can have own command profile for the same task. Profile is bounded to FileMaker Username, so no additional steps are necessary to find exact profile. The proposed speech command system can be implemented into Energy Monitoring System [2] due to FileMaker application and similar structure in general.

FileMaker scripting is similar to any programming language scripting or AppleScript. FileMaker Scripts operate with database fields and field content, layout Objects and object behavior. Any FileMaker supported mathematic operation or logic equitation easily can be included into FileMaker Script.

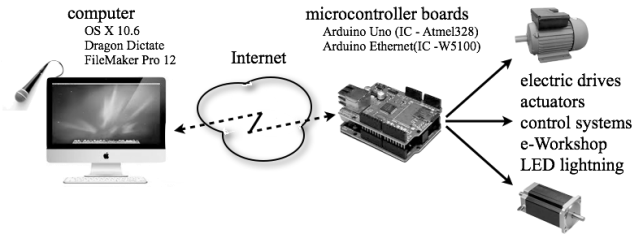

Fig. 1. Functional diagram of OS X based system

The written code is one example of possible variations of the speech - practically any set of words and any length of commands can be described and implemented. Command count is limited only by computer (running FileMaker) hardware (RAM size, disk size) limitations - practically unlimited.

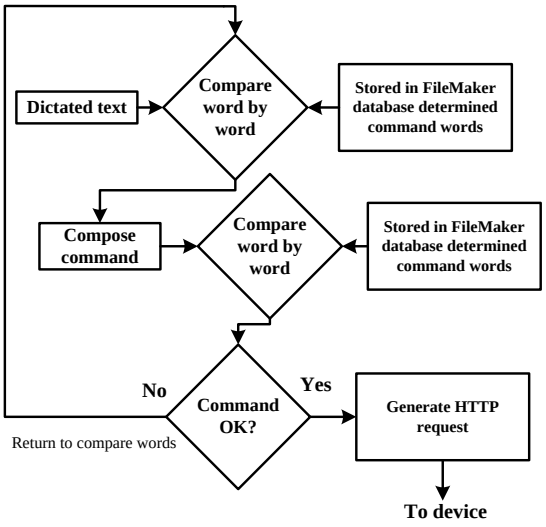

Fig. 2. Algorithm of the FileMaker program Code.

III. Conclusions

Developed voice control systems can be applied to control different systems and gain the functionality and additional comfort, as well as to perform commands when hands are occupied and even in unsafe conditions or locations, that are potentially dangerous.

Possible application of the system in noisy, dangerous, critical environments is not tested. Developed voice control system both versions must be tested by more users under different ambient noise conditions.

Speech localization module must be developed as well as possibility to use inexpensive system elements must be tested.

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Tractive Network on the Electrified Sections in Latvian Railway

Aleksandrs Nikolajevs (*Riga Technical University – RTU*) and Ļudmila Sergejeva (*RTU*)

***Keywords* – Rail vehicle, modulation strategy, power lines.**

The track circuits are the main element in the system of interval regulation of the train's traffic. The information about free sections of the railway lines and about the integrity of the railway's track wires provides the interval regulation of train's traffic. By track wires of track circuits, which at the same time is the floor channel of the automatic locomotive alarm, the information about traffic lights forward, is given to the locomotive. The main feature of the railway automatic devices system is the use of railway lines, where the backdraft currents flow, as the lines for transmission the automatic locomotive alarm in the code combinations to the locomotive, as well as for the control of free railway line. The electromagnetic compatibility of these devices is provided, using the frequencies, which differ from the harmonics of the traction current. However, modern electric locomotives are a powerful source of the interference in a wide range of frequencies. Used high-voltage filters not always may to provide the reduction of the interference level.

The increased traction current of the asymmetry in the elements of track circuits and the automatic locomotive alarm, lead to the generation of direct currents, which could worsen the quality of the functioning of these elements, causing the disruptions in their operation and the overlapping of automatic lock signals in front of moving train. As a result the safety of train's traffic is worse and the costs are increased due to additional stoppages and delays of the train [1]. The main source of the interferences on the electrified sections of the AC current is the traction power frequency and its harmonics. For the operation of track circuit the receiver and the radio transmitter are used. Depending on the type of track circuit, the different code combinations and forms of the electrical signal are used. For example, in tone track circuits of the third generation the amplitude-modulated signal is used, as well as the alternation of the different carrier frequencies (420,480,580,720,780 Hz) and the frequency modulations (8,12 Hz).

The intervals of code combinations may be filled by pulse or harmonic interferences. The impulse interferences usually are the result of abrupt changes in the traction current in the rails and the locomotive, as well as the result of the magnetization of the rails. The main source of the impulse interferences is the electric draft of the locomotive equipment.

The power lines also impact on the track circuits, creating the additional inductance. The impulse interferences appeared at random moments and may to misrepresent the duration of the intervals. As a result, in the cabin of the machinist, on the locomotive traffic light, the signal, which prohibits the traffic, appeared. In accordance with the current standards, the relative value of the traction currents difference has to be not more than 4%, when the value of the inverse AC traction current is equal to 300 A. The absolute value of the traction currents difference has not to exceed 15 A [2]. The difference between the traction currents in the track wires is directly proportional to the value of the longitudinal asymmetry and transversal asymmetry of the electric resistance of the railway line and the value of the traction current. The transversal asymmetry appeared, if railway wires have the different resistance to the ground. The transversal asymmetry always presents in places, where the railway wires are connected to the grounding circuits of the contact network [3].

The purpose of the modelling is to research the changes of the asymmetry coefficient of AC traction current under the coils of the automatic locomotive alarm, when the train moves on various railway track circuits. To implement such tests experimentally during operation is quite difficult; therefore, we propose to use software simulation in Matlab environment, as well as to check the values in the Electronics Workbench. The input resistances of railway wires are the main parameters of the distribution of the traction current under the coils of the automatic locomotive alarm. During this simulation the scheme of the back-draft railway network replacing was used within the non-regular lines [2], which were supplemented by the levelling choke-transformers. This model is characterized by the following sections: 1) for the stages of non-joint track circuits, when grounding of the traction substation is connected to the midpoint of the Drossel - Transformer, which is established on the border of stage to the station; 2) for the stages of track circuits of automatic lock code and for track circuits of the station, when grounding of the traction substation is connected to the midpoint of the Drossel - Transformer, which is established on the output - point of the track circuit.

In such sections the reversal traction currents in the rails have a maximal values [4] (f.v.). The intensity of automatic locomotive alarm failures and track circuits malfunctions in such sections are the highest. For example, the input resistance of the track wires can be calculated by the formula (1):

$$Z_{BX1} = Z_{14}^{'} + \frac{1}{\frac{1}{Z_{14}^{\bullet}} + \frac{1}{Z_{15}^{'} + \frac{1}{\frac{1}{Z_{15}^{\bullet}} + \frac{1}{Z_{16}^{'} + \frac{1}{\frac{1}{Z_{16}^{\bullet}} + \frac{1}{Z_{ДР12} + Z_{ДТ}}}}}}}. \quad (1)$$

The the distribution of back-draft traction current under the coils of the automatic locomotive alarm can be calculated by the formula (2):

$$I_{T1} = I_T \times \frac{Z_{BX2}}{Z_{BX1} + Z_{BX2}}. \quad (2)$$

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Smooth Braking of Train Using Adaptive Control Algorithms on Embedded Devices

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Anatoly Levchenkov (*RTU*) and Mikhail Gorobetz (*RTU*)

Keywords **– Rail vehicle, adaptive control, safety, control methods for electrical systems.**

I. Introduction

The authors put forward assumptions that having combined a programmable logical controller (PLC) or microcontroller with a control program based on an adaptive control algorithm and an existing train braking system, it is possible to create a new adaptive braking control system of a train, which will provide for an automatic smooth and, at the same time, precise (to a target stop point) braking of a train; and that another controller with a much smaller footprint connected to the same existing train braking system ensures an automatic stopping of the train before the red light.

The development of the system does not require considerable investments into the existing train braking control systems and any modernization of the railway infrastructure because all the information necessary for calculations can be obtained from a global positioning system (GPS) and a mechanic speed detection unit existing in the trains.

II. Review of Adaptive Control Algorithms

The main problem of classical approach for smooth target braking calculation is a necessity to receive data about various parameters of the train and railway infrastructure. Adaptive algorithms provide new approach, when the braking control system is self-adjusting to current conditions of the braking and performs the process adaptively without additional sensors and data.

The authors review definite adaptive control algorithms, with the help of which it is possible to perform a parametric adaptation and which could be effectively used in the system under discussion.

III. Algorithm for Train Anti-Collision Embedded Devices

The following variables are defined: χ_{u1}, ψ_{u1}, χ_{u2}, ψ_{u2} – latitude and longitude of train U_1 and train U_2; v_{u1}, v_{u2} – speed of U_1 and U_2; ρ_{u1}, ρ_{u2} – route section of U_1 and U_2, λ_{u1}, λ_{u2} – length of U_1 and U_2, B – braking distance of the train; ΔS – distance between trains.

The algorithm's general steps:

1. Obtain data from the satellite navigation.
2. Obtain data about the section of the route.
3. Transmit data to the control centre.
4. Control centre device Cvc detects if U_2 is following U_1 on the same route section i.e. $\rho_{u1} = \rho_{u2}$.
5. Control centre device Cvc using Rvc transmits U_1 id to Ci_{U2} and U_2 id to Ci_{U1}.
6. Ci_{U1} transmits χ_{u1}, ψ_{u1}, v_{u1}, ρ_{u1} and λ_{u1} to Ci_{U2}.
7. Ci_{U2} calculates ΔS between locomotive of U_2 and last wagon of U_1.
8. Ci_{U2} calculates braking distance B of U_2.
9. If ΔS is less or equal to B, then go to 10, else 11.
10. Ci_{U2} activates adaptive smooth braking to stop the train and to prevent the collision. Go to 1.
11. If braking is active and speed $v_{u1} > 0$, then go to 12.
12. Stop braking process. Go to Step 1.

IV. Analysis of Results and Evaluation of Efficacy

The results obtained from testing demonstrate that the developed PLC control program on the basis of an adaptive search algorithm allows controlling the train motion model parameters agreeably with the set theoretical curves with the comparatively not big differences of the parameter values. For an evaluation of the efficacy of the operation of the algorithm it would be necessary to improve the train motion model, which would allow achieving more precise results.

V. Conclusions

The offered algorithm of adaptive and precise braking of a train operates sufficiently effectively. Precisity is achieved by regulating the values of a current road driven S, of a speed V and of a braking acceleration according to the set theoretical curves in the process of braking.

For a more precise testing of the PLC control program, a more thorough train model is required which observes delays in the braking system and moments of inertia, effectiveness in different operation modes, inertia of a train, pneumatic brake control system model, etc.

Installation of embedded intelligent devices does not hamper operation of the existing braking system and increases efficacy of its operation.

The Arduino program needs a position and distance prediction routine as well as alternative data exchange protocol to send less data and handle lost or late data due to unstable radio signal.

The authors will assess the possibility to run data analysis powered by evolutionary algorithms in real time on such embedded devices.

The research leading to these results has received funding from the ARTEMIS Joint Undertaking under grant agreement n° 269265 and from Latvian Academy of Science and Ministry of Education and Science.

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Invariant Method of Load Independent Pressure Control in Steam Boiler

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***Keywords* – Optimal control, simulation, modelling, energy system management.**

I. Introduction

New approaches on the subject of development of the heat power units-turbines control technology is complex control of continuous-discontinuous processes using linear hybrid automata [1] and invariance of multi-variable control [2]. The main task of the given work is to develop and investigate the mathematical and virtual models of an invariant PID-DPC control system for steam pressure stabilization in a low pressure steam boiler VAPOR TTK-70, applying compensation of the steam load, as a disturbance, affect on the steam pressure.

II. Mathematical Model Of Steam Boiler Invariant Control System

The research subject is the model of two loop invariant control system of the steam boiler VAPOR TTK-70, developed in SIMULINK environment. To obtain the mathematical model of the two loop invariant control system – steam pressure closed loop feedback (PID) control and disturbance preemptive compensation (DPC) control loop, the operational equation (6), according to the algorithmic block-diagram of the steam boiler invariant control system (Fig. 1), has been compiled:

$$p(s)=\frac{i_0(s)\cdot W_{PID}\cdot W_A\cdot W_{SB}+(K_{Fl}\cdot W_C\cdot W_A\cdot W_{SB}-W_q)q(s)}{K_p\cdot W_{PID}\cdot W_A\cdot W_{SB}+1}, \qquad (6)$$

where $i_0(s)$ – Laplace transform of control system's input (reference) signal, mA; W_{PID} - transfer function of the PID controller; W_A - transfer function of the actuator; W_{SB} - transfer function of the steam boiler; K_{Fl} transfer coefficient of the flow meter, mA·kg^{-1}·min; W_C - transfer function of the compensation circuit; W_q - transfer function of the disturbance, as a load; K_p - transfer coefficient of the pressure transducer, mA·bar^{-1}; q(s) – Laplace transform of the steam flow, kg·min^{-1}.

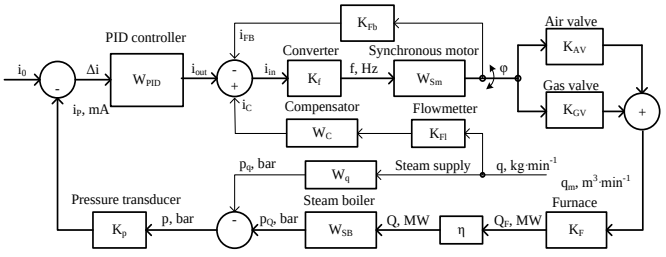

Fig. 1. Algorithmic block-diagram of the steam boiler PID – DPC invariant control system: i_0 – input setup, mA; i_p – steam pressure transducer output, mA; i_{out} – PID output, mA; i_C – DPC output, mA; q_m – gas mixture flow, m^{3}min^{-1}; Q_F – furnace output, MW; Q – effective heat flow, MW; p – steam pressure, bar; η - efficiency of the steam boiler with economizer.

IV. Simulation Procedures and Results

To simulate response of steam pressure *p(t)* in the steam boiler invariant PID-DPC control system with disturbance *q(t)* – steam expenditure preemptive compensation, the parameters of DPC circuit are calculated using invariant control algorithm:

$$W_C=K_C\cdot\frac{T_w\cdot T_s\cdot s^2+(T_w+T_s)\cdot s+1}{\tau_q\cdot T_q\cdot s^2+(\tau_q+T_q)\cdot s+1}=0.22\cdot\frac{95\cdot s^2+24\cdot s+1}{14\cdot s^2+9\cdot s+1}, \qquad (8)$$

where T_w = 5 min – time constant of water temperature rise; T_s = 19 min – time constant of steam pressure rise; τ_q = 2 min and T_q = 7 min – dead time and time constant of disturbance affect on steam pressure; s – Laplace variable, min^{-1}.

Simulation shows that the process parameter *p(t)* remains practically constant under any type of load – constant, steady changing, pulse or randomly fluctuating. If the steam load deviates from the rated value on ± 25 %, deviation of the steam pressure is only ± (1.5 - 3) % of set point value. Due to high speed preemptive operation of invariant control circuit, the disturbance is timely rejected by effective control of heat power (Fig.5).

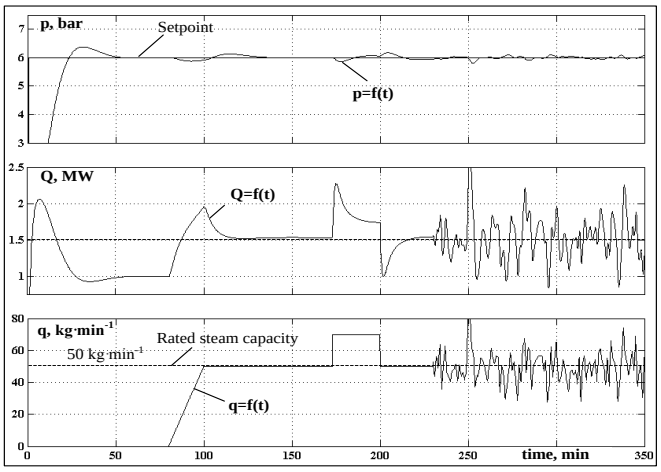

Fig.5. Simulated transient characteristics of invariant PID-DPC control system in SIMULINK environment under determinate variable load and randomly fluctuating load: p(t) – steam pressure, bar; Q(t) – heat flow, MW; q(t) – steam flow as a load and disturbance of the boiler, kg·min-1.

V. Conclusions

Invariant PID-DPC control system cancel out the affect of main disturbance - the fluctuating steam expenditure *q(t)* on the steam boiler output variable – the steam pressure *p(t)*. Introduction in practice the invariant PID-DPC control system with sub-optimally tuned parameters the output variable *p(t)* overshoot and fluctuations decreases up to ± (1.5 – 3)%, and through this makes the process of the steam boiler operation more stable and more efficient.

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Power and Electrical Engineering

Environmental and Climate Technologies

A review on suspended wood dust combustion. Efficiency and fuel quality

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Keywords **– moisture content, shape and size, swirl, volatile matter.**

I. INTRODUCTION

The combustion efficiency in low capacity wood dust suspension burners is reviewed. Fuel quality is viewed as the main contributor to the combustion efficiency. Wood dust moisture content, particle size and shape, amount of volatiles is discussed as the main contributors. Some additional aspects like burner ignition, fuel and combustion air feeding is discussed to increase the combustion efficiency.

II. COMBUSTION EFFICIENCY

For horizontal suspension burners the combustion efficiency is calculated as (1)

$$\eta_c = \frac{\frac{C_{fa}}{A_{fuel}*100}*33.9 + V_{CO}*283}{Q_z^d}*100 \text{ [1]}, \qquad (1)$$

where
V_{co} - amount of CO in the flue gases, kmol/kg_{fuel}
Q_z^d – net calorific value of the fuel, MJ/kg
G_{ubc} – unburned carbon content, kg/kg_{fuel}
C_{fa} – C amount in the fly ash, %
A_{fuel} – Ash content in the fuel, %

The carbon amount in the fly ash is taken into account due the assumption that all the particles are being carried away with the exiting flue gases. The calculated combustion efficiency (2), represents the total unburned carbon loss of wood fuel, i.e. it is the lost heat due to incomplete combustion.

In order to take into account the deposited ash – char burnout must be calculated (6):

$$b = \frac{1 - \frac{A}{ash_1}}{1 - A} \text{ [2]}, \qquad (6)$$

where
b – char burnout, %
A – ash content of the fuel, %
ash_1 –ash content of the collected char, %

It represents the degree at which the fuel particles have been burned during the combustion process.

III. WOOD DUST QUALITY IMPACT ON THE COMBUSTION

Moisture content, particle size and shape of wood dust and content of volatile matter are the main properties influencing the combustion efficiency.

Following effects can be noticed:

- High moisture content prolongs the drying time of the particle within the combustion chamber. For moist particles, the residence time within the flame zone must be longer to reach full combustion.
- Fine particles contribute to early and fast ignition due to faster drying and release of volatile matter. Larger particles take longer to combust.
- Particle shape influences the drying and ignition speed. For sphere-like particles reaction time is longer due to larger reactive surface area and enclosed fuel volume
- Volatile matter is the main contributor to the gas phase combustion ensuring large area of the combustion zone area. The higher vol. matter for the fuel, the lower amount of deposited ash.

IV. INCREASING THE COMBUSTION EFFICIENCY

One of the common techniques on how to decrease the effect is swirled combustion air supply. The achieved swirling flame is more stable due to occurring re-circulation of hot combustion gases from back of the combustion chamber into the burner inlet. The heat of the combustion gases dries the incoming fuel particles Due to the swirling effect an internal and external recirculation zones are formed [3].

V. CONCLUSIONS AND DISCUSSION

It can be concluded that main two parameters determining the combustion efficiency are the CO emissions (V_{co}) and unburned carbon in the fly (C_{fa}) and deposited ash (ash_1). In order to ensure higher combustion efficiency the main wood dust quality boundary conditions for small scale suspended wood combustions are:

- Moisture content of 10% must not be exceeded in order to efficiently combust 100% wood dust fuel blends.
- Particles of the wood dust blend should be smaller than 1 mm. The attention must be paid to the average diameter of the blend.
- The wood dust particles should be of flake-like and narrow shape.
- The volatile matter content for the wood dust should be 80% or higher.

To reach higher combustion efficiency, it is necessary to swirl the flame. Swirl number of 1 to 2.3 can be recommended.

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Advantages and disadvantages of different biological waste treatment methods: composting and anaerobic digestion in Latvia

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***Keywords* – biowaste, composting, anaerobic digestion, impact assessment.**

I. Introduction

European countries have to fulfil the Landfill Directive 1999/31/EC [1] and the Directive on waste 2008/98/EC [2] to reduce land filling of the biodegradable part of municipal solid waste to 35%. The Renewable Energy Directive (RED) 2009/28/EC [3] also has to be complied.

The use of biowaste as a resource allows moving closer to EU's common objectives by reducing the amount of waste disposed in landfills. Also by using biowaste to produce something (biogas, compost) the reuse of waste materials is increased. If the biowaste is used to produce the biogas then the biogas upgrading to biomethane quality and the distributing the biomethane through natural gas network is an opportunity to efficiently use renewable energy in more populated (urban) areas and increase the energy independence of country. This is a great amount that can be recycled to avoid waste disposal. Unfortunately the organic waste management is not developed in Latvia.

In Latvian waste legislation [4] only composting is mentioned as a product of biowaste and is mostly related to the green waste.

The aim of the research is to find an optimal solution for biowaste treatment in Latvian condition and to introduce and educate the public and stake holders of Latvia about biological waste management systems.

II. Materials and Methods

Within the framework of this work, quantitative and qualitative analysis of existing waste management projects in the area of biological waste treatment is performed. The work identifies qualitative and quantitative indicators of materiality of effect.

The research questions are answered through the review of literature, case studies and good practices on biological waste management projects. The research methodology is based on a fusion of quantitative and qualitative research; the data about waste management projects in the Latvia was collected through the archival analysis of relevant legislation, the use of questionnaires and semi-structured personal and focus groups interviews with the field experts, EIA programmes and reports, annual reports on the landfills operation.

The study started with the analysis of scientific literature and theoretical basis of biological waste treatment and EIA formation worldwide followed by the analysis of EIA and waste treatment legislation in the EU and Baltic states. Further a survey of biological waste treatment in Latvia was given.

III. Results

Of the 11 existing municipal solid waste (MSW) landfills in Latvia, six has a composting area (see Table I) for composting organic and green waste. Only two composting areas are actively used for biological waste composting.

TABLE I

Compost areas and their use in landfills

Landfill	Composting area (m^2)	Use of composting area
Krizevnieki	2000	-
Cinisi	1050	-
Kivites	-	-
Kaudzites	2000	-
Janvari	5038	+
Getlini	-	-
Pentuli	-	-
Dzila vada	+	-
Brakski	-	-
Grantini	-	-
Daibe	5632	+

"+" – the composting area exists, the composting area is actively used for composting the biowaste

"-" – the composting area do not exist, the composting area is not used for composting the biowaste

The study shows that the existing biowaste management system is not effective, therefore other solutions of organic waste should be sought for.

It is necessary to develop a separate collection of organic waste with further treatment using anaerobic digestion (AD).

Separate collection of biowaste provides a cleaner raw material for AD.

A solution for biowaste treatment in MSW landfills could be biowaste treatment with dry anaerobic digestion.

Composting should be used for treating green waste which contains lignocellulose.

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Alternative Energy for Brick Industry

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***Keywords* – Alternative energy, Bio-methane, Brick industry, Natural gas, Wind energy.**

I. Introduction

In Latvia brick kilns are fired with natural gas. It is well known that the brick firing is an energy intensive process requiring large quantities of fossil fuels. Therefore, research and comparison of alternative energy sources is necessary and essential. Bio-methane and wind energy are analyzed and compared from environmental aspect as potential alternative energy sources (a term used to refer to any energy source other than fossil fuels) for brick industry in the work.

II. Methods

Comparison of certain environmental aspects of natural gas, bio-methane and wind power was carried out using GEMIS (Global Emission Model for Integrated Systems) v.4.7 database. The database offers environmental impact information on fossil fuels, renewable energy sources, processes for electricity and heat production, raw materials, and transport [1].

Scenario analysis was carried out for the replacement of natural gas with bio-methane and wind energy. Change of environmental impacts due to substitution of natural gas is shown in Fig.1.

III. Results

The following environmental impacts were evaluated per 1 TJ of energy (Table I):

- CO_2 emissions - an important indicator that describes environmental impact of fuel conversion;
- cumulative material requirement - includes the total consumption of materials throughout product (in this case – energy source) life cycle;
- cumulative energy requirement - shows how much energy is embedded in 1TJ of fuel energy;
- land use - factor that describes how much land is needed to produce a certain amount of energy;
- employment effects - effects that each energy source has on employment levels.

TABLE I

THE GLOBAL RESULTS FOR PRODUCING 1 TJ NATURAL GAS, BIOMETHANE AND ELECTRICITY

	Natural gas	**Bio-methane**	**Wind energy**
CO_2 emissions [kg]	9230	3778	5137
Cumulative material requirement [kg], int.al:	5701	20371	21987
- nonrenewable	*817*	*4920*	*7782*
- renewable	*4780*	*15166*	*13968*
- other	*104*	*285*	*237*
Cumulative energy requirement [TJ], int.al:	1,23	1,61	1,04
- nonrenewable	*1,23*	*0,05*	*0,04*
- renewable	*0*	*1,56*	*1*
Land use [m²]	5,82	236	286
Employment effects [persons]	0,02	0,94	3,3

The following process data were used from the GEMIS database: natural gas (based on lower heating value-LHV) and supplied from "gas-mix-FI-2010"; bio-methane processed for gas-pipeline (LHV) supplied from "pipeline\bio-SNG-wood-forest-DE-2030"; electricity supplied from medium wind-park "DE-2000".

IV. Conclusions

When choosing fuels, all the criteria that characterize the fuel and all environmental impacts must be carefully considered as each energy source has pros and cons. Debate over what forms of alternative energy causes less environmental impact and which are most practical to substitute fossil fuel was carried out.

From an environmental point of view one of the most important criterions is CO_2 emissions and natural gas is the worst alternative in this respect. From this perspective replacement of natural gas with bio-methane or wind energy is fully justified.

Regarding the total cumulative consumption of materials, wind energy appears worse than bio-methane and natural gas because more nonrenewable and less renewable materials are needed for production and installation of equipment.

The total cumulative energy consumption for wind energy is by 15% and 35% less than for natural gas and bio-methane respectively. However, bio-methane and wind energy contain mainly renewable energy (i.e. 96-97%) contrary to natural gas which is non-renewable energy source.

When considering replacement of natural gas with an alternative energy sources, a manufacturer should be aware of the required technological changes. Therefore, substitution of natural gas to bio-methane is considerably more convenient solution as almost no technological changes are required. The situation is different in the case of using wind energy, and so far wind generated electricity has not been implemented into brick firing process although industrial processes may serve as an option for "storage" of surplus wind power generation.

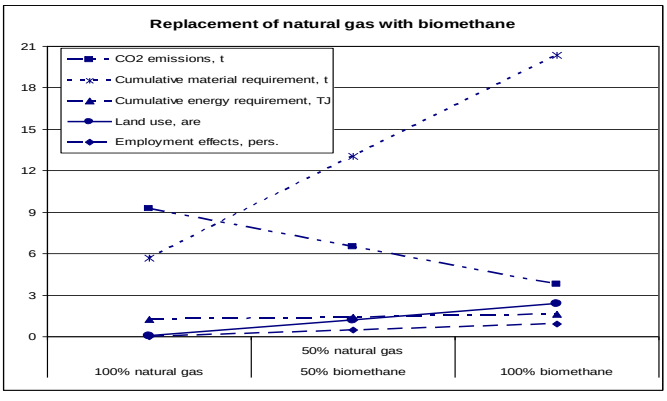

Fig. 1. Results of scenario analysis when natural gas is replaced with biomethane

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Assessment of sustainability aspects of the packaging's deposit-refund system in Latvia

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Keywords **– consumption, deposit-refund system, packaging, sustainability, waste segregation.**

I. Introduction

Reduction of municipal waste has been an important issue in Latvia as large part of waste is deposited in landfills. Even if sorting rate of different waste materials increases with every year, still, 46% of municipal waste was landfilled in 2010. Up to 20% of municipal solid waste is compiled of used packaging materials. Different experiences from other countries show the way to increase recovery rates for packaging materials by introducing deposit-refund system (DRS).

II. Operation of Deposit-Refund system

DRS means an extra payment for product which would be refunded after giving back the empty packaging unit. This system is mainly used for beverage drinks filled in different polyethylene terephthalate or glass bottles, as well as in aluminum cans. Packaging involved in DRS constitute on average 20% of all packaging waste [15].

There are several parties involved in the DRS (producers, retailers, consumers, government and other), which make the system more complicated since every participant has different interests and needs. The DRS can gain the optimal result only in the case when all the parties are economically or emotionally motivated to take part in the DRS.

The basic aim of the system is to increase the level of recovery of packaging waste. As deposit added to the products has been paid by customers, they are interested to return the empty bottles and cans in order to get back the money spent. Producers are participating in the system as otherwise they are obliged to pay the natural resource tax. If the tax is higher than the costs of participation in the DRS, producers have a strong motivation to involve. Retailers can use the DRS as a marketing resource to attract customers. Whereas for government the DRS is an instrument to fulfill the binding targets set by the European Union [16].

III. Aspects of deposit-refund System

Since there are many stakeholders involved in the DRS, it is necessary to find a balance among interests and needs of all the interested parties from economic, social and environmental points of view.

A. Social aspects

Introduction of deposit-refund system would affect the consumers as the prices will increase due to added deposit. Nevertheless, results of different surveys show that most of the population supports the DRS in Latvia. Also the municipalities which are responsible for managing waste in their administrative territory claim that the DRS would possibly be more effective than curbside container system.

From the other hand, producers are strongly against the introduction of DRS as it can reduce their income. Changes of consumer prices have larger influence on the consumption, and adding the deposit to the product can cause the drop of consumption of the beverage drinks by 1.5 – 5%.

B. Economic aspects

The economic estimates show that large investments will be necessary to implement the DRS in Latvia – more than 12 million EUR will be required in the first three years.

The returned packaging is collected by retailers. The retailers' costs of packaging collection are covered by producers in case of refillable bottles or by the operator in case of one-way packaging. This would increase the producers' costs for packaging waste management by 62% if compared to the existing system.

C. Environmental aspects

The main aim of the DRS is to enhance the material recycling rates, thus saving energy and resources. It is possible to save up to 97% of energy by producing cans from secondary materials compared to production from bauxite ore [17]. Production of PET from secondary materials saves 96%, but glass – about 30% of energy. Depending on the recovery rates it is possible to save a considerable amount of energy by recycling the packaging waste.

Another environmental advantage that can be gained by implementation of the DRS is reduction of littering. The results of the analysis show that the deposit packaging compiles only 11% of the total waste mass collected, or 28% of the total volume collected. Thus, by implementing the DRS the littering problem can be solved only partly.

IV. Necessity of deposit-refund system

It can be concluded that the potential benefits have to be evaluated in relation to the costs of the system before introducing the DRS in Latvia. In order to find the optimal solution for Latvian conditions it is necessary to develop a model that includes all sustainability aspects presented in a dynamic manner.

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Bioenergy resource development forecast for Latvia 2030

Dagnija Blumberga (*Riga Technical University*)

***Keywords* – bioenergy resources, wood energy, biogas, biofuel.**

I. INTRODUCTION

Latvia has great opportunities to become a country of green energy. Such aim would provide an opportunity to develop bioenergy resources in all sectors of national economy, including the transport sector. There is no fossil fuel production in Latvia, which can be considered as an advantage for future development of the energy sector in direction of increased share of bioenergy resources.

Characteristic of Latvian energy sectors is the high proportion (99%) of relatively small and low capacity energy sources. Less than ten energy sources from 1000 use capacity over 50MW. Another special feature of Latvian energy supply is developed district heating: approximately 70% of the heat consumer loads is connected to the district heating energy sources. Characteristics of small energy sources determine the requirements for energy resources: on the one hand they need to be energy efficient, but on the other hand it is important to use domestic energy sources. Currently natural gas share in centralized heat supply systems is 85%, which suggests that there are good growth prospects for bioenergy use in this particular sector. The advancement of Latvian energy sector cannot be separated from the development of country's economic. The development of bioenergy resources must be assessed in context with the development of all energy (particularly renewable energy) resources. Bio-energy development system must be balanced not only within the system, but also in perspective of the whole country's energy system. At the same time we should think about opportunities of obtaining bioenergy resources and the development of innovative technologies.

II. BIOENERGY SOURCES

Options for the use of bioenergy in Latvia fall into four major groups that differ with sources of raw materials.Fuelwood (trees, bushes);

- Agricultural waste (manure), straw and green fodder (corn, grass, cereals, oilseeds, etc.);
- Biomass from waters (sewage sludge and algae in the sea and water basins);
- Organic waste (from industrial plants and municipal waste).

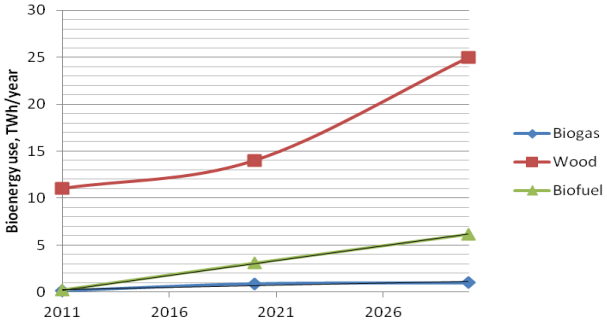

Fig. 1. Use of bioenergy

Fuel wood, whose yearly utilization facilities are 30 to 50% higher than its employment now, has the biggest share of Latvian renewable energy resource field. The reason for this lies in the poor use of forest residues, increasing cutting amount and energy efficiency of fuel burning equipment.

III. BIOENERGY TECHNOLOGIES

There are two directions for sustainable development of fuel wood utilization technologies in district heating companies:

- boiler houses furnaces that use a dry, previously dried wood with a moisture content not exceeding 25%;
- boiler plants using wet wood chips with a moisture content above 45%,that are equipped with gas capacitors - equipment used for steam heat recovery from flue gas.

Another bioenergy product is gas (biogas and syngas), which can be obtained from all mentioned sources of raw materials. From current point of view looking to the future, it is clear that biogas production from waste will remain until scientists find a way to use them for production of new products. Other important biogas production line expected in the near future is the third generation biogas production units, using fast-growing biomass: algae. Explosion of innovations in the development of syngas production can be expected over the next decade. Production of syngas will make it possible to operate small-scale biomass plants in cogeneration mode for electricity and heat production.

Transport sector faces an important choice: to develop electric transport based on green power or provide a greater share of biofuels, including biogas, in total consumption balance of transport sector. An important place in future should be provided for the second generation biofuel production units in Latvia. In order to progressively gain opportunities that would make it possible to give up fossil fuels, public transport and logistics should be developed in this direction.

IV. CONCLUSIONS AND DISCUSSIONS

Latvia has high potential bioenergy resources, which by 2030 is likely going to increase to 50% of the total energy consumption. This can happen only if the legislation will be improved in relevance to this objective and enough support provided for innovative bioenergy technologies.

Characteristics of Mechanically Sorted Municipal Wastes and Their Suitability for Production of Refuse Derived Fuel

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***Keywords* – Parameters of waste, pre-treatment, RDF, cement plant .**

I. Introduction

The largest proportion (76-94%) of collected waste in the three Baltic States is not sorted and is landfilled as from the Eurostat. The re-use and recycling of the EU household waste shall be at least 50% by 2020. Conversion of waste into refuse derived fuels (RDF) reduces the volume of waste, and provides fuel. The aim of the research is to detect the main parameters for pre-treated waste parts and to compare them with parameters stated for RDF by cement plant.

II. Material and Methods

The research was made of the mechanically pre-treated summer waste of city households and commercials from the landfill *Daibe* in Latvia. Samples (1-2 kg each) were taken from coarse, medium, and fine fraction, excluding metal, of unsorted waste (LVS EN 14899:2011). The manual sampling from the conveyor belt was used. The samples were weighed, dried at 103°C for 24 h and weighed. The morphological content was determined (sorted parts were weighed and weight percentage calculated) in 10 parts. The moisture, heating value, chlorine and sulphur, ash, heavy metals was determined and compared to *Cemex* cement plant requirements for alternative fuel specification in Latvia [8].

III. Results and Discussion

The mechanical pre-treatment of unsorted municipal waste has produced following parts: Coarse fraction 25%; Medium fraction 43%; Fine fraction 30%; Metal 2 %.

The distribution of the waste is shown in Table I.

TABLE I

CONTENT OF WASTE FRACTION (% OF DRY MASS; 95% CONFIDENCE INTERVAL; MEAN; STD. ERROR)

Content of Waste	Coarse fraction (n=11)	Medium fraction (n=9)	Fine fraction (n=9)
Paper, cardboard	46.1±8.87	28.3±4.11	1.6±0.50
Plastic	35.5±7.75	25.4±3.93	0.9±0.18
Small particles, putrescible	3.7±1.01	14.1±2.98	73.0±5.55
Hygiene (diapers)	3.3±2.24	2.0±0.75	0
Textile	3.7±3.39	0.7±0.31	0
Rubber	6.2±4.25	5.2±2.54	0
Wood	0.01±0.04	4.9±1.91	0
Metal	1.2±0.86	2.9±0.84	0.02±0.02
Glass	0	8.3±1.96	20.3±4.46
Mineral	0.02±0.02	8.1±3.42	4.2±1.58

The content of coarse fraction is characterized by relatively large amount of (46 %) paper and cardboard and by 36 % of plastic (both mainly as packaging); with no glass. Too large size of the sample explains the big standard error for paper, plastic and rubber. Samples of this fraction contained not grained, large waste (foot wear, magazines, half of bucket). The content of medium fraction is characterized by large waste diversity. The combustible part is about 82 % of the medium fraction. The average 70% of fine fraction are biologically degradable material and small particles (sand etc.), and about 27% are glass, ceramic, rocks; with no hygiene, textile, rubber, wood.

For all fractions the lower heating value does not correspond to the *Cemex* requirements [1]. It is because of large amount of moisture of the waste. The average lower heating value (6.65 MJ kg^{-1}) of the fine fraction complies with that from literature [2]. The higher heating value of the coarse (25.7 MJ kg^{-1}) and the medium (23.7 MJ kg^{-1}) fraction corresponds to *Cemex* requirements.

The only medium fraction has corresponding ash content (up to 15 %). The amount of sulphur and metals corresponds to *Cemex* requirements for all three fractions, but the amount of chlorine exceeds them. For the medium fraction it is even 5 times higher. It is explained by the content of PVC (toys, packaging and wire insulation produced when PVC was not restricted). Old paper and wallpaper could be the source of chlorine (1.1%) for the coarse fraction. According with Kai Sipilä [3], the waste contains 0.3-1.0 % of chlorine.

IV. Conclusions

1. The coarse fraction is most suitable for the production of the RDF. But it needs graining.
2. It is possible to increase the lower heating value of the coarse and the medium fractions by using drying or biological pre-treatment followed by mechanical pre-treatment.
3. The fine fraction can be used as covering material after bio-treatment and stabilization.
4. To decrease the waste moisture and to increase the amount of waste for RDF, the biowaste (including kitchen waste) source separation can be used, obtaining the biowaste for compost or biogas, too.
5. It is necessary to continue research to define whether the amount of chlorine always is so high.

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Comparison of Dolostone and Limestone Assessment Methods for Estonian Deposits

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Keywords **– Sustainability Assessment Method, Exergia Table Analyze, non – metallic aggregates.**

I. Introduction

This paper deals with introduction and comparison of Sustainable Assessment method for Estonian dolostone and limestone mining's as well. Sustainable method was developed for Estonian deposits last year for a mining's company OÜ Väo Paas. In this case an exergia analyze is in use to measure and compare the parameters. For limestone parameters gradation was used three - level risk matrix scale from British Standard BS 8800 „Occupational health and safety management systems" (f.v. Table I).

Work was to ensure and evaluate the practical output of the company's competitiveness in Estonia on the basis of the consumer's wishes and needs, because sustainability depends on the environment, socio-cultural parameters and also technological level. In his paper will be also given more convenient method for gradation and sustainable assessment analyze for non-metallic aggregates developed on Estonian deposits'.

II. The Methodology of Analyze

To organize an optimal analyze for both deposits it was proposed to use an exergia table analyze with a matrix of influence risks values, where a final product considered as a process and divided to four main parts: Economical, Environmental, Technical Feasibility and Social – Cultural also. The expected result of these studies was to explore a better one analyzing methodology for sustainable assessment in mining management. A specific monitoring large – scale tool and indicators were developed in order to access each branch of mining.

These exergia analyze tables were composed at excel program. It can provide a qualified image for end user and for company owners as well. For more information see an overview of dolostone analyze f.v. Table II and Table III of limestone analyze.

For both analyzes all economic indicators data was taken from the book records program Väo Paas OÜ mining company Kareda dolostone deposit and Tondi – Väo limestone mining branch over October, 2011. Economic indicators contains a part of the balance of the mining remnant stock and analyzes data of unused material, its volume which shows a risk of mining exhaustion, also a numerical overview of trading income and operating expenses as well.

Environmental annual reports of both branches were also used for describe an environmental indicators part. Validity of extraction permission should be comparable with overview data time. Some environmental indicators (Environmental Management Handbook) were added to limestone analyze, where an environmental aspects, goals, missions, actions and needs to protect and improve environmental conditions in and around facilities are clearly demonstrated. In case if the Handbook do not exist then risk is very high (5 points), when the Handbook is completed and approved by the company board member, then risk is minimal (1 point); at the other cases risk lever varies according to the handbook draft stages.

In limestone sustainability assessment at the socio - cultural part indicators of awareness and participating in tenders were divided into two separate parts and was calculated labor middle age by the average value; the nearest approximate was 50. By Estonian requirements' Work Safety Risk Assessment should be achieved 55 years since its first measurement, mostly because of the life expectancy. As the fact at this analyze middle labor age of workers were 50 and is estimated like acceptable risk upon condition of an annual health check monitoring.

In case the total risk of analyze is valid or more than the average, then supporting measures should be taken in these area of company activity. The analyze develop the scientific output of the optimal activity analyze, to ensure the practical output of the company's competitiveness in Estonia on the basis of the consumer's wishes and needs and to provide an optimal assessment of the capacities of different groups based on the company needs. The urgency of the research consists in management efficiency in the current market conditions. It is necessary requirement of the activity improvement, creation, development and company competitive advantages. For more accurate data research should be continued [1].

III. Conclusion

The sustainability assessment methods can be used for different purposes and at different levels: as a basis for decision – making when selecting among different remedial actions for a mined out area within time and financial restraints.

For successful development in the long – term of the company profound recognition of external and internal factors is required: dynamics of demand of consumers, formations of corporate culture and negotiation of weak aspects by optimal and effective use of internal resources in particular [1].

To carry through the study of sustainable assessment exergia analyze final determinations of impacts should be made for all non – metallic deposits and develop an overall assessment of the sustainability measurement scale. Real limitation of these both analyzes are large time – consuming for the analyze process. To make analyze easier at the future the exergia computer program should be prepared with the three - level risk matrix scale, in that case data could be quickly analyzed. As comparison has shown the three - level risk matrix scale provides more accurate data analyze and it could be used for all aggregates. The final step on this research will be estimation, also gradation of company sustainability status and recommendations to improvements if it is necessary.

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Construction sector needs to achieve the climate and energy targets 2020

Agris Kamenders *(Riga Technical University)*

Keywords **– construction sector workers, climate and energy targets 2020, low energy construction.**

I. Introduction

The aim of the analysis hereby was to determine the demand for employees in the construction sector and to forecast it for year 2020 in order to achieve the climate and energy targets the country has undertaken.

II. General Regulations

In Latvia buildings possess a huge technically attainable and economically justified energy efficiency potential which currently is not used to the due extent. The renovation of buildings in Latvia is very slow. It is often that only a partly renovation of a building takes place and the average energy consumption reduction achieved in renovated building projects is low due to the poor quality of construction work. When implementing a complex building renovation in accordance with the minimal Latvian Building Standard LBN 002-01 requirements it is possible to achieve at least 50% and bigger energy consumption reduction along with the provision of high comfort and use of renewable energy resources.

EU directive 2010/31/EU on the energy efficiency of buildings has established that starting from 31 December, 2020 all newly constructed buildings should approach zero energy building standards or should achieve a very low energy building criteria and the energy must be produced from renewable energy resources. Starting from 31 December, 2018 when renting or purchasing a building all public institutions must choose this kind of buildings.

Similarly, Latvia has undertaken several international commitments by setting specific energy and climate targets:

- to increase energy efficiency by 20% until year 2020;
- to increase the proportion of renewable energy resources in the gross energy end consumption to 40% until year 2020;
- to increase energy efficiency on the final user side achieving 9% energy consumption reduction in the period from 2009 to 2016;
- to raise the level of employment.

High quality of construction work in renovation and construction is one of the most important factors to make the investments in raising energy efficiency and use of renewable energy resources economically justified. The achievement of the established targets is impossible without a sufficient number of highly qualified construction workers.

III. Forecast

In 2011 17,940 jobs were occupied in building construction. To forecast the necessary number of employees until year 2020 three different scenarios were developed during the research:

1) Base scenario. The calculation is built on the GDP growth forecast of the Ministry of Economics of the Republic of Latvia predicting 2.9% growth in year 2012 and 4.6% growth in the period from 2013 to 2016. The GDP growth in the period from 2016 to 2020 is assumed as average 4%. According to the base scenario 19,949 employees are needed for the projects related to the provision of the energy efficiency of buildings and use of renewable energy resources.

2) Latvia 2020 scenario. For Latvia to achieve the climate and energy aims of 2020 to reduce the building energy consumption by 20% the investments of 1.5 to 1.8 mln LVL are needed. According to this scenario 38,056 employees are necessary.

3) Medium growth scenario. The scenario describes the situation where it is assumed that increasingly more buildings are renovated along with the development of new financial instruments which facilitate energy efficiency improvement and use of renewable energy resources, for example, ESCO (Energy Service Companies), rotation fund, tax reliefs, lower interest rates on loans, state guarantees etc. This scenario would require 29,003 employees in 2020 (Figure 1)[1].

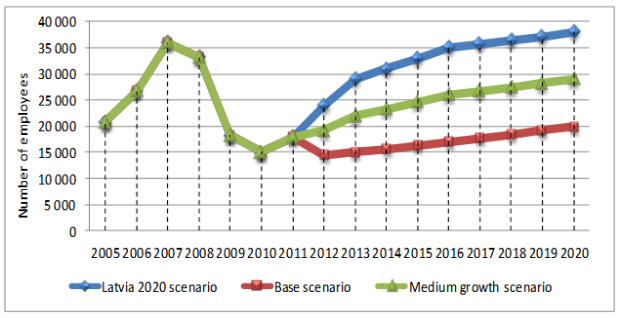

Fig. 1. Forecast of workforce needed until year 2020.

According to the climate and energy targets undertaken by the state the increasing of the number as well as knowledge and skills of the workforce would be necessary.

IV. Conclusions

As it is suggested by the analysis, vocational education Other recommendations institutions could prepare up to 5,166 new specialists by year 2020, which would provide for the additionally needed number of employees just for the base scenario. At the age around 60 it is possible that 90% of employees will not be able to continue their work in the construction sector. As the performed analysis suggests, by 2020 it is necessary to increase the number of the graduates of vocational education institutions as well as to provide adults with an additional qualification.

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Cost-benefit analysis of indoor climate impact on energy consumption and human health

Andra Blumberga (*Riga Technical University*)

Keywords **– indoor climate, productivity, energy consumption, human health.**

I. Introduction

Indoor air quality is determined by number of factors - temperature, relative humidity, air velocity and contaminants. Any of these factors being above or below comfort level has impact on human health and life quality, e.g. it might cause diseases, injuries or even mortality. On the other hand improved indoor air quality requires investments in air handling equipment as well as financial resources to cover operation, maintenance and energy costs. To prove the value of this spending and estimate benefits in monetary terms provided by it, human health and life quality is estimated by number of methods. These include market-based techniques, surrogate market techniques and survey-based techniques.

Market-based techniques are based on market prices to value what is affected by a change in the indoor air quality.

Surrogate market techniques employ price differentials in a surrogate market to estimate the values people place on indoor air quality.

Survey-based techniques are used in absence of data on market prices. The 'willingness to pay' concept is based on peoples preferences as the basis for pricing or valuing goods and services.

The main goal of this study is to estimate costs and benefits of indoor air quality improvement based on productivity loss, short-term sick leave costs, and investment, operation and energy costs of air handling systems. This is applied for country with cold climate (more than 4000 heating degree days), comparably low salary hourly rates and high energy tariff.

II. Methodology

A mathematical cost-benefit analysis model was developed to assess indoor climate impact on energy consumption, human health and productivity. A hypothetical sample room (75 m^3) served as calculation basis and different modes of use of the room where evaluated such as living room, kindergarten, office, gym, computer class, recording studio, and classroom.

The annual energy consumption is a function of number of occupants, installed capacity of electrical appliances and equipment, hours of use, outdoor air temperature and pollution sources.

Short-term sick leave depends on working area available per person and fresh air supply rate per person. The lower the area and fresh air volume, the higher the sick leave risk [1]. Productivity is a function of indoor air temperature. If the room temperature is below + 20°C or above +25°C the productivity decreases. Every degree above +25°C decreases productivity by 2% [2].

Calculations of costs generated by the sick leave rest on three hourly rates: 5 LVL/h, 10 LVL/h, 15 LVL/h. For the pupils the future earnings associated with different levels of educational attainment are calculated. Installation, operation and energy costs of air handling equipment are calculated based on supply air volumes. The energy tariff is 85 LVL/MWh.

III. Results and Discussions

Figure 1 illustrates that in all types of room and at all hourly rates benefits from installation of air handling equipment outweigh the costs from short-sick leave. The annual short-term sick leave costs exceed the investment, operation and energy costs by an average factor of 1 to 9.

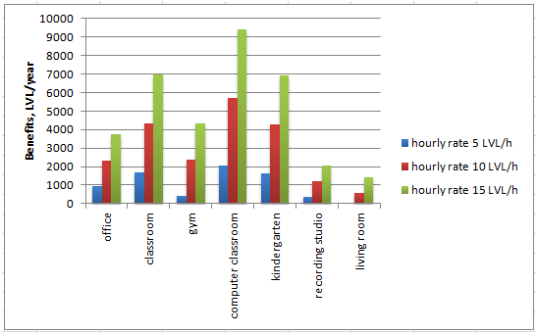

Fig. 1. Economic benefits from air quality improvement and reduction of short-term sick leave

Figure 2 shows that the annual benefits from increased productivity overweigh the investment, operation and energy costs of air conditioner by an average factor of 20 to 150 depending on type of room and salary hourly rate of persons occupying the room. The pay- back time of air conditioners is less than one year.

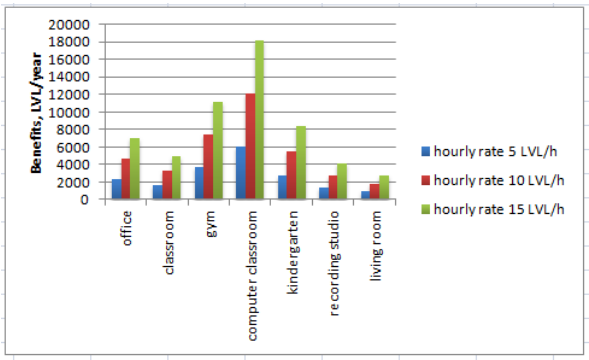

Fig. 2. Economic benefits from air quality improvement and reduced productivity loss

Investments in improvement of indoor air quality lead to improved work performance and less absence due to sick leave and it is both economically and technically viable.

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Determination of some important emissions of poultry waste co-combustion

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***Keywords* – Biomass, co-combustion, combustion emission, poultry litter, poultry waste.**

I. Introduction

Poultry waste (PW) is recognized as the main source of pollution from poultry farming. In confined areas, the poultry industry generates a huge amount of waste as by-product.

There are different alternative disposal routes for poultry waste; composting, anaerobic digestion, gasification and combustion. Combustion has the potential of providing a sustainable and environmentally-friendly disposal technology for the PW providing for both facility space heating and large-scale power generation. Combustion of PW represents a promising alternative to energy generation and reduction of emissions of the poultry house facilities.

However, according to the previous studies, complete combustion of PW alone due to the high moisture and ash contents as well as low heating value of the poultry waste could result in some problems; therefore, co-combustion of PW with coal (or lignite) can be considered as a better alternative remedy [1].

II. Experimental

Two tests are conducted; combustion of PW-only and co-combustion of PW with coal.

A. Fuel characteristics

The PW+coal ratios (based on mass flow rate) tested were 0/100, 25/75, 50/50 and 75/25. Tunçbilek coal and two types of PW (chicken manure with sawdust, PWS and chicken manure with rice husk, PWR) were investigated.

B. Experimental set-up

The experimental set-up was a special bottom-feed combustion system. Via this feeding system, combustion of high-volatile content coal and biomass with high efficiency and low emissions can be achieved. A schematic diagram of the combustor is shown in Fig. 1. The thermal capacity of the combustor is about 80 kW and it is used in hot water production. Generally, the experimental set up was designed to operate with chicken farm waste and coal.

III. Results

Combustion and co-combustion experiments were carried out to investigate the feasibility of the poultry waste combustion and to increase the understanding of the dynamic characteristics of the combustion process in the special bottom-feed combustor when using poultry waste and coal+poultry waste mixtures.

A. Combustion results

The effect of excess air ratio on the combustion emissions of PWS and PWR and also the effect of excess air ratio on the L_{CO} (combustion loss due to carbon monoxide incomplete combustion), L_{Ch} (combustion loss due to hydrocarbons incomplete combustion), L_C (combustion loss due to unburned carbon in ash) and combustion efficiency of the PWS combustion were obtained. L_{CO} and L_{Ch} could be calculated using CO and C_mH_n emissions of the flue gas. L_C calculation was made by weighing and analyzing the collected ash from the ash hopper at the bottom of the combustor.

B. Co-combustion results

In this section, baseline data of co-combustion was first obtained for combustion of the coal alone and then co-combustion tests for poultry waste with rice husk mass fractions of 25%, 50% and 75% are performed.

The cause of the increase of the CO emission can be categorized as follows:

- Raising hydrocarbon concentration due to the higher amount of volatile matter released from PWR can prevent further CO oxidation [2].
- Relatively high content of PWR results in the formation of HCl, which can inhibit the CO oxidation by consuming the radicals OH and HO_2 [3].
- Unburned volatile matter can be considered as an additional source of CO [4].

IV. Conclusion

Combustion experimental results reveal that for both PWR and PWS, the increase of the excess air ratio has a remarkable effect on CO and CH_4 emission while its effect on NO_x and SO_2 emissions are ignorable. Moreover, the increase of the excess air ratio leads to first an increase and then a decrease in the combustion efficiency.

Based on the experimental results, for both poultry waste types, an average excess air ratio range of 1.5-1.6 can be considered as optimum value from the combustion performance perspective.

Comparing the combustion results with emissions limit values of the Air Quality Control Regulation (AQCR) of Turkey reveals that, apart from CO concentration, other emissions are below the allowable limits.

For co-combustion of poultry waste and lignite coal, various ratios of PWR to Tunçbilek coal ranging from 0 to 100 wt. % are tested. The increase of the PWR mass fraction results in the increase of CO and CH_4 and reduction in NO_x and SO_2 emissions. Combustion efficiency of the PWR co-combustion is found to be about 98-99%.

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Development of actively controlled ceiling panel with incorporated phase change materials

Andra Blumberga and Kristaps Kašs (*Riga Technical University*)

***Keywords* – phase change material, thermal energy storage, latent heat energy, thermal comfort.**

I. Introduction

One of the biggest difficulties associated with broader use of renewable energy sources (RES) is related to relatively uneven energy supply, therefore alternative energy sources must be implemented to provide secure energy supply at all times. Phase change materials (PCM) present high potential for heat energy storage which eliminates several difficulties associated with the drawbacks of RES uneven energy supply. Modern office buildings and facilities with high internal heat gains require large amounts of energy to power buildings engineering systems and space conditioning systems. Typicaly indoor conditioning units are used to provide comfortable indoor temperature conditions for the occupants of the building and to avoid negative effects of overheating. Conditioning unit subtracts the heat energy form the office space and rejects it to the surroundings while using a significant amount of energy in the process. PCM have the potential to reduce the diurnal indoor temperature fluctuations and to displace space conditioning loads to off-peak energy supply periods. This is usually achieved by utilizing free night time ventilation principles, where the cool night time air is stored in PCM.

II. Potential of PCM applications

There have been numerous studies of PCM incorporation into lightweight and retrofitted building walls, floors and ceiling to achieve building indoor space passive conditioning. PCM phase transition temperatures ranging from 20 ^{0}C to 27 ^{0}C have been mentioned as suitable for achieving comfortable indoor temperature conditions. The studies show that during the daily cycle with high heat loads, the PCM accumulates the heat from the surrounding and stores it as latent heat. To ensure comfortable indoor temperature conditions in the summer months, the room temperatures must be kept at 21 ^{0}C to 27 ^{0}C. A numerical and experimental analysis was carried out by Koschenz et al [1]. The aim of the research was to investigate a passive cooling technique involving ceiling panel with incorporated micro encapsulated paraffin and gypsum composite PCM with melting temperature of 20 ^{0}C and aluminum fins to enhance the heat transfer within the ceiling panel. Time period in which the PCM could store the latent heat, was 7 hours. In this time period the PCMs temperature had risen by 4 K reaching 24 ^{0}C, and the simulated room temperature rose to approximately 28 ^{0}C. In total 290 Wh/m^2 of heat energy was stored as latent heat in the PCM. In another research carried out by Pasupathy et al. [2], an analytical model was developed to describe the heat transition from the roof slab during summer cooling period. In this research an analytical model describing heat flow through three layers consisting of top roof concrete slab, PCM panel and room ceiling concrete slab was developed. An experimental set up was designed to validate the mathematical model. The results showed, that ceiling panels with incorporated PCM could reduce the overall diurnal air temperature fluctuations. In addition an experimental investigation was carried out, allowing water to pass through the PCM to enhance the cooling. Although noticeable cooling effect of the PCM was observed, it was concluded that the amount of cold water needed to maintain sufficient cooling effect was too high.
Little research has been done on heat utilization from the PCM. In most cases free night time cooling ventilation is used to extract heat and to prepare the PCM for the next daily cycle. In some cases capillary water tube system is embedded into the PCM system to ensure adequate cooling during the heat rejection phase in the night time. Another drawback is the additional conditioning needed when heat flux to the PCM is not sufficient enough to cool the space. In this case conditioning unit is not only cooling the indoor air, but also the PCM, resulting into inefficient cooling energy use.

III. Further research

Further research is related to examining the possibilities of reducing the energy amount needed for space conditioning and exploring the methods of regenerating the PCM to avoid the necessity for additional space conditioning. To exclude the possibility of space temperature rise due to insufficient latent heat storage in the PCM, a model which includes a heat pump for excess heat removal will be developed. By incorporating a heat pump system into the PCM, it is possible to regenerate the PCM and subtract the latent heat from PCM as low potential heat energy for efficient use within the building. One of the applications for the use of low potential heat may be for DHW preparation. If a heat pump is used, adequate DHW temperatures may be reached. To achieve sufficient heat flux from the surrounding to the PCM and to provide comfortable indoor temperature conditions a PCM with a lower phase transition temperature can be applied, which would result in a similar feel to that, when entering a room with massive, cool concrete walls. In winter periods ceiling panel with incorporated PCM could reduce the heat flux from the top floors of the building to the surrounding if a PCM with lower phase transition temperature is chosen. A more detailed research is needed to verify these assumptions.

Analytical and experimental system investigation is required to optimize the dimensions and operational conditions of PCM ceiling panel with incorporated heat pump evaporative contour system and simulate its daily operational conditions in different seasons.

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District heating return temperature influence on the flue gas condenser capacity

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Keywords **– flue gas condenser, DH return temperature, condensation, latent heat.**

I. INTRODUCTION

Heat recovery and deep cooling of flue gas has its own specificity. It cannot be limited to performance analysis of boiler and condenser, in which deep cooling of flue gas takes place. Recovered heat has low potential (temperature), consumer for it has yet to be found. Such a consumer can be a heating system where recovered heat is used for primary heating of district heating network water. District heating systems influence on the use of utilized heat is related to temperature level in heating network. [1]. Return temperature has essential influence.

II. DESCRIPTION OF THE COMMERCIAL EXPERIMENT

Industrial experiment with a flue gas condenser was carried out at heating network boiler house in Ludza. Woodchip boiler with capacity of 8 MW was installed in the boiler house. Outside the boiler house a two-stage condenser was mounted, in the horizontal part of it at the centre of gas flow a spray nozzle have been installed, in the vertical part a different group of nozzles, spraying liquid, which comes into direct contact with the flue gas, were installed.

Experiment was carried out during the heating seasons in 2010. and 2011. Following parameters were measured: boiler capacity Nk, MW; condenser capacity N_{ko}, MW; amount of injected water G_k, m^3/h; flue gas temperature before and after the condenser t_{1g}; t_{2g}, ºC; temperature of injected water t_{2k}, ºC; water temperature after the condenser t_{1k}, ºC; water network return temperature t_{1t}, ^{0}C; amount of oxygen in flue gas O_2, %. In this work statistical processing of data and multifactor empirical model establishment were carried out using software STATGRAPHICSPlus. The changes of dependent variable condenser capacity N_{ko} depending on independent variables of equipment characteristic parameters are reflected by regression equation that can be expressed with (1).

$$N_{ko}=-0.2913+0.7173d+0.0255H_m+0.0521N_k+0.0438t_{1K}-0.0332t_{1T}-0.0108t_{2K} \quad (1)$$

The equation shows that six parameters are statistically significant for operation of equipment, the increase of two of them causes decrease in condenser capacity. These parameters are heating network return temperature and water injection temperature of the condensing capacitor. The paper further describes influence of heating network return temperature.

III. RESULTS OF THE EXPERIMENT AND DISCUSSION

Condenser capacity changed depending on the network return temperature are shown in the Figure 1. We can see that correlation coefficient R = 0.71, indicates a satisfactory correlation of data. Dissipation of data can be explained by the influence of other independent variables that are reflected in equation on the condenser capacity. Heating network flow and return temperature are variable values and depend on the heat consumption, which increases with decreasing outdoor air temperature. To provide bigger heat load flow temperature must be increased and that results in increase of return water temperature. Condenser efficiency decreases with lowering outdoor temperature.

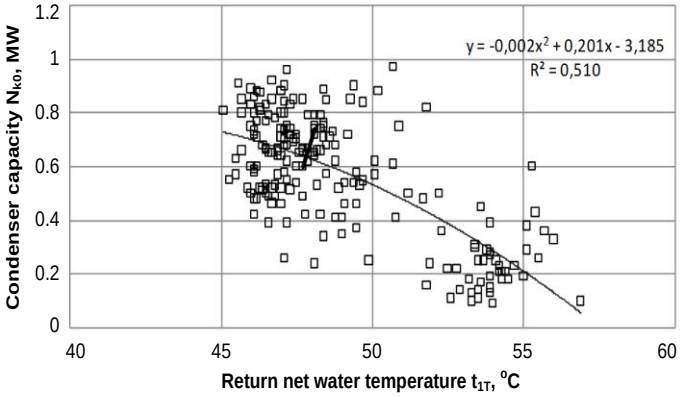

Fig.1. Changes in condenser capacity depending on the return temperature of net water.

With increasing return water temperature condenser heat capacity is decreasing, because heat exchange between heating network and condenser water circuits is declining in network water heat exchanger [2]. Cooling of water heated by condensers in heat exchanger becomes less efficient and through the nozzles water is injected in condenser with higher temperature. In case of increased injected water temperature, dry heat exchange between droplets and the flue gas and mass exchange is worsening. In case of condensation, water steam partial pressure on water droplet surface is lower than the partial pressure in flue gases. With rising water droplet temperature, partial pressure of steam on the droplet surface increases and partial pressure difference decreases. As a result flue gas condensation process deteriorates and flue gases are eliminated from condenser with higher moisture content. Deterioration of dry heat exchange is associated with an increased temperature of eliminated flue gas. In general, less intense heat and mass exchange worsens flue gas heat recovery and decreases efficiency of the boiler house. [3].

IV. CONCLUSIONS

Result analysis shows that with increasing return network water temperature the condenser heat capacity drops because heat exchange between heating network and condenser water circuits is declining in network water heat exchanger. As a result injected water temperature increases, dry heat exchange between droplets and the flue gas and mass exchange worsens, which means that condenser efficiency is decreasing.

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Drying agent recirculation influence on energy consumption of the drying process

Zane Sproģe, Ivars Veidenbergs (*Riga Technical University*)

Keywords **– drying process, energy consumption, sawdust drying, drying agent recirculation**

I. Introduction

Sufficient material (energetic wood) moisture content is crucial factor for effective energy production process. To obtain sufficient material moisture content it is necessary to dry material. Ineffectively implemented drying process causes significant loss of profit, as well as air, water, visual and noise pollution, which in turn can lead to local and regional environmental impact. Moreover it is very important to implement measures and methods that minimize the total consumption of energy to obtain effective drying process of sawdust to produce pellets for households heating applications [1].

II. Methodology

Belt type dryer designed for sawdust drying in pellet production plant was investigated in this paper. Belt type dryer uses heat form biomass cogeneration station to heat air and obtain sufficient drying agent to dry sawdust.

The drying process is one of the most important and energy intensive processes in sawdust pellet production plants. In addition, pellet producers often have lack of credible information about the drying process which in turn contributes to a significant increase of energy consumption and environmental pollution. Therefore it is useful to develop mathematical model to achieve optimal drying result with less energy consumption and less monetary lost [2, 3].

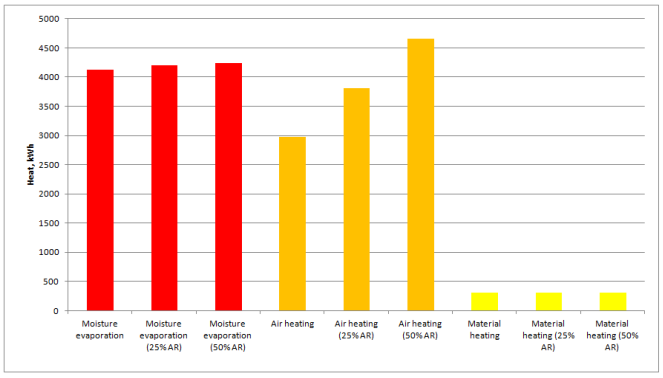

Fig. 1. Detailed heat energy consumption for drying process in cycle without and with drying agent recirculation

Characteristic material and dryer coefficients and values were used in mathematical calculations for establishment of drying process model. This model was developed for drying process in cycle and annual basis, thus, it is possible to successfully evaluate the drying process energy consumption variation depending on process variables, in this case – outside air temperature and moisture content, as well as the material moisture content before drying. Simulation results showed that electricity consumption depends on outdoor air moisture content, but the heat energy consumption depends on outdoor air temperature, and material moisture content affects the overall energy consumption.

Due to the fact that energy consumption in industrial drying is relatively high, it is very important to establish methods and measures that will minimize overall energy consumption to obtain material with lower moisture content as possible. One of the most frequently mentioned methods in scientific literature how to reduce overall energy consumption of the drying process is drying agent or outgoing air recirculation, channeled directly to drying chamber.

Mathematical model was established for two drying process modifications – with and without drying agent recirculation. Energy requirement for both of drying process modifications was calculated and evaluated. In figure 1. and 2. it is seen how heat and electricity requirements are changing due to drying process modifications – with or without drying agent recirculation.

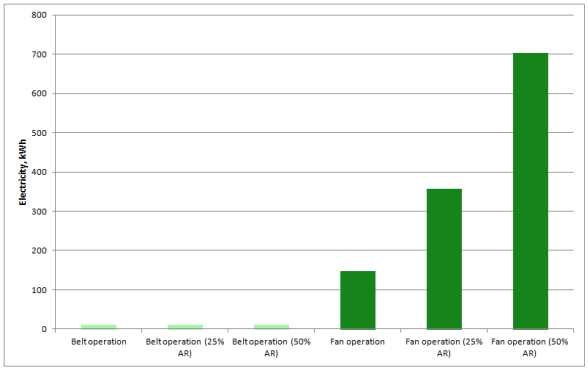

Fig. 2. Detailed electricity consumption for drying process in cycle without and with drying agent recirculation

As it is seen in figures above, energy consumption both heat and electricity consumption increases using drying agent recirculation as a drying process modification. Thus leads to a fact that drying agent recirculation is not an energy consumption minimizing activity.

III. Conclusions

Results of modeling of drying process with drying agent or air recirculation shows that increasing the degree of re-circulation of 1%, electricity consumption was increased by 3,77%, heat consumption will increase by 0,5%, but total plant operating costs increased by 3,84%. Thus, it can be assert that the drying agent recirculation is not an energy consumption minimization operation.

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Ecoinnovation diffusion in the building energy efficiency market

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Keywords **– Innovation, ecoinnovation, energy efficiency, ecoefficiency.**

I. Introduction

In recent years the development of EU environmental policy is aimed to build a closer relationship between environmental and innovation policy. Particular attention is focused for the promotion of ecoinnovation in construction sector.

The literature review on "ecoinnovation" found many different definitions of ecoinnovation [1]. The Wupertal Institute for Climate, Environment and Energy for their research [1] of the most relevant EU policy for reducing energy use and improving resource efficiency, used a comprehansive definition of ecoinnovation, given by Reid and Miedzinski (2008) and they defined ecoinnovation as "the creation of novel and competitively priced goods, processes, systems, services, and procedures that can satisfy human needs and bring quality of life to all people with a life-cycle-wide minimal use of natural resources (material including energy carriers, and surface area) per unit output, and a minimal release of toxic substances".

However, studies done by so far points that a lack of relevant data and indicators have hampered the development of policies and measures for promoting ecoinnovation [2].

Stimulating ecoinnovation initiative in the construction sector significant results in waste reduction, energy efficiency and climate change abatement can be achieved.

II. Drivers and Barriers of Ecoinnovation in Buildings' Energy Efficiency Market

Buildings' sector development studies have found that ecoinnovation for buildings refurbishment in Europe have not fully been developed yet [1]. However companies in the construction sector are more likely to have brought a new product or service to the market (i.e. system innovations) [3].

Trends contributing to ecoinnovation in housing sector are associated with high-impact use of construction materials, access to appropriate and affordable housing, growing demand for housing space, increasing urban sprawl and lower urban density and growing energy consumption in the housing use phase [3]. According to Timo Makela, these trends partly offset environmental policies and lead to additional demand for action [3].

The table I below shows an example of the main barriers and drivers for ecoinnovation in energy efficiency renovation of buildings [1]. This table I discloses very complex and dynamic system of interrelations between factors that affects the diffusion of ecoinnovations in buildings energy efficiency market.

TABLE I

Drivers and barriers in refurbishment of old buildings

Drivers	**Barriers**
1. Socio-economic: 1.1. General economic development; 1.2. Demand for housing/building space; 1.3. Hours of use per year; 1.4. Number of households and firms; 1.5. Development of energy and material prices (including energy or emissions taxes) and interest rates); 2. Technical: 2.1. Availability of low-impact technologies and materials; 2.2. Development of infrastructures affecting location of residential and non-residential buildings; 3. Natural: 3.1. Climatic zone where building is located; 4. Cultural-institutional: 4.1. Willingness of residents to participate in shared housing concepts; 4.2. Readiness for public administrations to develop green building and infrastructure concepts on former industrial areas in city centers instead of further following the strategy of urban sprawl.	1. Socio-economic: 1.1. Limited incentives for landlords or tenants to invest in ecoinnovation; 1.2. Long payback periods of ecoinnovation in housing and construction; 2. Financial: 2.1. Insufficient financial means for initial investment; 2.2. Transaction costs for receiving information, advice and financial support often is high; 3. Cultural-institutional: 3.1. Life Cycle thinking is not widespread; 3.2. Lack of information about existing support measures for tenants and landlords; 3.3. Insufficient motivation, training and qualification of planners and installers; 3.4. Insufficient information of tenants and building owners about ecoinnovations.

The study [1] concluded that there are urgent need to create EU policy for promoting ecoinnovation aimed to address the barriers for ecoinnovation and the most attention should be focused on such informational and socio-economic barriers:

- Lack of understanding of benefits;
- Lack of coordination;
- Resistance to change;
- Low awareness /education about ecoinnovation;
- Price of the ecoinnovation being higher than the alternative;
- High transaction costs for information or advice.

III. Further Research

Sustainable energy consumption in buildings and ecoinnovation diffusion involves a complex, socially embedded and socially constructed market. Further research will focus on application of a system dynamics approach to explore the short, medium and long term impact of different policies promoting ecoinnovations in building energy efficiency sector. This approach will enable to make the relationship between cause and effect explicit in complex, dynamic systems that have delays, feedbacks and non-linearities.

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Economic modelling of potential losses caused by floods

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Keywords **– GIS, DTM, Flood Area, Topo to Raster, Spatial Analyst.**

I. INTRODUCTION

The developed technique of economic modelling is intended for defining the size of potential damage caused by floods, and is estimated by the initial value of objects and water depth in the area of their location. Dependent indicators are called *"values of damage"*. The present research aims to emphasize the necessity and possibility of using the complex approach, which is based on applying modern techniques of mathematic modelling.

Mathematic model represents an approximate description of natural phenomena and processes, expressed by mathematic rules and mathematic symbols [1].

Geographic Information Systems *(GIS)* technology is the main instrument of the research.

GIS is a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes [2].

As a "pilot territory" serves the flood endangered territory of the Daugava River at the border zone of Daugavpils city.

II. GENERAL REGULATIONS

The first stage by American Environmental Systems Research Institute *ArcGIS 10* software has been developed hydrologically correct raster surface – *Topogrid* with cell size *10m *10m*, produced with the aid of interpolation technique *Topo to Raster* module *Topogrid* (see fig.1. f.v.).

The present technique has been created by Michaels Hutchinsons on the basis of the computer software *ANUDEM* in 1988 – 1989.

The second stage involved hydrodynamic modelling of water flowing at the river drainage. The tool of hydrodynamic modelling *Flood Area* has been developed by the companies: *Geomer GmbH, Heidelberg, Germany, and Ruiz Rodriguez, Zeisler & Blank, Wiesbaden, Germany*.

Flood Area is a two - dimensional flood modeling tool for defining the borders of flooding zone during changes of water level integrated in *ArcGIS* software. The calculated result presented an assumed height of the water rise depending on the initial water level in the river. The prime parameter for hydrodynamic modelling served the water level, its size was added as an attribute of *GRID-theme*.

The hydrodynamic approach was used for calculating the water flow between the neighbouring raster cells (land surface) to the moment of aligning the water level. Then the estimated values of the depth of overflow water have been saved in the new *GRID - theme*.

The third stage as the basic modelling parameters served the water level and the rate of cadastre value of objects. The cadastre value of land parcels, buildings and engineering constructions is determined on the basis of the public data distribution portal: The State Land Service (www.kadastrs.lv).

With the aid of the spatial module *ArcGIS/ Spatial Analyst* each raster cell identified the risk value of material losses: Arc Toolbox/ *Spatial Analyst/ /Flood Damage.*

III. OBJECTS

As a result of modelling the dynamics of water environment have been obtained maps identifying depths and zones of flooding with probability 1% and 10% in case of extreme water level rises. The result of hydrodynamic modelling is presented on fig.2.

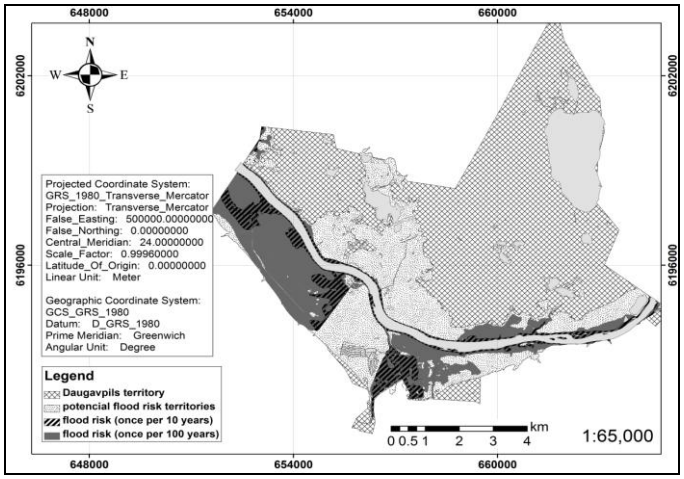

Fig.2. The map of flooding zones with probability 1% and 10% during extreme rises in water levels.

The *"value of damage"* was determined by the standard method which has been developed for application in the whole of the Netherlands. The size of economic damage caused by floods *S* (expressed in LVL's) is defined by the initial value of object and the depth of water in the area of their location, by equations [3]:

$$S = \sum_{i=1}^{n} a_i n_i S_i \qquad (1)$$

Where α_i is the "damage factor" for category *i*, n_i the number of units (e.g. houses) in category *i* and *Si* the maximum damage per unity in category *i*.

The result of economic modelling presented the developed raster, identifying the total estimated territory surface: *Arc Toolbox/ Spatial Analyst/ Economic Valuation GRID* (see fig.3 f.v.)

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Ecological Scarcity Method: Adaptation and Implementation for Different Countries

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***Keywords* – Life Cycle Impact Assessment, Ecological Scarcity Method, Transformation Rule, Greenhouse gases.**

I. Introduction

Ecological Scarcity Method was developed in Switzerland. The method is used for Life Cycle Assessment (LCA) of products and processes.

The application of the method gives the opportunity to present different environmental impacts in the same units, eco-points (EP). The latter means that it is easier to see the share of each category in the overall result and set the plan of actions toward the reduction the most negative ones. Thereby the method assists the environmental management and decision making.

II. Spread of the Method

The current version of EcoScarcity method is mostly oriented on internal use. All impacts are assessed from a Swiss perspective [1]. Creation of the transformation rules could set up favorable condition for unification and filling the gaps if it is needed because the selection of substances is guided by their ecological and political relevance for other countries.

III. Driving Rorces for the Environmental Limitations

Critical and actual flows are the key parts of the formula for Eco-factors calculation (1). For each country the critical and actual flow are individual and stipulate national conditions.

To make the transformation rules appropriate it is necessary to define driving forces for limitation of one or another substance in different countries. In this paper the main focus is on defining transformation rules between Switzerland, Germany and Russian Federation.

IV. Transformation Rule Concept

Transformation rule (TR) should advance the determination of Eco-factor for different nations if the direct calculation is not possible for some reasons. Direct calculation is feasible if critical and actual flows explicitly identified.

It should reflect the difference between the countries. Therefore TR in general is a function of national critical and actual flow. Critical and actual flows in its turn are functions of driving forces.

V. Example: GHG

D. Transformation rules

The functional analysis gives results.

$$TR_f = \frac{f(Eco-factor)^{Swizerland}}{f(Eco-factor)^{Germany}} \approx 16{,}3 \quad (17)$$

$$TR_f^{'} = \frac{f(Eco-factor)^{Swizerland}}{f(Eco-factor)^{Russia}} \approx 7 \quad (18)$$

$$TR_f^{''} = \frac{f(Eco-factor)^{Russia}}{f(Eco-factor)^{Germany}} \approx 2{,}3 \quad (19)$$

The rating in this case is: 1. Germany; 2. Russia; 3. Switzerland.

Fig. 11, 12 and 13 show that Germany is the most consistent in GHG reduction. Besides that, the trend of actual flow has the same character as the trend of critical flow.

The TR should include the functional analysis for the more realistic result. The function indirectly includes the information about driving force for the limitation or current situation.

VI. Conclusions

The paper is just a first attempt for the transformation rule definition and application. There is no unambiguous transformation rule. Various parameters should be taken into consideration.

The degree of the influence differs from country to country as well. The trend of the actual and critical flows helps to identify the correspondence between special parties. The TR could be change in accordance with the function of the trend.

Each country can define its own TR and calculate Eco-factors, based on national conditions and priorities.

EcoScarcity is method that use distance-to-target, could be considered as a valuation factor on the characterized midpoints results, that is, at the level of environmental problems such as global warming and others [2].

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Energy engineering students on their way to expertise in sustainable energy

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Keywords **– competencies, curriculum, energy engineering, expertise, life cycle assessment, sustainability.**

I. Introduction

Sustainable energy is based on the principles of sustainable development and it includes economic, ecological and social dimensions. It is a challenging combination in education. Expertise in sustainable energy means understanding the relationships and conflicts between various actors' parties and technical solutions. Technologies that promote sustainable energy include renewable energy sources, such as biomass, hydro, solar, wind, wave, geothermal energy and tidal power, and also technologies designed to improve energy efficiencies. Higher education should educate energy engineers in different industrial sectors so that they are able to act and make correct sustainable choices in the future environment. These choices have consequences on the whole society where energy is used. Development of higher education and research is as an important part of public responsibility in the Bologna Process [f.v.5]. Even though both energy and environment are closely linked to each other in politics and strategies, increasing environmental awareness and systems thinking still present challenges for teaching energy engineering. Also, sustainability remains to be implemented in the energy degree programmes. This kind of situation seems to be true also in other universities outside of Finland [10].

The objective of this study is to investigate the expertise related to sustainability in higher education. Future challenges and required skills are explored through recent studies [7], [f.v.8] and [f.v.9], which have listed the key competencies that engineers need in their working life. Sustainability and expertise are discussed on the basis of a literature survey. This paper discusses teachings in sustainable energy engineering in the Finnish context.

II. Development of Expertise

Expertise can be developed in formal and informal settings [11]. Education provides basic skills to people who are able to function independently, perceptively and effectively, allowing them to excel in their field of work [f.v.12]. Developing the skills of students is an important goal for teaching and preparing students for professional life. However, developing skills is not enough. There are three dimensions to developing curriculum in higher education, that is, knowing, acting and being, all of which should be considered [f.v.13]. This refers to the fact that in formal higher education, learning of new knowledge is usually well represented, and the development of certain skills is also considered. However, the dimension of being is often not that well integrated into the curricula.

A better balance is needed between various teaching and learning practices in addition to the skills and educational learning outcomes in building the students' future careers. Future teaching methods do not mean that the old ones must be totally replaced with the new ones, but they could involve simple improvements and new arrangements. However, it seems that developing teaching practices is not enough. Future education should support identity development and collaboration by working in groups instead of working alone.

III. Future Trends in Energy Issue

When educating future energy engineers it is important to consider the future trends in energy issues in different industrial sectors. Research and innovation activities have to be strengthened in the areas of energy systems, entire production-consumption chains and energy and material efficiencies [7]. New solutions must be developed in the field of decentralized energy systems in cooperation between the different technology developers. Efforts in these fields could combat climate change and scarcity of raw materials. Policy innovations and voluntary agreements could also improve the use of sustainable energy and awareness in environmental impacts.

IV. Future Expertise in Environment and Energy

Future expertise on environmental management of energy engineering should involve awareness of global problems in mapping and foresight of the environmental risks. Future skills in energy education should also include the set of sustainability tools. Skills of life cycle thinking and systems approach are necessary in preparing long-term energy decisions. In the coming decades, renewable energy sources will not be able to satisfy the total demand for energy [f.v.25] and [f.v.1].

V. Conclusions and Discussions

The findings show that energy engineers need a life cycle approach on energy systems, a deep know-how of energy engineering and an ability to think critically and creatively to solve energy problems. Regarding future trends in energy issues, sustainable solutions should be based on the long-term goals for the ecology, the economy and for energy and material efficiencies. Integrating various learning environments would help the students to enhance their sustainable energy expertise and possibly develop multidisciplinary and interdisciplinary skills for sustainable energy solutions throughout their education. Conclusion is that the integration level of energy and sustainability still seems to be low in the energy curriculum.

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Energy saving and GHG Emission Reduction in a Micro-CCHP System by use of Solar Energy

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Keywords **– Micro CCHP, Stirling engine, Solar energy, Greenhouse gas emission, Energy saving.**

I. Introduction

The micro CCHP (m-CCHP) systems are typically designed at less than 30kW electric to produce both electricity and useable thermal energy onsite or near site, reducing the energy losses that occur in transmission and distribution. At "Dunarea de Jos" University of Galati was designed and built a m-CCHP system within the framework of the project "Integrated micro-CCHP – Stirling engine based on renewable energy sources for the isolated residential consumers from the South-East region of Romania", granted by the EEA Financial Mechanism. The system was designed to operate only with renewable energy, biogas for Stirling engine and wood pellets for the auxiliary heating boiler. In order to reduce the fuel consumption and therefore the greenhouse gas emission were integrated in the system photovoltaic panels and evacuated tube collectors. This study deals with the environmental and economic analyses based on the energetic model of the m-CCHP system. In the study, the operation of prime mover (Stirling engine) matching the electric load was considered [14] .

II. System Description

The studied m-CCHP system consists of a natural gas Stirling CHP, an adsorber chiller, a hot water storage tank, a cold water storage tank, an auxiliary heating boiler, solar collectors, photovoltaic panels, two cooling towers and pumps to circulate the fluids. The residential building equipped with the m-CCHP system has 270 m^2 and was designed to correspond to the A energetic class.

III. Power, Heating And Cooling Consumptions

There are many calculation methods used to estimate for buildings the energy requirements for electricity, domestic hot water, space heating and cooling. One of the most used calculation methods due to its simplicity is the degree-days method to estimate the heating and cooling loads in buildings in winter and summer periods. Using the RETscreen software [15] there were found, for Galati as location, the monthly average daily solar radiation in plane of PV panels and solar collectors (kWh/m²/d), the monthly number of degree-days for heating and degree-days for cooling. It was found that in April, May, September and October when either heating or cooling is not necessary, the amount of heat produced by the solar collector and the Stirling CHP exceeds the total heat demand and a part of the heat generated by the Stirling CHP is rejected in a cooling tower [16].

IV. Energy Saving And Greenhouse Gas Emission Assessment

The energy saved by the photovoltaic panels varies from 7.47% in December to 28.27% in July and the energy saved by the solar collector varies from 13.35% in December to 59.62% in April (Fig. 3).

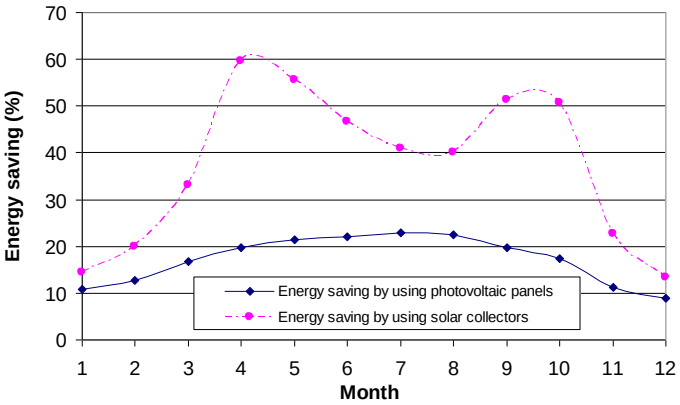

Fig. 3. Energy saving by using solar energy in the m-CCHP system.

Using the GHG emission factors and knowing the energy consumptions of the m-CCHP system in both cases with and without use of solar energy, there can be calculated the reduction of GHG emission. The result is shown in figure 4. The total GHG amount in CO_2 equivalent saved through use of solar energy in the m-CCHP system in one year is about 4709kg CO_2, which means a reduction by 31.98%.

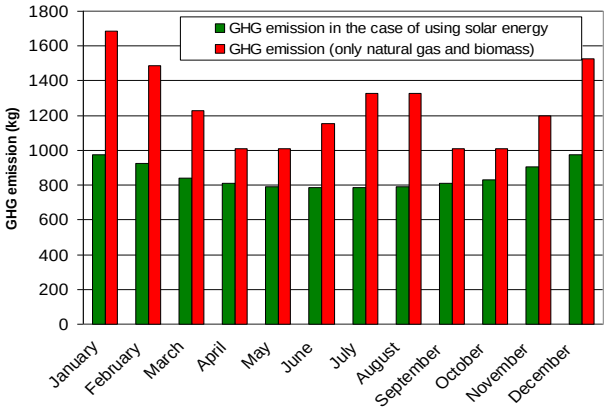

Fig. 4. GHG emissions of the m-CCHP system.

The use of solar energy in the m-CCHP system leads also to savings in fuel cost. Taking into account that in Romania the fuel costs are: 0.032 €/kWh for wood pellets and the 0.028€/kWh for natural gas, result a total reduction of fuel cost of about 722 €/year.

V. Conclusions

The total amount of energy saved in a year by using solar energy is of 2060 $kW_{el}h$ and of 15656 $kW_t h$. The reduction of GHG emission is of 4709 kg $CO_{2\text{-eq}}$, which means a reduction by 31.98%. The reduction of fuel cost is of 722 €/year.

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European Union Emissions Trading System with Regard to Climate Change Mitigation in Latvia

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Key words: tradeable permits system, European Union Emissions Trading System, greenhouse gas emissions.

I. Introduction

Latvia is included in the framework of the European Union Emissions Trading System (EU ETS). The goal of the paper is to analyse the volumes of greenhouse gas (GHG) emissions from the EU ETS participants in Latvia in relation to their participation therein. For these purposes the methods of statistical analysis, as well as the results of previously performed survey are used [7].

II.EU ETS as a Climate Change Mitigation Measure

The EU ETS is a tradeable permits system. A tradeable permits system is an economic instrument that establishes a tradeable permits market with the aim at minimal costs to achieve the rationalization of the volumes of certain assets denoted by permits. Tradeable permits within the EU ETS denote volumes of GHG emissions and are called European Union Allowances (EUAs) [13].

III. EU ETS Implementation in Latvia

The largest source of GHG emissions in Latvia in 2004 was transport sector, but the total amount of GHG emissions from the EU ETS installations in Latvia was only 2 939 000 tCO_2e or 27 % from total GHG emissions.

The amount of total free-of-charge allocated EUAs in Latvia in 2005-2010 in general are considerably larger than verified GHG emissions thus creating significant surpluses of EUAs (Fig.2 in f.v.). In the 1st period Latvia's companies needed only around 70% of free-of-charge allocated EUAs, but in the first part of the 2nd period – around 92 % of EUAs.

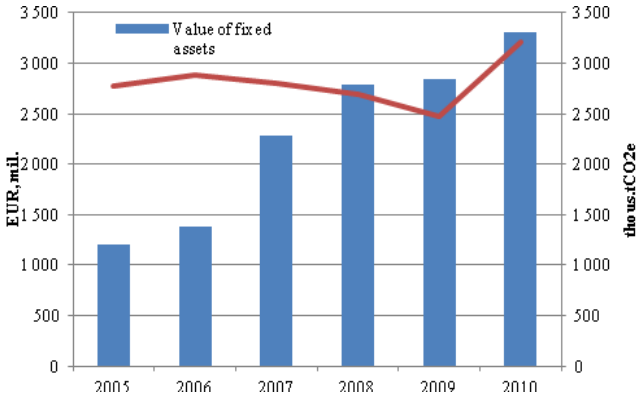

Fig. 1. Value of fixed assets of companies' participating in the EU ETS in relation to their GHG emissions

The author recognizes that considering on overall large over-allocation of free-of-charge EUAs, the EU ETS does not impose significant constraints on its participants in Latvia and mostly it is an opportunity to gain additional profits by selling surpluses of EUAs, i.e. due to sufficient free-of-charge allocations of EUAs, companies are not forced to invest in GHG emissions reductions and related technologies conversion or improvement. The total value of transactions in 2005-2007, according to author's estimations (assuming that the price of transferred EUAs is the average price of EUAs spot contracts and EUAs forward contracts with deliveries by the end of 2007, 2006 and 2005, if feasible, on the date of transaction), is 70 022 383 EUR (61 979 981 EUR for EUAs sold and 8 042 402 for EUAs purchased) and total income is 53 937 579 EUR (Fig.4 in f.v.).

IV. EU ETS Impact on Its Participants' GHG Emissions in Latvia

There is a strong correlation between the value of fixed assets and GHG emissions in 2005-2010. The author recognises that this strong correlation most likely is due to the investments in technologies improvements or conversion from energy resources with relatively high GHG emission factor to energy resources with relatively low or "zero" GHG emission factor. Moreover, 79% of respondents in the survey answered that the EU ETS has either slightly or significantly promoted GHG emissions reduction in their company particularly (Fig.10.).

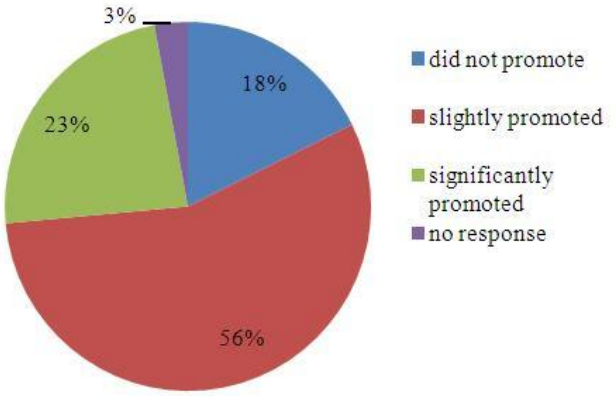

Fig. 2. Summary of responses to the question "How much did the participation in the EU ETS promote the GHG emissions reduction in your company?" (percentage of total number of respondents).

The author concludes that in Latvia the EU ETS in 2005-2010 was not a strong incentive for GHG emissions reductions. At the same time, however, the EU ETS has been one of the arguments in favour of the reduction of GHG emissions.

V. References

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Evaluation of the Energy Performance of the Modeled Solar Cooling System under Latvian Climate Conditions

Dzintars Jaunzems (*Riga Technical University*)

Keywords **– Energy performance, solar cooling system, system modeling, assessment of economic and environment impact.**

I. Introduction

Europe 2020 is the EU's growth ambitious strategy for the coming decade. Each Member State has national targets to reach in the climate and energy sector.

Solar cooling systems are an attractive technology to cover cooling loads [1,2]. However, in Latvia these systems are not known and are generally not considered feasible.

II. Description of the Work

Simulations of solar cooling system to cover research target building cooling load in Latvian climate conditions have been done in this paper.

A. Research Target Building

The research target building is a typical three-storey building in Latvia with a relatively small proportion of transparent building envelope (~11%) and simple architecture. It is an office building with a ceiling height of 3 meters. The total usable floor area is ~ 772 m^2, where the cooling load is required only for 524 m^2. The amount of air in the building is equal to 1262 m^3/h, and the air exchange rate is 0.545 h^{-1}.

Average building heat gain is 6 W/m^2. Maximum cooling load $Q_{c,max}$ is 17,8 kW_c, cooling load duration t_c is 692 h/year and specific building cooling energy consumption $Q_{s,c}$ is 6,97 kWh_c/m^2 per year where the defined indoor temperature of the building t_{set} equals 24 °C.

B. Solar Cooling System and Simulation Model

In order to cover the cooling load of the building an absorption type cooling system available in the market with nominal cooling load of 20 kW_c was selected. Solar collector array was planned to cover 80% of total heat consumption of heat driven absorption cooling unit.

In order to provide solar energy fraction of 80%, a cooling equipment with 20 kW_c nominal capacity requires a 45 m^2 vacuum tube solar collector.

Thus the capacity of the solar accumulation tank depends on the solar thermal system and varies from 40 to 75 l/m^2. Heat medium flow is provided by a circulation pump (max flow is 200 kg/h).

In order to provide the stated fraction of 80% of solar energy in Latvian climatic conditions, the specific area of the installed solar collector varies from 3-5 m^2/kW_{cold}, depending on the type of the collector.

The TRNSYS simulation program was used to simulate the solar cooling system and evaluate its operation. This simulation program has a modular structure which makes it possible to divide the existing system into mutually connected components (solar collector, cooling unit, etc.), see Figure 1. Each component is simulated separately using mathematical relations available in the TRNSYS data base or which can be developed using different data processing programs or programming languages e.g. MS Excel, Matlab or C++.

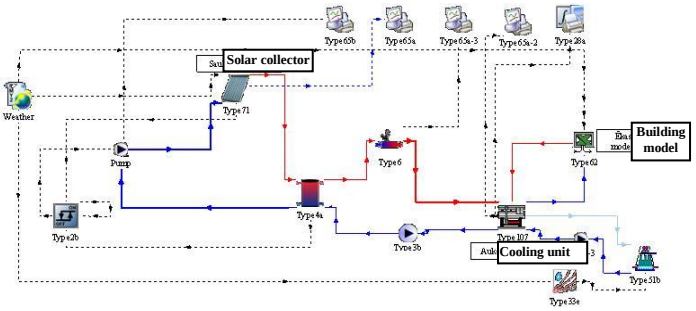

Fig. 1. Diagram of simulated solar cooling system in the environment of TRNSYS simulation program

III. Evaluation of Solar Cooling System Modeling Results

The results of the simulation analysis showed that solar thermal energy can cover a significant part of the thermal energy needed for the cooling equipment from the technical and energy aspects.

Figure 2 shows the temperature and cooling equipment heat load fluctuations of a simulated solar collector with 45 m^2 area. If the solar thermal system had a smaller heat collector area or flat solar collectors were used, an additional heating source would have to be used to ensure the necessary temperature level for the cooling equipment.

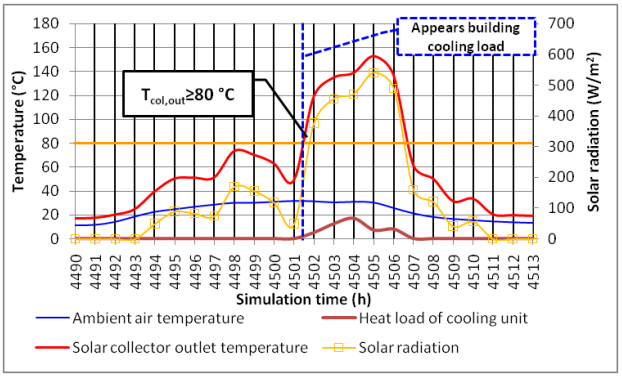

Fig. 2. Required changes in heating load of cooling device and supply temperature of solar collector (area 45 m^2)

A solar thermal system with a 45 m^2 vacuum tube solar collector is able to provide the required temperature level for the cooling equipment and cover almost 4200 kWh i.e. 80% of all the heat energy required for the cooling equipment.

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Framework conditions for heat use from biogas plants in Europe

Ilze Dzene, Claudio Rochas (*Riga Technical University*)

***Keywords* – biogas, heat, market conditions, CHP, efficiency.**

I. Introduction

In many European countries the production and use of biogas is increasingly recognized as a suitable and sustainable energy option in a renewable energy mix. Most biogas plants produce electricity in combined heat and power (CHP) plants due to technical availability of CHP systems and according support measures like electricity feed-in tariffs. However, in many cases these plants are not, or only partially, operated in CHP mode. The problem of how to efficiently use heat from biogas plants at the European, national and local project level is addressed by the BiogasHeat project (Development of Sustainable Heat Markets for Biogas Plants in Europe) which is supported by the Intelligent Energy for Europe Programme of the European Union (EU) [1].

One of the first tasks of the BiogasHeat project was to describe framework conditions for heat use from biogas plants in different European countries. In this paper a summary of regulations on biogas heat use in nine EU countries is provided.

II. Framework conditions for biogas heat use in EU countries

Several countries are now beginning to introduce incentives or obligations to use this waste heat, which would considerably improve energy efficiency and sustainability of biogas plants. The following chapters present the situation on heat use from biogas plants in nine BiogasHeat target countries: Latvia, Germany, Croatia, Czech Republic, Italy, Poland, Austria, Denmark and Romania.

A. Latvia

More than 30 biogas CHP plants are currently operating in Latvia. Existing legislation is not requiring efficient use of heat, except the case when biogas producer qualifies for the mandatory purchase of electricity following the feed-in tariff regulations for cogeneration plants. In that case the sound heat use is required in order to fulfill the efficiency criteria set by the respective regulation.

B. Germany

Germany with more than 7000 biogas plants is the largest biogas producer in Europe. In the past, the heat from biogas CHP plants was often only used for selfconsumption, and most heat was wasted. In 2009, the Renewable Energy Act (Erneuerbare-Energien Gesetz – EEG) [2] was improved and included dedicated incentives for the use of heat from biogas (CHP bonus). In 2012, newly installed biogas plants are required to use at least 25% waste heat during the first year of operation and at least 60% heat in the following years.

C. Croatia

There are eight biogas plants operating in Croatia. The heat produced in biogas plants is only occasionally used for own purposes. One of the reasons behind this is lack of incentive fees for heat or other mechanisms to stimulate its use. Recently adopted new feed-in tariff system is setting a new requirement for biogas plants above 300 kW_{el} of a minimal annual total plant efficiency of 50% to qualify for the feed-in tariffs.

D. Czech Republic

More than 220 biogas plants are operating in Czech Republic. In most cases heat from the biogas-CHP plants is wasted. To change the current situation and to make better use of heat, changes will be required in public support schemes and tariff policy.

E. Italy

More than 300 biogas plants are installed in Italy. The incentives for the heat use from biogas are represented by the Energy Efficiency Certificates (TEE), also known as white certificates: these are negotiable securities that certify energy savings in the end use of energy.

F. Poland

In Poland 12 agricultural biogas plants are operating. Most of the heat from biogas CHP plants is wasted. Existing legislation is not requiring efficient use of heat.

G. Austria

There are about 600 biogas plants in Austria. Support for renewable energies is regulated by the Green Electricity Act 2002. In 2009 the Act was amended and a minimum efficiency of 60% for biogas facilities was introduced.

H. Denmark

In Denmark there are over 180 biogas plants. Heat from biogas plants is used in district heating systems. A biogas plant without heat use would not be economically feasible in Denmark.

I. Romania

There are only few biogas plants in Romania, but many new plants are in planning phase. Existing legislation is not requiring efficient use of heat.

III. Conclusions

The viability of a large number of biogas projects in Europe is merely based on support mechanisms for electricity, like for example feed-in tariffs. In relation to these electricity support schemes, the simultaneous use of heat is often not considered. Biogas industry needs examples, business models and strategies to foster the use of heat from biogas plants. In most of the EU countries the appropriate policies to enhance heat use from biogas plants is lacking.

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Future energy efficiency benchmark for renovated multi-apartment buildings

Krista Kļaviņa, Claudio Rochas *(Riga Technical University)*

Keywords **– Ventilation heat loss, air change rate.**

I. Introduction

The majority of Latvian housing stock, mostly apartment buildings, was built from the year 1955 to 1992, after the World War II. 77 % of Latvian population lives in apartment buildings. The heat insulation properties of these buildings initially were below the present requirements; as a result of property fragmentation most buildings are not sufficiently managed and need urgent renovation. The average specific heat consumption in households is 220 to 250 kWh/m^2 per year. It is reflected in the national energy consumption structure, household sector is responsible for 33 – 44 % of the total energy consumption, but more than 70 % of the total heat consumption.

II. Renovation Experience

It can be assumed that the apartment building renovation experience in Latvia has begun in the year 1999 when a prototype multi-apartment building renovation was created in Latvian – German cooperation, proceeding with several apartment building renovations. In these buildings 45 to 55% space heating energy savings were achieved. [1] Similar savings were planned for independently carried out renovations but the actual results ranged from minus 3,3 to 35,7%. It was found that these failures were a result of faulty construction work. [2]

The implemented renovation works can be divided in three main groups – exterior wall, basement and attic or roof insulation; hot water system renovation; space heating system renovation. There has been no case of ventilation heat recovery implementation in a multi-apartment building renovation. However its potential has not yet been studied.

III. Latest Renovation Results

The present multi-apartment building renovation quality and energy efficiency level that is obtained can be seen in Figure 6.2.

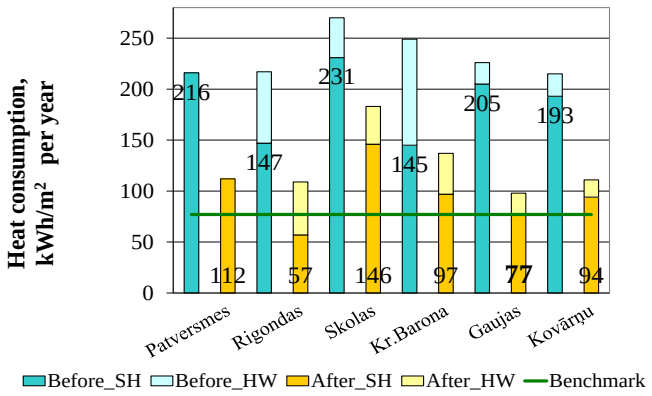


Fig. 1. Specific heat consumption benchmark

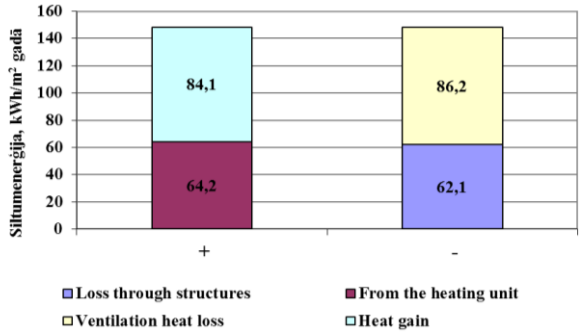
The savings in space heating for renovated buildings on average is 49 %. However the space heating cannot be analyzed separately because in most cases part of the domestic hot water is used for bathroom space heating. There are some projects where this has been corrected (Kr. Barona, Gaujas, Kovārņu in Figure 6.2.). In these cases the measured space heating consumption reflects the actual situation. Thus 77 kWh/m^2 per year is seen as the highest energy efficiency attainable in a renovation using contemporary methods.

IV. Ventilation Potential

The next step is to find a way to do even better. It is noticed that the heat potential in the effluent ventilation air is unknown. So a study is carried out using IVL 10 and IVL 10-N air flow and temperature transmitters in a renovated multi-apartment building.

First, it was noticed that the assumed natural ventilation in a multi-apartment building is strongly affected by the mechanical ventilation from the individual apartments and forms a different behavior that is dependent on the activity of the inhabitants not just the outside temperature.

Next it was found out that in this particular case the building is hyperventilated. The average air change rate is 1.11



h^{-1} when in such a building it should be around 0.88 h^{-1}.

Finally the heat balance of the building was made, see Figure 6.3.

Fig. 2. Building heat balance

The ventilation heat recovery is a vide subject and the recovered heat proportions and the possible efficiency has to be further studied. It is not possible to have maximum recuperation efficiency in a building that is not built for such purpose so for the sake of creating a provisory value for the future renovations it is assumed that half of the ventilation heat loss could be recuperated giving a new building energy efficiency benchmark **38 to 42 kWh/m^2** per year.

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Historic brick building exterior wall insulation materials

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Keywords **–historic brick buildings, energy efficiency, heat flow measurement, hygrothermal modeling, masonry**

I. INTRODUCTION

In Latvia there are a great number of old brick buildings of historic value and which is an evidence of the architecture of that time. These buildings are monuments of masonry traditions and culture and a significant part of housing stock. With building standards becoming ever higher, old buildings struggle to keep up. To reduce energy consumption of old buildings, an increase of heat resistance for envelope is required. This study is done within ES ERAF BSR co – financed Project "Cool Bricks – Climate change, cultural heritage and energy efficient cultural monuments." Project aims are to find new solutions to bring old brick buildings to existing energy efficiency standards without losing their historic value.

II. INTERIOR THERMAL INSULATION SYSTEM

From energy efficiency point of view, decorative facades create excess surface, leading to increased heat losses and some elements become more exposed to environment effects. Decorative elements are also limiting insulation application possibilities. Firstly, exterior insulation cannot be applied, as original look must be kept, secondly, if exterior wall has air gap, drilling holes could be forbidden by heritage commission, leaving interior insulation as only choice.

One of the problems of interior thermal insulation systems is that thermal bridges cannot be fully eliminated, as usually not all interior walls can be insulated because some interior may be of historic value. Other problem is that interior insulation decreases temperature in exterior wall that can lead to faster deterioration of bricks and mortar in cold climate due to freeze-thaw cycles.[1]

III. INSULATION MATERIALS

Insulation material choice is affected by construction of wall – thickness, materials used, drying capacity, possible air gaps and parameters – U value, material heat conductivity and others.

Thermal insulation materials and vapor/air barriers must be looked at together with predicting insulation layer effects on existing wall and determining if there is possible increase in moisture level in walls, too low temperatures at outer surface during the cold part of the year, moisture accumulation in rooms, mold growth or other introduced changes.

To decrease moisture level in wall, vapor barrier must be used, where latest technology involve barrier that change permeability when seasons change, increasing drying rate. To increase outer surface temperature, thickness of insulation must be calculated so that heat flow through the wall is reduced, but temperature drop is acceptable. Moisture accumulation in rooms occurs when buildings become air tight for energy saving reasons and proper air ventilation is not installed. One of solutions is to install ventilation, that require relatively more funds then other solution that would be to install dehumidifiers. Lateral is cheaper, but not a solution for bedrooms as they are too loud.[2]

IV. HYGROTHERMAL MODELING

Hygrothermal modeling can be carried out with thermal and moisture transfer software like WUFI that uses climate and material data to calculate temperature, moisture and dew point layout in two-dimensional elements. Modeling must be done till time period of 10 years to see, if moisture levels are increasing or decreasing, where the former could mean that insulation system must be changed and the latter that the tested insulation materials are appropriate. In same manner, temperature layout can show if chosen insulation thickness is too thick. Dew point is indicator of combined moisture and temperature layout and can also help to determine where moisture level is more likely to change.

Quality of simulation is related to input data of materials and climate. Therefore creation of database for masonry materials in Latvia is needed.

Simulations with software can help to reduce cases, where too thick insulation or wrong construction is applied and wrong materials used for refurbishment of old buildings.

V. RESULTS

It can be concluded, that the use of different insulation material is acceptable, but great care must be taken to insure necessary drying potential of wall. Heat and moisture transfer software modeling for long term can be used to provide additional security.

VI. FURTHER RESEARCH

Heat flow measurements are planned for brick wall with interior insulation, using traditional and state-of-the-art thermal insulation materials.

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Industrial Research of Condensing Unit for Natural Gas Boiler House

Jelena Ziemele, Dagnija Blumberga, Ilze Laicāne (*Riga Technical University),* Normunds Talcis(*JSC Rīgas Siltums)*

Keywords **– condensing economizer, energy efficient, latent heat, flue gas.**

I. Introduction

Each EU member state has to reach energy and climate target in 2020 by improvement of energy efficiency and use of renewable energy [4].

One of the most important aspects of energy and ecoefficient solutions is compliance of environment protection requirements. As one of the key measures to improve energy efficiency of existing boilers is by utilization of flue gas heating.

Analysis of data of flue gas condensing unit in boiler house and results of industrial research work are carried out with the 10 MW condensing economizer, installed behind the natural gas fuelled 116 MW water heating boiler KVGM 100 in SC "Imanta".

II. Industrial Experiment Description

A condensing economizer is classic tubular heat exchanger used for heat transmission from hot heat-transfer agent (flue gas) to cool (heating network water) [2]. The economizer is installed in the boiler's KVGM-100 flue gas channel and is placed between the fan and chimney. The return water from district heating (DH) network is used as heat-exchange agent in economizer. The circulating water is heated up by absorbing physical and condensing heat energy.

The framework of industrial experiment includes number of measurements which are illustrated in Table I.

TABLE I
INDUSTRIAL RESEARCH DATA

Parameter	Measurement unit	The measuring range	Designation scheme
Temperature before the economizer	^{0}C	36,8 – 55,9	T_2
Temperature after the economizer	^{0}C	41,2 – 58,6	T_2'
Flue gas temperature before the economizer	^{0}C	68,1 – 127,0	T_3
Outdoor air temperature (the average daily)	^{0}C	(-20,3) – (+21,1)	$T_{āra}$
Economizer heat production (per month)	MWh	410 - 4400	Q_{eko}

III. Regression Analysis of Data

Regression analysis methods are used for statistical processing of industrial research data. Regression analysis designates random variable changes in precise quantitative parameters – importance of stochastic links expressed with functional correlation. In result of regression analysis is possible to obtain quantitative parameters for statistical correlation closeness of the independent and dependent random variables and determine regression coefficients [3].

One of many correlations is found between return water temperature versus outdoor temperature and it partly confirms the qualitative control of DH system. When parameters obtained in the coldest month are expressed separately, it is possible to conclude that with decreasing outdoor temperature network return water temperature increases (Figure 5).

Correlation expressed in the form of linear regression equation.

$$t_2 = -0{,}8183 t_{arg} + 39{,}485 \qquad (2)$$

where

t_2 – water temperature of the return network, °C;

t_{arg}- outdoor air temperature, °C.

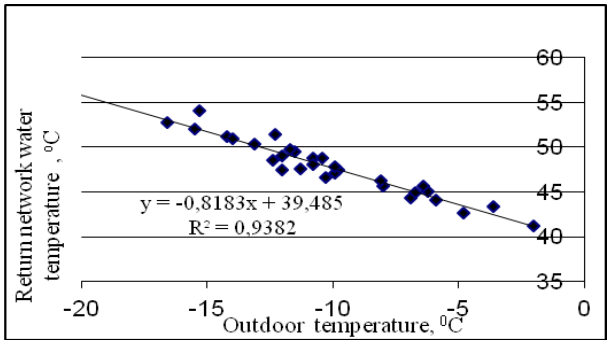

Fig. 5. Return network water temperature versus outdoor temperature in January 2010

As result of work there is graphically reflected empirical dependence obtained by regression analysis: capacity of condensing unit versus outdoor temperature. Characteristics for more effective work of condensing unit present several linear equations on the basis on these data.

IV. Conclusions

1. The considerable increase of the return network water temperature according to graphic of heat supply network temperature is the factor that restricts the latent heat output at low outdoor temperature. If return network water temperature is higher than 52 ^{0}C, economizer stops functioning in condensation mode and heat production decreases by 43%, in comparison to mode where temperature is 42 ^{0}C

2. The most efficient operating mode of economizer, as it was established during experiment, is that with the boiler load 92 MW, which is close to nominal, and economizers load accordingly 8,5 MW.

3. Use of condensing economizers allows to save 5,4 million n m^3 of fossil fuels and reduce carbon dioxide emissions by 10290 tons or 7% during the period from January 2010 to December 2011.

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Energy planning model in small size municipalities

Marika Rošā (*Riga Technical University*)

Keywords **– energy planning, energy action plan, priorities, municipalities.**

I. Introduction

Energy action plan is an integral part of the regional development planning documents. It includes simultaneous development of separate energy system elements. Energy action plan is like guidelines that outlines the path for future development.

If energy planning is viewed as an opportunity analysis, then it is an issue of the selection of the most appropriate engineering solution today, tomorrow and in more distant future, as well as the issue of the economic justifiability of chosen technology, looking not only at possible sources of funding, but analyzing internal savings and profits as well [1].

II. Methodology

Methodology for the establishment of energy action plan includes current situation analysis and energy development hypothesis based on assumptions and priorities. Energy plan should include calculations, which confirms that technological solutions are economically sound and environmental impact, in case of implementation of the suggestions, is minimal.

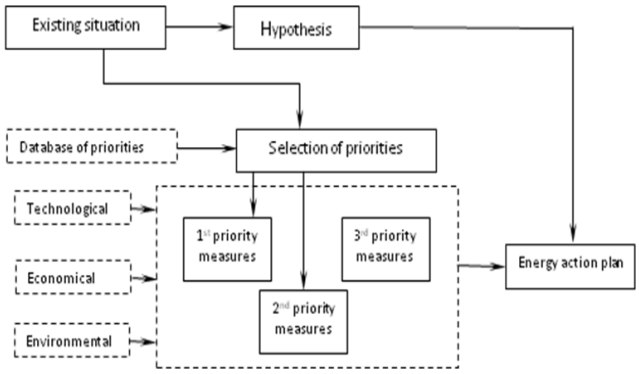

Fig.1. Algorithm of energy action plan methodology

Energy planning in present stage tends to focus on the operation of activities and energy efficiency improvement opportunities of systems in local municipalities. The energy action plans must be sustainable and based on main directions of energy planning at national and regional levels, as far as possible evolving innovative and energy efficient power generation from renewable sources. However, greater emphasis has to be put on the improvement of energy efficient consumers. For the maintenance of energy-efficient power transmission system, it is very important to set goals. In the database of priorities, measures are arranged according to features, mainly based on principles of balancing savings and expenses in short-term and long-term periods.

Sustainable energy planning in municipality level (district) is closely linked to promotion of renewable energy within electricity generation, heating and cooling and power supply safety, energy efficiency increase in products and services sector and buildings, which is one of the main directions for the development of energy and climate policy in the European Union.

III. Existing situation and hypothesis

Energy consumption forecast of municipality is based on the assessment of current situation. Several years of statistical data provides information about future prospects. On the basis of that and experience of the experts it is possible to make assumptions about forthcoming reduction in energy consumption. For example, realization of residential building renovation projects over several years has provided us with the information that achieved energy savings will most likely be of 30 - 50%. This will happen within the period of next 5-10 years. Similar approach is also used for energy development of other sectors. The bars represent current energy consumption in one district, but the situation after 18 years represented by horizontal lines. See figure 2.

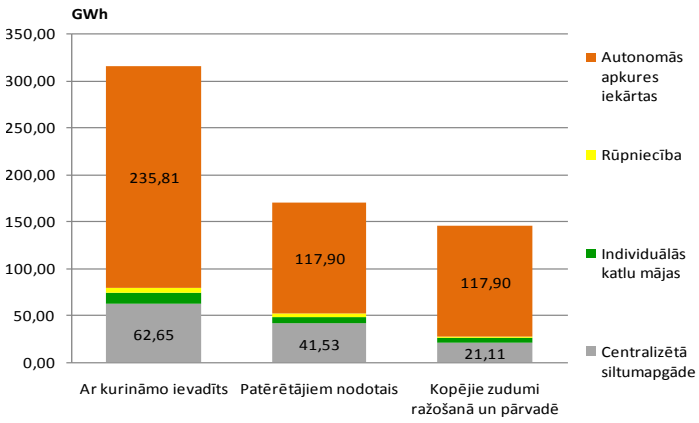

Fig.2. Example of forecast of future development of energy consumption

Energy planning is a cyclic process that includes consultations with all involved parties and regular changes in many previously made decisions, rather than linear sequence of steps. This means that energy action plans requires adjustments every 3-5years.

IV. Conclusions

Formation of the development hypotheses for the district energy sector has to be based on current situation analysis; therefore the analysis of current situation must be included in district energy action plan. The measures that are not only economically profitable, but also helps to convince consumers of the advantages of energy saving, have the highest priority.

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Influence of Temperature and Pressure Change on Adiabatic and Isothermal Methanation Processes

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Marco Klemm, Isabel Kiendl (*Deutsches BiomasseForschungsZentrum*)

Keywords **– biomethane, adiabatic and isothermal, methanation, SNG, thermodynamic equilibrium modeling, renewable energy sources.**

I. Introduction

Energy plans of many countries anticipate an increased use of biomethane for energy supply, i.e., in power and heat production as well as in the transport sector. Existing infrastructure of natural gas storage, supply and application provides a good platform for transfer to biomethane utilization on a larger scale. Upgrade of biomass-derived synthesis gas, originating from different sources, to the quality of natural gas (SNG - Synthesis Natural Gas) via methanation process for further injection into the natural gas grid is one key element of the biomethane system. Maximisation of efficiency of the methanation process is of critical importance in order to make the biomethane technology viable for wider application. The aim of the study was to improve efficiency of methanation process by finding the optimum temperatures and pressure. Theoretical modelling of adiabatic and isothermal methanation processes by using thermodynamic equilibrium calculations was employed as a method for the study. The results show the impact of temperature and pressure changes on the overall efficiency of the methane production. It can be concluded from the study that knowledge about relation between temperature, pressure and the efficiency of the methanation process gives a possibility to optimize the process under various biomass synthesized gas input conditions.

II. Used Methods

The methane production from biomass can occur in two ways and, depending on the chosen extraction method, the operation conditions and the final products can vary [0]:

a) thermo-chemical conversion of biomass, leading to biomethane;
b) bio-chemical conversion of biomass, leading to bio-gas.

The main differences between these two methods are that during the thermo-chemical conversion biomass gasification is followed by the methanation process, but bio-gas production occurs during the anaerobic digestion of biomass [0].

Methanation technologies are being developed and researched since approximately 1950s. Fixed bed or adiabatic methanation technology was developed to achieve needed heat condition and to extend the use of catalysis. By the use of fluidized bed methanation reactor it is possible to achieve practical isothermal conditions and in the same time by isothermal methanation the synthetic gas and fluidized bed reactor working material are better mixed than by fixed bed methanation reactor [0].

The adiabatic (Figure 1) and isothermal (Figure 2) methanation processes were studied by using thermodynamic equilibrium models and with help of Aspen Plus® software. This program is intended for modelling chemical processes and their detailed analysis, as well as the determination of the mass and energy balance.

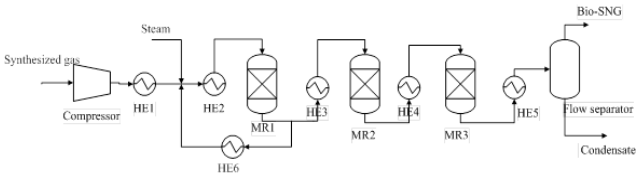

Fig. 1. Process scheme of adiabatic methanation (HE – heat exchanger, MR – methanation reactor).

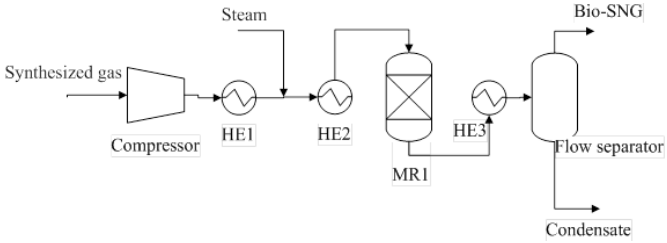

Fig. 2. Process scheme of isothermal methanation.

The ranges of values of the pressure and temperature used in the modelling of both processes are shown in Table I.

TABLE I

THE RANGE OF VARIABLE VALUES OF PRESSURE AND TEMPERATURE, WHICH ARE USED IN THE MODELLING OF BOTH METHANATION PROCESSES

Parameter	T, K	P, bar
Adiabatic metanation	513 - 873	2 – 100
Isothermal metanation	373 – 673	2,5 - 20

III. Conclusions

The results of this work indicate that the temperature change has a greater impact on the outcome of methane in adiabatic methanation than the pressure change. Comparisons of influence of pressure changes on isothermal and adiabatic process allow concluding that in adiabatic methanation, by constant incoming temperature, methane outcome downstream of the first and second reactors increases with the pressure increase.

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Necessary amount of spray water for optimal flue gas condenser operation

Gundars Galindoms, Ivars Veidenbergs *(Riga Technical University)*

***Keywords* – Flue gas condenser, optimization, heat utilization.**

I. Introduction

A calculation model was developed to determine optimal flue gas condenser operation modes in evaporation and condensation zones. One of optimization parameters that could be changed is amount of water to be spayed into flue gases. Optimal amount of spraying water was determined in various boiler operation modes.

II. Methodology

It is significant to recover heat from outgoing flue gases in boiler house. It is done using direct contact heat exchanger where water is sprayed into flue gases [1]. Unit consists of two parts - evaporation part where water is sprayed into hot flue gases to decrease its temperature and increase moisture content and condensation part where cooler water is sprayed into moistened flue gases to provide condensation thus recovering latent heat of phase change. This helps to reduce fuel usage and cleans and dries outgoing flue gases.

The calculation model and optimization software was developed to calculate optimal operational modes of condenser [2]. Main goal of evaporation part of the unit is to achieve maximum possible moisture content in flue gas in the end of evaporation part at specific flue gas temperature. Main goal of condensing part is to get highest possible condenser power at the bottom part of the unit [3]. In both parts there is a parameter that can be changed to get various output results and it is amount of sprayed water. This parameter was used as changeable optimization parameter.

III. Results

Optimization calculations were performed using different boiler house output power values and corresponding gas flow rates and moisture content in flue gas values. Also various sprayed water temperatures in evaporation and condensation parts were taken into account in calculations.

Optimization results of evaporation part shown in Fig. 1.

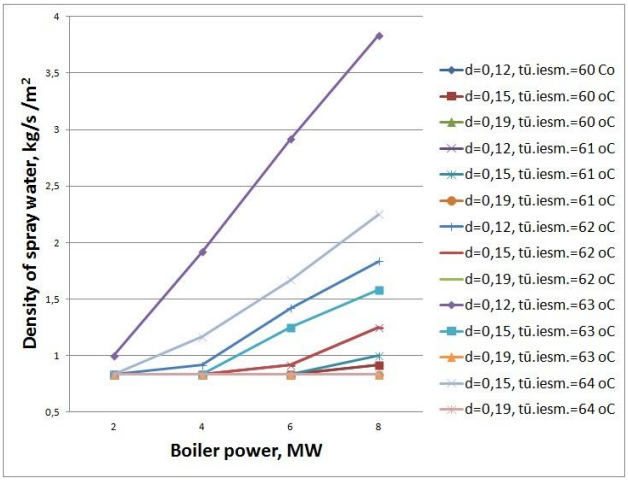

Fig. 1. Density of water in optimal evaporation part operational modes.

Density or necessary amount of sprayed water increases when boiler power increases and if temperature of spaying water increases.

Optimization results in condensation part show that the calculations for the necessary amount of sprayed water displayed optimal results. This can be seen in figure 2. It can be seen that density of sprayed water varies from 12,4 to 13 kg/s m^2 or it is 43 to 45 kg/s in all used operational modes of boiler house.

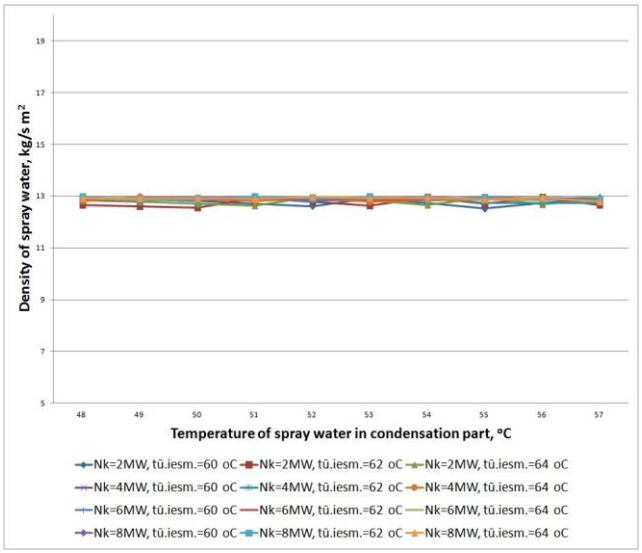

Fig. 2. Density of water in optimal condensation part operational modes.

It can be seen that while the determined amount of water to be sprayed is taken into account during operation, optimal performance of condenser unit can be achieved and water amount change into those determined boundaries does not significantly influence condenser unit output.

IV. Conclusions

Amount of necessary amount of water to be sprayed to achieve optimal heat exchanger operation modes was determined for both - evaporation and condensation parts of the unit. To achieve optimal operation mode in evaporation part necessary amount of water increases by increasing boiler power if temperature of sprayed water increases. To achieve optimal operation mode in condensation part increase of boiler power and fluctuation of sprayed water temperature does not significantly influence condenser output. The amount of water sprayed should be within determined values.

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Optimization of existing office buildings. Integration of photovoltaics and shading devices

Linda Drukmane , Claudio Rochas *(Riga Technical University)*

Keywords **– existing office buildings, photovoltaics, shading devices.**

I. Introduction

Office buildings are often equipped with glass facades, which cause discomfort to people working in buildings because the space becomes overheated. It is possible to install external shading devices in order to avoid such a situation and to reduce solar radiation and overheating during summer. These installations are more effective if compared with internal devices.

A lot of low quality office buildings were constructed during economical growth. Architectonic solutions for building, e.g., glass facades cause significant impact of heating and cooling consumption.

The aim is to find the possibilities how to reduce energy consumption and optimize the system if photovoltaics and shading devices are used.

II. Technologies

Both new projects and renovation of existing buildings, BAPV and BIPV technologies are effective in residential, commercial and industrial buildings. If a solar shading device is used to avoid unwanted solar gains in a building, PV panels can be used as part of the shading device.

A. Building Applied Photovoltaics (BAPV)

BAPVs are added devices that provide additional functionality to an existing building. PVs can be installed on roofs as wall panels, semi-transparent facades etc [1].

B. Building Integrated Photovoltaics (BIPV)

BIPV are integrated devices that replace usual devices providing structural integrity of the building. Possibilities for BIPV application can be following – windows, roofs, facades, skylights etc [2].

III. Shading devices and placement of PV modules

There are usual shading devices that are made from aluminum, wood, glass etc. or PVs that have a double effect – prevent space from overheating and at the same time can produce energy.

3 types of shading devices are available – without shading, with fixed shading and dynamic shading.

Important parameters are the height of windows, the type of shading device and orientation of building [3].

IV. Methodology and Optimization

A. Methodology

An algorithm of optimization system has been made based on [35]. *TRNSYS* software model has been developed. It gave results about heating and cooling consumption and temperature graph. Then *STATGraphics* software was used to statistically process the data. Correlation graph was developed as well. To optimize the system, *MSExcel* was used and optimal parameters for system were found.

B. Optimization

To optimize the system there is a need to make changes of 3 operational parameters:

- the length of shading device;
- the gap between the window and shading device;
- the number of installed PV's.

V. Results

As a result of the performed optimization measures the system works at its best if:

- the length of shading device is 1,5m;
- the gap is 0,16m;
- the total area of PV is 2704 m^2.

In this case the net present value (NPV) of the system is 535 884 Ls and investment cost equal to 561 316 Ls.

It has to be mentioned that the data for the case with shading device was selected as a random number, but the graph shows the trend that it is possible to reduce cooling demand and that also means the reduction of costs.

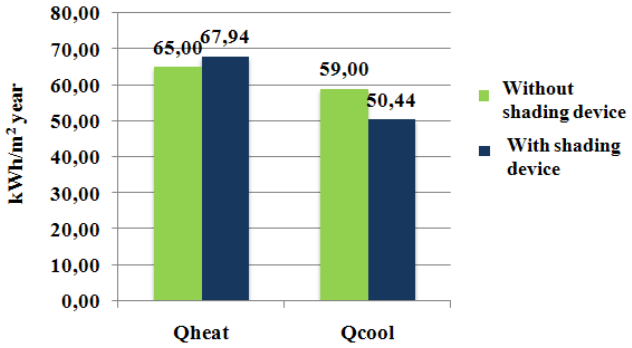

Fig. 1. Comparison of heating and cooling demand with and without shading devices

VI. Conclusions

The building model has 2 scenarios – without shading device (reference case) and with shading device that produces electricity as well.

The 3 operational parameters mentioned before have a good correlation with NPV.

In this case it was assumed that cost of PV system was 246 Ls/m^2. And for this example an optimum was reached if part of shading elements is covered with PV.

The costs of PV systems are still high but in recent years a tendency of price reduction for such systems has been observed.

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Performance of the Solar Combisystem in Function of the Flow Rate in the DHW Recirculation Loop

Aivars Žandeckis, Dagnija Blumberga, Claudio Rochas *(Riga Technical University)*

Keywords **– solar combisystem, DHW preparation**

I. Introduction

European Commission Directive 2009/28/EC set an ambitious but reachable target – to raise renewable energy share of gross final energy consumption in European Union to 20% till 2020. Latvian target within the Directive is to reach 40% renewable energy share of gross final energy consumption. According Central Statistical Bureau of Latvia in Latvia 70 % of the total heat energy produced in the country was used for household purposes in 2010. The increase in price for fossil fuels has forced households to consider alternative heating systems.

This study is a part of the optimization of a new solar and pellet thermal system installed for a multifamily building in Latvia. The goal of the study is to analyze the influence of flow rate in the district hot water (DHW) recirculation loop on performance of the solar combisystem.

II. Methodology

The methodology used is based on TRNSYS dynamic simulation and parametric study. Simulation model describes experimental combisystem and is validated by Žandeckis *et al* [1]. Characterization and evaluation of performance of the combisystem is done using fractional solar consumption (FSC) methodology. The optimization criteria are fractional thermal energy savings by solar energy.

In the studied system DHW preparation is organized by using external heat exchanger (HEX) (see Fig. 1). *Bales* un *Perrson* [2] stated that use of external heat exchangers is more beneficial in comparison with integrated HEX.

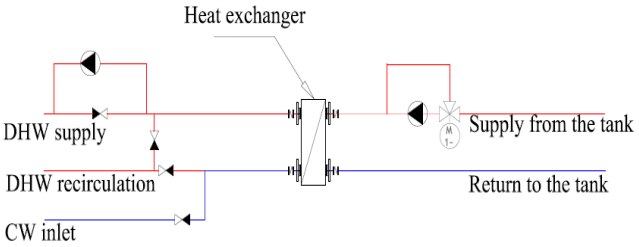

Fig. 1. Principal scheme of the primary and secondary DHW loops separated by heat external heat exchanger

Temperature in the bottom of the accumulation tank is a function of the return temperature on the cold side of the heat exchanger. Return temperature is depending from the four parameters and is calculated according equation (1).

$$t_{dhw.hexC.rt2} = \frac{m_{dhw} \cdot t_{cw} + m_{dhw.rec} \cdot t_{dhw.hexC.rt}}{m_{dhw} + m_{dhw.rec}} \qquad (1)$$

where,

$t_{dhw.hexC.rt2}$ – return temperature, cold side of the HEX, ºC;
m_{dhw} – DHW consumption, kgh^{-1};
t_{cw} – temperature of cold water, ºC;
$m_{dhw.rec}$ – flow rate in the DHW recirculation loop, kgh^{-1};
$t_{dhw.hexC.rt}$ – temperature of recirculated DHW, ºC.

Flow rate m_{dhw} is defined by the hot water consumption. Temperature of inlet cold water (t_{cw}) typically is below 10 ºC and mostly depending only from outdoor temperature. Low temperature of cold water is defining potential for performance of solar thermal systems. By reducing flow rate $\dot{m}_{dhw.rec}$ it is possible to reduce temperature of recirculated hot water. However because of bacteria growing risk it is required to keep $t_{dhw.hexC.rt}$ value above 45 ºC.

III. Results

Flow $\dot{m}_{dhw.rec}$ is the main factor that determinates temperature at the bottom of the tank (t↓) and performance of solar collectors, see Figure 2.

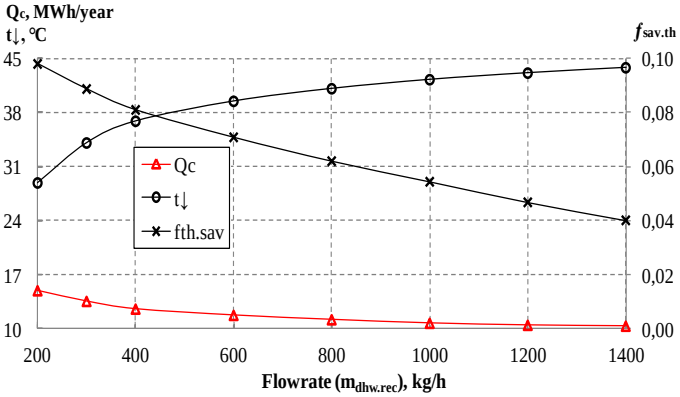

Fig. 2. Changes in energy production in collectors (Q_c), fractional thermal energy savings ($f_{sav.th}$) and temperature at the bottom of the tank (t↓) depending on flow rate in DHW recirculation loop ($m_{dhw.rec}$).

By reducing flow rate in the recirculation loop from 1400 kgh^{-1} to 295 kgh^{-1} an increase of 31 % or 3.21 MWh per year in energy produced by collectors was achieved. Heat consumption for hot water recirculation decreased by 20 % or 5.12 MWh per year. This leads to the increase of FSC value by 3 %-points. Taking into account the reduction of consumed heat energy $f_{sav.th}$ and $f_{sav.ext}$ values increased accordingly by 9.6 %-points and 9.5 %-points. In the experimental solar system $\dot{m}_{dhw.rec}$ value of 295 kgh^{-1} was set as minimum to prevent risk of bacteria growing.

IV. Conclusions and Discussions

Flow rate in DHW recirculation loop is a critical parameter affecting performance of every solar heating system. To high flow rate results low energy output from solar collectors and higher energy consumption for DHW recirculation. During optimization process lowest acceptable temperature in recirculation loop must be considered.

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PLA biopolymer production assessment. Case study

Rihards Rušenieks, Dagnija Blumberga *(Riga Technical University)*

Keywords **– biopolymers, polylactide, greener production**

In the history of humankind plastics first appeared on 1862, when Parkesine (celluloid) was discovered. Polymers experienced a huge leap in the middle of XX century with development of polyvinylchloride (PVC), polyethylene (PE) and polypropylene (PP). Since then polymers are used in almost every sphere of industry and life. Fossil-based polymers are durable against decomposition in environment. This aspect complicates polymer waste management and landfill disposal. Another issue is shortage of fossil resources. From this point of view fossil-based polymers are not sustainable option and new solutions should be found.

A step to the course of sustainability is bioplastic - a new generation biodegradable polymers, made from renewable resources. Currently biopolymers are used mainly in production of packing, shopping bags, disposable dishes, films, medical and hygiene products. Most of the biopolymers are biodegradable or decomposable in period of time defined by EN 13432 standards. By improving the characteristic of biopolymers, wider application of this material is expected. Amount of current world biopolymer production is 1% of all produced polymers (annually world produces 205Mt of polymers), however market grow is 30% in the year.

Goal of the authors' research was to study biopolymer production possibilities in Latvia, using local raw materials. Economic research was done as well.

Polylactide (PLA) biopolymer was chosen for study, which takes up 15% of produced biopolymers. PLA is biodegradable and is used in production of disposable dishes, food packaging and shopping bags. Supreme PLA manufacturer is USA company Natureworks LLC, which production capacity is 140 000 t/y in plant of Nebraska, Blair. New plant with designed capacity of 75 000 t/y is under construction in Rayong, Thailand.

Main PLA raw material is starch, which can be extracted from grain crops – fodder wheat, barley, potatoes, corn and sugar beet, as well as dry whey.[2]

Production process begins with extracting starch from raw material. Next step is obtaining dextrose from starch by enzyme hydrolysis. In this step macro molecules are separated through enzymatic addition of water. From dextrose lactic acid is produced by bacterial fermentation in water environment, continuously adding alkaline to preserve neutral pH environment. In this step huge amounts of byproduct – salt of lactic acid (sodium lactate) – is produced (1 mole of salt on 2 moles of acid or 1 kg salt on 1 kg acid). Lactic acid after several other phases of operations undergoes polymerization process. Two ways of polymerization can be used – direct condensation and ring opening polymerization. End-product is granules of PLA polymer, which can be further processed in making plastic products for end-consumers. PLA polymers can be processed in general polymer processing equipment and undergoes injection molding and extrusion exactly as fossil-based polymers.[3]

Each of PLA raw materials contains different amount of starch. It means different consumption of raw material for production of 1 kg PLA. Price is vital as well; therefore economic research was done for each type of raw material. PLA production demands huge amount of starch, so starch shall be produced *in situ*. Summary about production values is given in table (price in LVL; prices on May, 2012) [1].

TABLE 1

PLA RAW MATERIALS

Raw material (r.m.)	**Starch, %**	**Consumption of r.m., kg/kg PLA**	**Ls/kg r.m.**	**Ls/kg PLA**
Potatoes	18,1	8,51	**0,050**	**0,42**
Wheat	61,0	2,52	**0,125**	**0,32**
Barley	58,0	2,66	**0,118**	**0,31**
Sugar beet	17,0	9,00	**0,019**	**0,17**

Raw material is chosen, depending on availability and price at the given point in time. This option requests well developed logistics and supply management. Location of plant shall be in Rēzekne, which is determined by proximity of raw materials and woodchip for boiler house, as well as necessity and benefits of regional development.

Designed capacity of plant is 20 000 t/y. Currently the average market price of PLA is 1,5 €/kg. With this price NPV, IRR, profitability index (PI) and sensitivity analysis of project was calculated. Project life time was estimated as 10 years. According to the calculations done in the work, project pays off in period of 10 years and highest influence to NPV is created by end-product price.

Production shall be almost exclusively for export markets, however small amount of PLA biopolymers may be demanded in domestic market, as at least two companies are producing plastic products out of PLA. To increase competitiveness of biopolymer and to support penetration in foreign markets, Latvia should apply green tax policy, guided towards usage of renewable resources based plastics and decomposition.

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Policy instruments for increasing the use of wood fuel in Latvian district heating systems

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Keywords – Renewable energy, climate policy, policy analysis, system dynamics modeling

I. Introduction

Increasing the share of renewable energy in gross final energy consumption is one of the core targets of the European Union`s climate and energy policy towards 2050. In order to allow transition to a renewable energy based society and to reinforce a sustainable future development, strengthening the most appropriate policy strategies is the primary key aspect [1].

Latvian district heating systems are historically characterized with high share of imported natural gas. At the same time there is an important potential of locally available biomass resources. A system dynamics model was developed in order to look for the best environmentally and economically feasible policy strategy to accelerate transition from fossil to renewably sound economy in energy systems with large impact of non-renewable energy resources.

II. EU climate and energy policy

The European Union (EU) has been one of the leading forces taking action on mitigation of global climate change. Leaders of the EU have agreed on three binding climate and energy policy goals to be reached by 2020 (known as '20-20-20' targets): (1) a reduction in EU greenhouse gas emissions (GHG) of at least 20% below 1990 levels; (2) an increase in renewable energy share in final energy consumption for at least 20%, and; (3) a reduction in final energy consumption of at least 20% due to increased energy efficiency.

A. Policy instruments

A number of national level policy measures are implemented in the EU Member States to help achieving the above mentioned targets, e.g., legislative standards and norms, 'feed-in' tariffs, subsidies, and awareness raising activities. In addition, the EU Emission Trading System (ETS) came into force in 2005. EU ETS includes 11,500 operators in 30 European countries (EU Member States, Iceland, Liechtenstein and Norway) and is the main international level mechanism for reducing industrial GHG emissions in a cost-effective way [2].

B. The EU Emission Trading System

The EU ETS operates based on a cap-and-trade principle. This means setting a limit or cap on the amount of GHG emissions that may be emitted. The limit is allocated or sold to operators in form of emission allowances which represent the right to emit a specific volume of GHG emissions.

Previous experience of the EU ETS has gained doubt about its effectiveness therefore several notable changes will be implemented starting from the third operational period in 2013 which will affect system operators increasingly.

III. System dynamics modeling

System dynamics is a modeling methodology that investigates casual relationships between the behavior of a complex system and its underlying structure. System dynamics modeling is a widely used tool for policy analysis.

This digest provides insight into the use of system dynamics modeling for evaluation of the effect of different climate policy instruments to increase the share of wood fuel in Latvian district heating systems.

A. System dynamics model

The proposed system dynamics model considers relationship between heat energy generation tariffs for different resource types and their corresponding installed capacity in district heating systems. By applying different combinations of four policy instruments, the best policy strategies for transition to wider use of wood fuel are analyzed. Policy instruments include: (1) subsidies for technology transition from natural gas to biomass boilers, (2) risk reduction related to the use of wood fuel, (3) increased efficiency of wood fuel utilization, and (4) GHG emission trading.

B. Emission trading module

The effect of three national level climate policy instruments has already been widely discussed previously by the authors [3]. Therefore this work mainly focused on the assessment of the EU ETS.

Emission trading module of the system dynamics model evaluates the effect of the EU ETS based on an assumption that district heating operators will be willing to transfer to wood technologies when costs for buying emission allowances will exceed investment costs in GHG emission reduction measures (technology transition).

IV. Results and discussion

Results of modelling show that national level climate policy measures are substantial for promoting the use of renewable energy. With combining these policy instruments it is possible to significantly increase the share of wood fuel in Latvian district heating systems.

Also the EU ETS confirms its essential role in promoting the use of renewable energy, especially, in its third period of operation which incorporates significant operational changes.

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Potential energy savings and retention water from green roofs in comparison with conventional ones

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Keywords **– Energy savings, Retention, Insulation, Retrofit.**

I. INTRODUCTION

Buildings account for almost half of primary energy consumption, consumption that results in CO2 emissions in developed cities (including Amsterdam). Impervious surfaces absorb and reradiate solar radiation creating what is known as the "urban heat island" effect, where average air temperatures in highly developed areas are much higher than in the surrounding landscapes. This high temperature leads to an increase in a building's cooling costs, particularly during the summer. A very promising solution for the reduction of emissions and the consumption of energy is the green roofs project. The purpose of this research is to evaluate the possible solutions provided by recent studies for the reduction of energy costs with the use of green roofs and how these projects can be used in the Watergrafmeer area in Amsterdam [3].

II. METHODS

A literature review of green roof projects was undertaken to collect data published mainly during the period 2003-2010. Field measurements were introduced by Georgia and Tufts Universities in the USA, and compared with several studies conducted mainly in Germany, in order to measure the evaporative cooling effect of a green roof, which is considered to play an important role in the reduction of heat flux and the retention of water. Germany was chosen due to comparable climatic conditions with the Netherlands. A life cycle assessment (LCA) was chosen as the appropriate method for evaluation of the long-term environmental impacts of a project. In the beginning, a bottom up LCA was conducted assuming a 50-year building life [16].

The reference case is an eight story residential construction in Madrid. Alternative roofs with different characteristics were selected for the LCA. The LCA showed that there are differences in solar absorbance between the different materials. The area of Watergraafsmeer was chosen due to characteristics of the area. Watergraafsmeer mainly comprises a polder. It is located 5.5 m below sea level (the lowest part of Amsterdam), which makes it a residential area vulnerable to water related problems such as flooding. Moreover, the age of its buildings starts from the beginning of 20th century, making the area ideal for retrofit.

In this case study an investigation of the energy balance of a Dutch house will be introduced. We will investigate the energy balance of an average Dutch house.

III. RESULTS

The results will be divided into three categories: Retention of water, energy savings and retrofit potential. Studies conducted in the universities in the USA (Tufts, Georgia)are useful in so far as proving the water retention effectiveness of green roofs, however in terms of climate and building type; Berlin is a much better indicator of potential water retention rates. A comparison between Berlin, Brussels and Amsterdam was made. The similarities between Brussels, Berlin and Amsterdam can be found in the annual precipitation rates. The effectiveness of a green roof is also affected by the season. During summer they have their highest retention rates, which are reduced scientifically during winter periods.

A UK study showed high energy saving for green roofs. Given corresponding building types present in the UK and Netherlands, similar results can be expected pertaining to the energy saving potential of green roofs in the Netherlands. The future cost reduction for green roofs in comparison with the cost of flooding or prevention measures for storm water will make green roofs an economically attractive proposal. The green roof project has benefits for the area.

IV. DISCUSSION

This research was conducted in June 2010 in order to investigate the benefits that can be provided by green roofs to the citizens in the Watergraafsmeer area in Amsterdam. The results of the studies were in agreement, showing the energy savings and the storing potential of water from the projects. Green roofs can reduce energy use for heating in winter and cooling in the summer. The importance of green roofs in the retention of the water and the design of the building cannot be neglected. In the area of Watergraafsmeer the heating losses may be higher (more rainfalls → wet substrate) and the costs higher to construct a heavier substrate, but it also depends on the plantation, which enhances retention, another important aspect in a green roof project. In water retention, water is stored by the substrate and then taken up by the plants, from where it is returned to the atmosphere through transpiration and evaporation. As for the hurdles that need to be overcome, the lack of regulatory incentives, design guidelines and building standards are the most important.

V. CONCLUSION

The energy benefits from the construction of a green roof project in the buildings of Watergraafsmeer area are very high because these projects can reduce the energy use for heating in the winter and cooling in the summer. The main limitations surrounding green roofs are the lack of knowledge of the public and incentives from the government. It is not only important that actions that lead to informing citizens through campaigns and advertisements as to the benefits of the project be taken up, but also that there are incentives to make them economically feasible.

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Remote sensing applications for planning irrigation management. The use of SEBAL methodology for estimating crop evapotranspiration in Cyprus

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Keywords- evapotranspiration, SEBAL, algorithms, irrigation management.

I. INTRODUCTION

In this paper, the evapotranspiration of groundnuts (Arachis hypogaea, L.) in the area of interest located in Cyprus was determined as the residual of the energy balance equation using the measured net radiation (Rn), the soil heat flux density (G) and the estimated sensible heat flux density (H). The plots cultivated with groundnuts, used in this paper, had quite same canopy characteristics [1] such as age, height, ground cover, leaf area index (LAI), since the only available period for cultivating them is from May to August. Phenological stages of the crop were identified in order to follow the phenological cycle and be as accurate as possible. The objective of this paper was to compare the observed ETa values with those reported in Cyprus in the past using the Epan method. The results of the paper refer to the year 2009.

II. METHODOLOGY

SEBAL [2] model was applied for the first time in Cyprus. In order to be as accurate as possible, all crop related parameters for SEBAL were adapted to the soil, geomorphological and meteorological conditions of the island. Then SEBAL methodology was employed to estimate ETa of groundnuts at the places of interest.

Five Landsat images of the island were used and transformed into ET_a maps. The images were acquired during specific dates in the irrigation period of groundnuts. The irrigation period starts in May and ends in middle of August. The results of the paper are compared to those of Epan method. Then, statistical methods are applied to check if deviation is statistically reasonable.

The evaporative fraction was computed from the instantaneous surface energy balance at satellite overpass on a pixel-by-pixel basis:

$$\lambda E = R_n - (G_0 + H) \quad (1)$$

where: λE is the latent heat flux (W m^{-2}), R_n is the net radiation (W m^{-2}), G_0 is the soil heat flux (W m^{-2}) and H is the sensible heat flux (W m^{-2}).

III. RESULTS

The SEBAL method derives the evaporative fraction from satellite data. Actual evapotranspiration can be easily obtained from the product of the evaporative fraction and the net radiation. The SEBAL remote sensing technique is not restricted to irrigated areas, but can be applied to a broad range of vegetation types. Data requirements are low and restricted to satellite information although some additional ground observations can be used to improve the reliability.

The maps of ETa show the daily value of ETa on the date of image acquisition. Figure 4 presents the ETa map (Landsat 5 image) of a groundnut study plot for the 07/07/2009, in mm/day. These maps were employed to infer the value of ETa of groundnuts in all available images at that time from Landsat 5 and Landsat 7 satellites (Table 2). The value of ETa refers to the mean value of the four plots of groundnuts at the area of interest which follow the same fenological cycle. Finally ETa values of groundnuts were compared to the Epan method results that found in the past (see Fig. 5) [3].

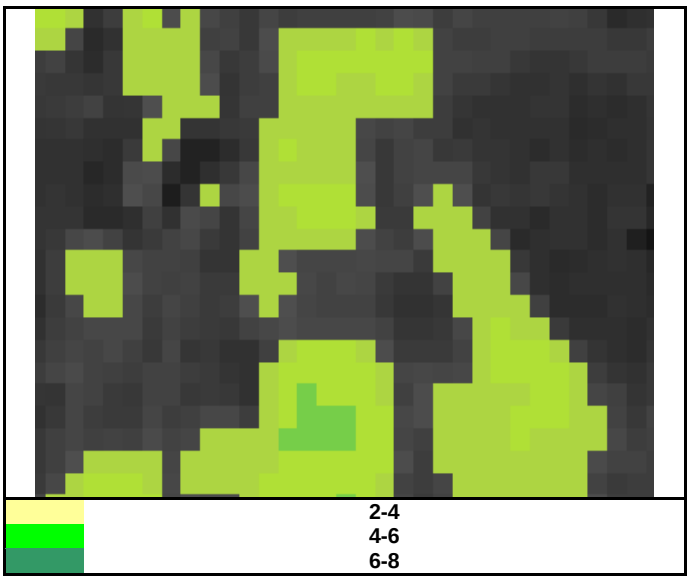

Fig. 4. Example of ETa map for groundnuts plots in the area of interest (7-7-2009)

IV. CONCLUSIONS

The application of SEBAL algorithm in Cyprus has provided new opportunities in irrigation water management. It is the first time when the specific algorithm is employed for estimating ET in Cyprus. From a technical point of view, SEBAL adapted to Cypriot conditions can be a very useful tool in the hands of water policy makers in order to support decision making on water policy matters.

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Scientific Communication in the Curriculum of Environmental Engineering Science Students

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***Keywords* – scientific communication, scientific presentations, IMRAD, environmental engineering**

I. Introduction

Knowledge and skills of scientific communication are essential for students and professionals of any discipline. Regardless of whether the student intends to continue their education in doctoral studies, these skills are important for searching, screening and understanding primary scientific literature, presenting their research results orally and in writing and generally being able to formulate their thoughts clearly, concisely and precisely.

Teaching scientific communication is aimed at providing students the tools to successfully write up their bachelor's thesis as well as most other (semi-)scientific texts their might encounter in their professional life. Preparing and performing oral scientific presentations is also taught and trained.

II. Methodology

A block of 20 academic hours of scientific communication is taught to third year bachelor level students within a four credit point course titled "Introduction to environmental research" (code EAS720). The course also includes topics like the scientific method, a short overview of science history, instrumental chemical analysis methods, introduction to ecotoxicology and nanotechnology. Additionally, the students visit on site the Academic library of Riga Technical University, the Latvian Environment, Geology and Meteorology Centre and its Environmental laboratory.

The course includes both lectures and practical exercises. Following topics are covered in the lectures:

- What is the scientific method?
- Why publish scientific articles?
- What is a scientific publication?
- Types of scientific publications. What is a primary scientific publication?
- The academic style of writing
- IMRAD- Introduction, Materials and Methods, Results and Discussion – the standard format of primary research publications
- The process of getting a manuscript published. Selection of appropriate scientific journals. Communication with journal editors. Peer review.
- How to choose a good title of the publication?
- Selecting the keywords and writing an abstract
- How to write the Introduction?
- What to consider writing the Materials and methods section?
- The Results and how to prepare good tables and figures
- How to write the Discussion section?
- Citing literature sources: the different systems and how they work. Using citation management software.
- Acknowledgements: how and whom to acknowledge?
- Ethics in research and publishing: the basic principles
- What one should now about copyrights?
- How to prepare a poster presentation for conferences?
- Oral scientific presentations in thesis defense, scientific conferences etc.

The practical exercises in this course include studying materials and doing practical work in avoiding scientific jargon and, especially, redundancy in a scientific text, discussing scientific ethics on real cases, doing peer review of other students' written text, searching and analyzing primary research publications, preparing and delivering oral scientific presentations of one's own as well as published research etc.

At the end of this course the students are asked to read and analyze a selected primary research publication, preferably in the field of their bachelor's work, summarize it and deliver an oral scientific presentation of the work. Other students and the lecturer ask questions and comment on the presentation. That way the students practice not only the preparation and delivery of an oral presentation, but also answering to questions, making sound arguments, debating and defending their opinions.

A number of books were used in preparing this course [1-4, among others]. I highly recommend the book of Day and Gastel [1] to the students and I think it should be mandatory reading for all doctoral students, at least in natural sciences.

In addition to the literature, personal experience of the lecturer is important and has been highly appreciated by the students. The author of this course has a number of publications in highly ranked international peer reviewed scientific journals that have been well cited.

III. Results and Conclusions

In the practical exercises the students showed a marked improvement in understanding and creating a scientific text, tables and figures. I believe that this course has, at least in part, contributed to the on average particularly well written and presented bachelor theses this year.

There is a need for a book or other type of material on scientific communication in Latvian. Even though, nowadays science is primarily communicated in English and fluency in English is certainly important for the students in this course but not mandatory. It is also planned to prepare a kind of course in scientific communication in our institute specifically designed for doctoral students.

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Teaching Environmental Management Systems to Environmental Engineering Science Students

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Keywords **– Environmental Management System. ISO 14001 standard. Eco-management and Audit Scheme EMAS.**

I. Introduction

The overall aim of the study program "Environmental Engineering Science" is to prepare versatile specialists capable to perform sustainable development in industry and different other fields of activities. One of the main requisites for sustainable development is rational environmental performance which should be properly managed. In order to create such grasp there is the course "Environmental Management Systems" included in the program.

The aim of the course "Environmental Management Systems" is to provide theoretical and applied knowledge and understanding of strategies, forces and current approaches to management of environmental development in companies and other organizations. A strong driving force in this field is the international standards ISO 14001 and Eco-management and Audit Scheme EMAS. These standards provides a systemized way of giving companies or other organizations assurances that a system is in place to manage and enhance environmental effects.

II. Methodology

Environmental management is a multidisciplinary area. It includes many topics such as cleaner production, pollution prevention, energy efficiency, other resources saving, ecodesign, systemdynamic, etc. These problems are discussed in other courses [1].

The course "Environmental Management Systems" is based on profoundly understanding the main principle of EMS – so-called Deming Cycle "Plan, Do, Check, Act". This model puts great emphasis on the concept of continuous improvement.

The course also provides knowledge about the different tools that usually are used in the environmental work of companies or other organizations. Especially important are practical skills in the use of appropriate tools for the environmental management system (EMS) implementation and maintenance in real life situations [2].

In our institute we continuously work on different improvements of the teaching methodology. More and more attention is devoted to interactive teaching and practical trainings.

The students are trained in two different ways. The main practical work they shall fulfill in small groups. Their task is to prepare an EMS for an imagined or really existing organization in accordance to the ISO 14001 requirements. This task takes almost whole semester.

Five years ago students used to obtain their "practical skills" by the way of a role-play. The students had to prepare an EMS for a virtual company.

Next year students already worked on a real existing organization. It was our Institute of Energy Systems and Environment. The EMS was prepared in accordance to all requirements of the ISO 14001.

The next year students performed the internal audit, evaluated the EMS suitability and made necessary corrective actions.

Commonly held 6 motivations for the implementation of an EMS in a university are:

- Better regulation of responsibilities;
- Better environmental performance documentation;
- Reduced risk of regulatory breaches;
- Cost reduction;
- Improved personnel motivation and training;
- Better environmental communication.

These motivations can apply to almost any organization. Specific to universities, an EMS may improve public perceptions by providing evidence of its social responsibility, assist in student education and training, provide access to research grants and encourage inter-departmental collaboration.

An EMS methodology is expected to spread to more universities in the coming years in Latvia.

The last two case studies have been the most fruitful. The student groups worked on two real existing companies. One of them was a medical waste treatment company, and another was an industrial high-tech production company. In the both cases our student teams prepared excellent environmental management systems, created real environmental programs (proposed some more environmentally friendly technologies), instructed the employees, and performed the internal EMS audit in these companies. In both cases the companies got the ISO 14001 certificate which acknowledges the high quality of the students work.

The second practical work students have to fulfill individually as a home work. The task is a comparative analysis of environmental management systems at different levels – international (ISO 14001), European (EMAS), and national level (particularly Latvian). The analysis includes environmental policy, environmental aspects, environmental programs, and monitoring on their implementation. The skills obtained in such way are useful for environmental specialists working for municipal, governmental or international institutions.

III. Results

Complete with case studies of successful EMS applications involving environmentally friendly technologies, the course provides a resource for all those engaged in the challenge of accelerating the development, transfer and adoption of EMS principles. It is intended to strengthen the linkages between policy makers, producers and suppliers, users and funding institutions.

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Team approach promotes households to save energy at home

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Keywords **– households, competition, team approach, energy saving measures.**

I. Introduction

The energy saving issues becomes more important in order to achieve the EU energy efficiency target by 2020. Within the household sector lies one of the greatest energy saving potential [1]. One of the main barriers for carrying out energy efficiency measures at households is the behavioral aspect [1;2]. Therefore it is important to find the best way to encourage households to change their energy behaviour and save energy at home.

II. Energy Saving Competition

In framework of Intelligent Energy Europe programme a project "Energy Neighbourhoods 2" has been implemented in Latvia. The aim of the project was to rise community awareness and run energy saving competition by forming energy teams (5-12 households per one team) in order to demonstrate that in four months (1st December 2011 until 31st March 2012) it is possible to save at least 9 % on their energy consumption by changing energy behaviour. In order to achieve better results, each team had their own energy master, who was responsible for energy data and helped team members to implement energy saving measures at their homes. During the competition period following different activities were organized:

- On-line tool for energy data submission;
- Training courses for energy masters;
- Starting, motivation, and closing event;
- Eight energy saving tips;
- Challenges to reduce CO_2 emissions.

Before start of the competition each household had to hand in information about energy consumption in reference period which is at least nine months long and includes one full winter season. During the competition period in the beginning of each month the households submitted the actual energy meter readings in the on-line system. Based on the meter readings energy consumed during the competition and the predicted annual energy consumption was calculated and total energy savings were estimated by subtracting reference energy consumption from predicted annual energy consumption. The energy savings in the on-line system were represented in percentages (%) and actual measurement (kWh) – considering both electricity and heat. Also, the savings on CO_2 emissions (kg CO_2) were presented.

A. Energy Neighborhoods in Latvia

Overall, 15 energy teams began the competition and involved 81 households (~ 203 people). At the end of the competition there were 13 energy teams with 70 households (~ 175 people), and 68 households with valid results. Two households were disqualified from the competition due to failed submission of energy meter readings.

On average one energy team consisted of five households. The majority of households were living in the apartments (47) and were trying to reduce only electricity consumption (50). A smaller number of households were living in private houses (21), and saving electricity and heat (12). In addition, there were only six households who tried to save electricity, heat and water.

III. Results

In total the energy teams managed to achieve the planned energy savings by 8.8 %, which corresponds to 37 630 kWh and 1129 kg CO_2 emissions in four months competition period. The specific results by each energy team are given in Table 1. While all teams were not able to save energy, they managed to achieve more than 9% savings in overall energy consumption.

TABLE 1

Results of participating energy teams

Name of Energy Team	Energy savings, %	Energy savings, kWh	CO_2 savings, kg
Zaļā iespēja	33.7	7716	231.5
Ādama iela@CO	28.7	3440	103.2
JVĢ	23.4	11 425	977.3
RITM-V	22.0	5488	536.9
TINTUKI	20.7	2879	86.4
ZRKAC	18.6	2430	72.9
Taupīgie Jelgavnieki	14.3	4020	120.6
Zaļie Elektrozaķi	13.8	1779	53.4
Dzirnas	12.6	5613	589.1
Silti sirsnīgā saime	10.2	942	28.3
Vīri zilos kreklos	9.5	1070	32.1
Taupīgie "Enerģētiķi"	*-4.5*	*-5152*	*-1966.8*
Iglu	*-5.8*	*-4402*	*-52.5*

In order to achieve the above mentioned energy savings following main energy efficiency measures were implemented at homes:

- Turn lights off and use daylight more;
- Switch off the stand-by regime (TV, music centre, computer, etc.,);
- The lightning system change (installation of compact fluorescent lamps);
- Intelligent use of electrical boiler.

The practical results show that behavior change and low investment energy efficiency measures have energy saving potential of about 15% in typical households in Latvia.

IV. Conclusion

"Team work" and energy master were recognized as the key elements that allowed to achieve high energy savings and change the energy behavior of households.

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The challenges of Zero-energy buildings

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Keywords **– energy efficiency, low-energy building, zero-energy building.**

I. INTRODUCTION

In the EU climate and energy package a goal has been set to reduce annual primary energy consumption by 20% by 2020. The building sector is responsible for 40% of total energy consumption, hence there lays a great potential for energy and CO_2 emission savings. In order to achieve the EU „20-20-20" goal, national legislations has to respond via regulations set.

EU Directive 2010/31/EU on the energy performance of buildings requires that local regulations on minimum energy performance requirements has to be overseen over time in accordance with the new technologies in the market and reaching nearly zero energy consumption by 2020 thereby reducing the carbon dioxide emissions as well.

II. CHALLENGES FOR ZERO-ENERGY BUILDINGS

Moving towards zero-energy buildings (ZEB) is a great challenge for both setting policy tools and selecting technologies. Directive 2010/13/EU defines ZEB as „a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby." Extensive literature review on definitions and calculation methodologies of ZEB carried out by Marszala et. al [1] has shown that there is a lack of a commonly agreed ZEB definition worldwide as well as no standardized calculation procedure exists and the calculation methods are developed for particular ZEB projects. They also mention that the first examples of ZEB buildings are just emerging and the balance calculation methodology has to be tested and agreed on one common method, definition and parameters taken into account (metric of the balance, period of the balance, type of energy use, type of balance, renewable energy supply options, connection with the grid infrastructure and the requirements for the building) [1].

At the moment to build a ZEB takes a complicated, sophisticated, time consuming design process including simulations and research which is not affordable for an average consumer. The technique of the design is not very flexible, it is dependent on the solar energy amount available and the site.. The EU financed research project "NorthPass" showed that meeting the same thermal performance values in colder climate of Northern Europe require additional measures, better performance of components of the building and economical investment compared to milder climate.

To lower national benchmark for energy consumption in the buildings, the new technological solutions are needed, and paradigm's shift in design and operation processes required. The mainstream trend in high energy performance building design is based on passive methods when building is insulated to the extreme and the air exchange rate is reduced to minimize energy losses. But ongoing improvement of thermal performance of insulation materials is getting close to its limits, performance of glazing system has been increased to the level where there are more heat gains that loses through glazed surfaces, heat recovery systems are close to 100% in particular circumstances. That leads to an urge for new concepts of heating, cooling and ventilating the buildings, for innovative ideas for the building envelope to improve thermal performance.

Emerging concept of an „active-house" regards building as energy storage system for renewable sources, e.g. building envelopes can accumulate energy utilising heat capacity and insulating characteristics of materials. Ongoing development of this concept highlights the way to a whole system design (WDS). Yet it is largely undefined with ambiguous elements and difficult to implement. In their study, Blizzard et. al propose to synthesize processes, principles, and methods into a framework for sustainable holistic design, including 20 elements the fields of sustainable development, systems thinking, engineering, architecture, urban design, planning, and sustainable management [2].

The other possibility to introduce the new concepts lies in biomimicry (from the Greek words bios, meaning "life," and mimesis, meaning "to imitate") - a new science that studies nature's models and then uses these forms, processes, systems, and strategies to solve human problems. It is based on what humans can learn from organisms and their ecosystems, but not on what can be extracted from them [3]. There are already examples of nature inspired solutions that help reduce energy consumption in buildings, for instance: (1) photovoltaic system collects energy from the sun like leaves harvest sunlight in photosynthesis process, (2) in the high-rise Eastgate Centre building in Harare (Zimbabwe) passive cooling concept was implemented inspired by self-cooling mounds of African termites (building uses only 10% of the energy of a conventional building its size), (3) building facade shading system mimicking the skin of plants interfering with the surroundings reduces energy demand for cooling the building as well (Qatar government building).

In accordance to the one of WDS designing principles, i.e. the focus on the fundamental desired outcome the aim of the new technologies for building components would be: (1) high energy-efficiency, (2) life cycle that has a minimum impact to the environment, (3) beneficial to the users health, (4) cost-effective and available to a wide range of buildings and end users, (5) to be as independent as possible from specific circumstances (site orientation, average air temperature, solar radiation), (6) the same price level for different climates-otherwise those countries of colder climate lose their competitiveness.

Following both methods the product with a high added value can be delivered. Not only in terms of energy efficiency. The interdisciplinary solution can make a contribution to the environmental, social and economical aspects, both locally and globally.

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The development of industrial symbiosis networks in Latvia

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Keywords **– material flows, industrial symbiosis, wood processing industry.**

I. Introduction

Industrial symbiosis seeks to improve the efficiency of industrial companies, by providing sustainable options for use of waste or by-product materials and energy. Industrial symbiosis is concerned with creating inter-firm cooperation and providing a collective benefit for the involved companies. This is accomplished by finding a suitable use for any waste or process by-product from one company within the manufacturing process of another company. By implementing such resource-saving measures any company could become more environmentally friendly and reduce its impact on the environment.

Conclusions drawn from the literature analysis suggest that the concept of industrial symbiosis is not included Latvian legislation. Moreover the waste management policy in Latvia indirectly contributes to the export of waste, thereby acting contrary to the principles of industrial symbiosis.

Though there is a lack of legislative framework for the development of industrial symbiosis in Latvia, resource and by-product exchanges might have been formed due to economic conditions during the crisis. The aim of this research is to determine whether inter-firm resource and by-product exchanges have been formed between companies within Latvian woodworking industry and to characterise the identified cooperation networks according to industrial symbiosis principles.

II. Approach

Forestry and woodworking industry is one of the largest industries in Latvia, both in terms of turnover and number of companies. Although woodworking industry suffered great losses and reduction of production capacity during the recent economic crisis, now it is showing the greatest extent of recovery. Both production and export amounts are rising again. The reduction of impact on the environment created by wood processing industry is very important in order to ensure sustainable development. The main impacts within this industry are created due to the use of fossil fuels within the production process and landfilling large amounts of inorganic wastes as ash or biodegradable wastes as wood materials. Such wood processing by-products as bark, cuttings, sawdust and wood chips have high potential of recycling or can be used as fuel.

To identify inter-firm cooperation between woodworking companies in Latvia, the publicly available information was gathered from waste management information system and pollution permits issued to the largest companies.

III. results

A number of wood product exchanges and one waste energy exchange were identified by analysing data of the State statistical survey “3-Wastes” [1]. Although of the absence of industrial symbiosis promoting policies, Latvian companies have for economic reasons created by-product exchange flows that are corresponding to the principles of industrial symbiosis. A summary of identified exchanges, their location and number of involved companies is presented in Table I.

TABLE 1
IDENTIFIED WOOD MATERIAL AND BY-PRODUCT EXCHANGES IN LATVIA

Company/Network	Saw mill	Wood processing company	Furniture manufacturing	Biofuel company	Other company	Waste handling company	District Heating	N°. of companies	N°. of exchanges
Bolderāja		1				1	1	3	2
Inčukalns	3			1	1			5	6
Ūdens street			1	1				2	1
Tukums				1	1		1	3	2
Ventspils	1				1			2	2
Salacgrīva				1	1			2	1
Rauna			1	1				2	1
Viļāni	1						1	2	1

The main distinction of these exchanges is that the by-products are used for manufacturing of high added value products and this is done closely to the origin of by-products. Therefore less transportation is required and landfilling of by-products is avoided. The identified exchange of waste energy is formed between a company which is producing biomass boilers and has an on-site testing facility. The waste heat from boiler testing is supplied by means of hot water to local district heating company.

IV. Conclusions

Although the concept of industrial symbiosis is not incorporated in Latvian legislation, some companies in wood processing industry in Latvia have already established inter-firm cooperation due to economic conditions. For further development of industrial symbiosis this term has to be recognized and included in the Latvian legislation. The use of waste materials and manufacturing by-products instead of raw resources should be promoted and inter-firm cooperation should be promoted. Another important factor for the development of industrial symbiosis networks in Latvia is promoting the re-use of waste and by-products close to their origin. At the national level industrial symbiosis promotion mechanisms, in particular, voluntary mechanisms need to be implicated. National recognition of industrial symbiosis could advantage sustainable development of industry and overall economic development of Latvia.

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The Regulation Possibilities of Biomass Combustion

Vera Suzdaļenko, Mārtiņš Gedrovičs (*Riga Technical University*), Maija Zaķe, Inesa Barmina (*University of Latvia*)

Keywords **– co-firing, gradient magnetic field, propane, recirculation zone, swirling flow, wood pellets.**

I. Introduction

The focus of the recent experimental research is to analyze the regulation possibilities of biomass combustion. Three possibilities were chosen: a) biomass co-firing with propane, b) swirling flow with recirculation zone and c) using of a permanent magnet. The aim of research is to provide stable, controllable and effective biomass combustion with minimum emissions. The special pilot device was created where wood pellets were combusted separately and co-fired with propane.

II. Experimental Device

The experimental research of the regulation possibilities of biomass combustion was carried out by using the special constructed pilot device which capacity is maximum 3 kW.

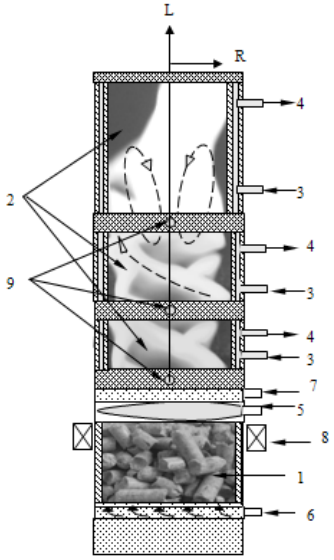

Fig. 1. Pilot scale-up: 1 – wood fuel gasifier, 2 – water-cooled combustor, 3 inlets of cooling water flow, 4 – outlets of cooling water flow, 5 – propane burner, 6 – nozzle of primary air supply, 7 – nozzle of secondary air flow, 8 – permanent magnets, 9 – diagnostic sections.

Wood pellets co-firing with fossil fuel propane was carried out by using propane burner (5). It initiates gasification of wood pellets and complete the burnout of volatiles.

The air in the pilot device was supplied in two places: primary air was supplied below pelletized wood layer (6) and its rate was varied from 40 l/min to 55 l/min, secondary air was supplied above propane burner (7) and its rate was varied from 70 l/min to 100 l/min.

To provide experimental study of the magnetic field effect on wood pellets combustion a permanent magnet (8) with 2 couples of poles was placed between propane burner and primary air flow close to the bottom of the combustor. The permanent magnet provides a relatively weak field with a mean axial field gradient up to dB/dz = 0.8-1.0 mT/m, fixed close to the walls of the combustor.

III. Results and Discussion

A. Wood pellets co-firing with propane without magnetic field effect

Previous experiments [1] have shown that the formation of swirling flame flow is closely connected with the primary and secondary air supply rates determining the swirl intensity. The air swirl number (S) during experiments was in a range of 0.8-1.0. The formation of the flow field structure near the outlet of the secondary air is developing at high level of the turbulence, providing the variations of Reynolds number in a range of 3000-10000. The formation of the central recirculation zone near the outlet of gasifier promotes the enhanced mixing of the flame compounds and determines the formation of the reverse axial heat/mass transfer up to the pelletized wood layer enhancing wood fuel heating, gasification and burnout of volatiles.

B. Magnetic field control of combustion process

The Japan researchers have found that the presence of magnetic fields have caused significant changes in diffusion flame behavior, such as changes in radioactive emissions from the flame, changes in flame shapes and sizes [2] and [3].

During experiments, when magnetic field was applied, the axial flow velocity approaches to the minimum value, promoting the field-enhanced reverse axial mass transfer of the flame species towards the higher magnetic field induction. The field-enhanced radial and reverse axial mass transfer of the paramagnetic oxygen disturbs the shape of the flame velocity profiles, decreasing the axial and tangential flow velocity compounds.

The magnetic field affects the increased rate of CO_2 during wood pellets and propane co-firing. It correlates with increased combustion efficiency with radial expansion of the flame reaction zone and the formation of increased air excess close to the channel walls

IV. Conclusions

Co-firing and magnetic field could be used as controlling possibilities of combustion process, providing the increasing of produces amount of CO_2 emissions and increasing flame temperature and efficiency. One of the problems could be mentioned that increased temperature cause the slight increase of NOx emissions.

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Toward cleaner production of asphalt pavement

Lelde Timma, Dagnija Blumberga *(Riga Technical University)*

Keywords **– asphalt pavement, cleaner production, environment management, energy efficiency.**

I. Introduction

More than 50 years ago a work "Silent Spring" was published. For the first time, it brought environmental pollution problems to attention of mainstream public. Nowadays preservation of environment is one of the main subjects for studies. In order to limit the levels of emissions, firstly, the dilution strategy and external cleaning technologies were implemented for industry. Currently, stricter environmental regulations are introduced and prices for energy and raw materials are growing, therefore, only way how to remain competiveness is to integrate methodology of cleaner production. A cleaner production is provision of services and production of goods with minimal impact on the environment in boundaries of existing technological and economic possibilities.

Based on the State Environmental Service data on polluting permits of B category for the sector of chemical industry, on 21st February 2012, 133 permits in total were issued, where 14 % of them accounted for the asphalt industry. The aim of the research is to review possibilities of implementation of cleaner production for asphalt pavement industry. Only production of bitumen-bound asphalt layers is considered in this study.

II. Reference system

The reference system is currently working at asphalt pavement factory in Latvia. Introduction of cleaner production is assessed for this system. The rated capacity of the factory is 320 tons of asphalt per hour. The plant currently works under hot-mix asphalt production technology. The production unit consists of "cold" dosimeter system, conveyers, scales, drying cylinder, filters, and exhaust system for flue gases, mixers and storage units. As energy source natural gas and electricity from grid is used. In the reference system for asphalt pavement production mineral aggregate, sand, dolomite powder, bitumen emulsion and additives are used. As recycled material particle matters from filters are used in production.

III. Implementation of cleaner production

For the assessment of cleaner production measures at asphalt pavement factory, methodology presented by the professor P.O. Persson will be used, see Fig. 1 [1].

A. Substitution of raw material

A substitution of mineral materials is of great potential use because they account for 90-95 % by mass in asphalt pavements. The raw materials used, can be replaced by waste products from other industries [2]. The main indentified flows of waste materials suited for asphalt pavement production are: fly and bottom ash, recycled asphalt, recycled asphalt shingles, used motor oil, recycled glass, steel slag, waste tires, construction waste, recycled polymers and recycled brick powder. By using waste materials it is possible to achieve the reduction of bitumen emulsion consumption for asphalt pavement up to 20 %. This means saving of non-renewable resources and reduction of production cost at the same time.

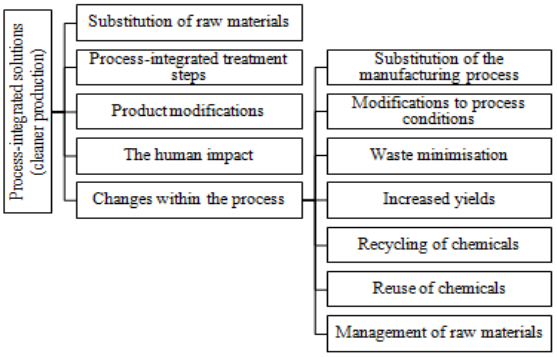

Fig. 1. Schematic overview for cleaner production assessment [1]

B. Process-integrated treatment steps

Based on the guidelines of Best Available Technologies for the Production of Asphalt Paving Mixes [3], flue gases should be treated in firstly in cyclone and then in bag houses. Reclaimed material from the flue gas flow can be reused in asphalt pavement mix as mineral filler.

Beside particle matter flue gases contains heat energy (up to 180 °C), which can be used in the production line for preheating mineral materials. Flue gas recirculation units for asphalt pavement industry are already commercially available.

C. Product modifications

All introduced modifications to the asphalt pavement by introducing recycled materials are limited by Latvian legislation which regulates the quality of asphalt pavements.

D. The human impact

Productivity can be increased by regular training of the operators. Also equipment will maintain for longer time, risk of injuries is reduced and quality of final product increases.

E. Changes within the process

Proposed changes within process include substitution of natural gas burner to the pulverized wood dust burner. Modifications to the factory production line in order to produce warm-mix asphalt instead of hot-mix asphalt pavement. In order to monitor the effectiveness of manufacturing process the specific indicators (for example kWh of energy per ton of final product) should be introduced. Bitumen vapor condensation unit and changes within storage of raw materials is vital for reduction of emissions and minimization of material losses.

By integrating cleaner production measures asphalt pavement fabrication can become sustainable production unit.

IV. References

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Analysis of Indicators of Environmental impact assessment for roads

Liga Lieplapa, Dagnija Blumberga (*Riga Technical University*)

Keywords **– indicators, environmental impact assessment, benchmark method, roads.**

I. Introduction

Roads present a significant impact on environmental quality, therefore the environmental impact assessment (EIA) procedure helps to predict the long-term implications of planned motorway and assess their relevance. As a result of the work benchmark method for prediction of impacts was developed and approbated on the basis of environmental indicators.

II. Methodology

The quantity assessment of expected environmental impact is provided by indicators giving the highest impartiality in EIA process. Environmental indicators were selected for EIA of motor road projects, with the analysis of application of these indicators in 14 reports concerning EIA of motor road projects.

A benchmarking method, where data from EIA reports is used as an input data to determine numerical value of indicators, was developed to forecast environmental changes for motor road projects. Application of the method is not limited to data collection, comparison and analysis, it can be a tool used to forecast and determine changes in the state of examined object detect its weak points and as a foundation for recommended measures to improve the state of it. The method is based on definition of the thresholds – search for the optimal value between two values [1].

Benchmarking method for assessment and prediction of motorway impact on air quality was developed on the basis of measurement data of existing roads, and demonstrate a sufficiently high level of reliability. Methods are based on the correlation between two or more factors, in this case – concentration of the pollutant (for example PM10, NOx, CO) emissions in the air and the number of cars. The existing background pollution concentration and allowable concentration limit are taken into account.

Air quality changes from the motorway can be described with a simple relationship (2.1):

$$C = Cf + Ca, \qquad (2.1)$$

where C – air quality, Cf –background quality (before commencement of economic activities), Ca – impact of the road.

The impact of the road, in turn, is associated with a variety of factors, which vary depending on the status of the object - construction, operation or closure. For example, the factors influencing quantity of PM10 emissions in the air can be expressed by the following equation (2.2):

$$C_{PM}=f(n, k_1, k_2, v, i_1, i_2, W, w, z), \qquad (2.2)$$

where n - total number of motor vehicles, k_1 – coefficient determining the proportion of heavy vehicles, k_2 – coefficient determining the proportion of cars, v – driving speed (m/s), i_1 – deterioration of tires, i_2 – deterioration of asphalt, W – degree of deterioration, w - moisture on the road (mm water equivalent), z - land use (agricultural land, wood, etc.).

Within this work the analysis of correlation between atmospheric emissions from road transport and one of the major factors influencing it - the number of cars traveling on the road in a certain unit of time, was carried out. Other factors were not addressed in this work, since a very good correlation with the number of motor vehicles was observed.

III. Results and Discussion

PM10 concentration indicator was used for the comparison of emission data distribution with benchmark; it describes the correlation between PM10 emissions (mg/m^3) and number of vehicles (in thousands). The estimated (estimated) data scattering in EIA reports, is much larger than the measured PM10 data distribution. In addition, in some cases regardless of the intensity of the transport calculated air emissions are relatively uniformly low and not correlated with the benchmark. PM10 indicator correlation with number of vehicles on the measurement data is quite good, demonstrating the reliability of the benchmark methods. However, the estimated data for PM10 indicator varies with a large scattering (Fig. 1).

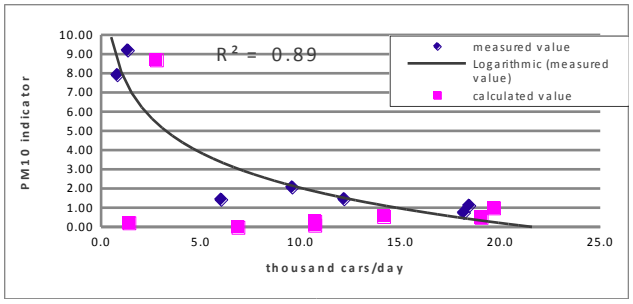

Fig.1. Variation of PM10 indicators

The pollution from road transport shows the differences in methods of determination of the air emission concentration used so far in EIA in producing the believable outcome. The forecasted emission concentrations in some analyzed cases are close to zero level.

IV. Conclusions

Benchmarking method has been developed and tested for air emission forecast in the case of motorways. The basis of the method is correlation between two or more factors, in this case, between the pollutant (PM10) emissions in the air and the number of cars. Background pollutant concentration and allowable limit value of pollutant concentration will be taken into account. The method is simple, easy to use and with high reliability.

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Management Strategy for Hazardous Waste

Jānis Vilgerts, Lelde Timma, Dagnija Blumberga (*Riga Technical University*)

Keywords – hazardous waste, indicators, sustainable management, pollution prevention and control, waste management strategy.

I. Introduction

During the past year authorities, manufactures and scientists have been focused on the management and treatment methods of hazardous wastes, because they realized that "prevention costs" of activities connected to handling of hazardous waste are lower than "restoration costs" after damage is done.

Uncontrolled management of hazardous substances may lead to contamination of any ecosystem on Earth: freshwater, ocean and terrestrial. Moreover leakage of toxic gasses creates also air pollution and can cause risks of fire and explosion, damage for human health, etc.

Therefore, studies on hazardous waste management strategies are mainly contributed to the need of environmental protection and insurance of healthy life.

II. Framework of European Waste Legislation

The 6th Environmental Action Programme [1] sets down target for decoupling between environmental pressures and economical growth. In the framework of the Programme the initiative "Towards a thematic strategy on the prevention and recycling of waste" has been developed. Within the initiative the guidelines for waste management strategies has been set down.

By combining the knowledge on weaknesses of existing waste legislation and findings of thematic strategy the Directive 2008/98/EC on waste was developed. Therefore the legal framework for one of proposed targets of the Programme is set down in the Directive on waste. One of the main aims of the waste legislation is to break a link between the amount of waste produced and the indicators of economical prosperity in country.

The legal norms of Directive 2008/98/EC on waste are also integrated in the Waste Management Law of Latvia.

III. Statistics of Hazardous Waste in Latvia

One of indicators for sustainable development is amount of generated hazardous waste. The statistical data shows that in European Union around 97.7 million tons of hazardous waste were generated in year 2008. The amount of generated hazardous waste in Latvia is shown in Fig.1.

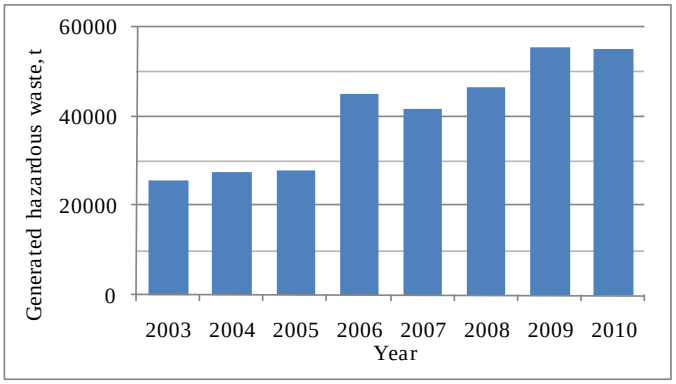

Fig. 1. The amount of generated hazardous waste in Latvia [2].

As can be seen in Fig.1., the amount of hazardous waste generated in Latvia is growing steadily from year 2003 until year 2010.

The contribution of generated hazardous waste to total waste flow in the European Union was 3.7 % in year 2008. In Latvia the same indicator was changed from 2.3 % to 5.4 % between year 2010 and year 2003 [2].

The share of hazardous waste in the total waste flow hardly reaches 5 %, but it should be stressed out that even in small amounts hazardous waste may present serious risk for the ecosystems. Therefore management strategies for handling of hazardous waste are one of the leading discussions both - at local and at global level.

IV. Guidelines for Hazardous Waste Management

Reliable and appropriate management strategy for hazardous waste demand following legal and technical basis:

- strict fulfillment of both international and local laws and definition of clear responsibilities for all involved parties;
- registration of permit for waste operators and special supervision by competent authorities;
- technological solutions and transportation for waste handling cannot pollute the environment and cannot have influence on human health;
- consideration of waste management hierarchy principles; by preferring prevention, re-use and recycling of hazardous waste streams instead of recovery and disposal.
- choose between state-of-art technological solutions for hazardous waste handling system should be made on basis of socio-economical calculations.

The listed bullets present only the main pre-conditions for sustainable waste management systems, but there are still additional conditions for each case to be taken into account.

The waste materials increasingly are seen as a valuable resource for manufacturing. Therefore closed loop systems are becoming both environmentally sound and profitable solutions for industry [3].

IV. Summary

By steady increase in amount of generated hazardous waste in Latvia, it is essential to introduce best practices and state-of-art technologies for management hazardous waste. The system should have strict legal background and clearly defined responsibilities. A choose of waste management systems should be based on socio-economical calculation.

V. References

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Economic analysis of cleaner production measures for concrete blocks production

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***Keywords* – concrete blocks, cleaner production, wood ash.**

I. Introduction

Over the past 20 years, an issue of reducing waste in manufacturing processes has gain importance, therefore a technologies with zero emissions has been studied worldwide. In Latvia increasing interest is paid to issues related to energy efficiency and reduction of impact to the environment. It is connected to the limited amount of fossil fuel resources and their efficient use. Many heat supply systems is using a wood chips as fuel. In year 2010 the amount of ash accounted in Latvia was nearly 10000 tons and almost all of them deposited in the waste polygons.

The aim of the work is to assess the use of ash for production of concrete blocks from cleaner production and economic point of view.

According to Latvian legislation, furnace ash is not classified as hazardous waste, therefore additional measures for ash transportation, use and storage would not be needed in the company.

II. Reference System

Principles of cleaner production were applied to factory for concrete blocks manufacturing. Technological solutions were offered for the factory with a production capacity of 60000 m3 per year. The production line consists of storage tanks for raw materials, dosing system, a mixer for raw materials, molding equipment for concrete blocks, a drying room and storage with the packing line. An existing factory uses water of good quality, electricity and heat, which is supplied by natural gas.

III. Economic Analysis for Cleaner Production Measures

For traditional production of concrete sand, gravel, cement, water and plasticizers are used. The main active component is cement. Based on the literature [7] the chemical composition of the ash is similar to the composition of Portland cement. In several references [4;6] the experiments are described where concrete blocks with 10-40% by weight of cement replaced with wood ashes where manufactured. The strength tests of the product are preformed after 28 and 60 days, in the tests they found out that the strength of the concrete complies with the standard, if the ash replaces 20% of cement by weight.

A 3960 tons of ashes can be utilized in the production line with nominal capacity of 60000 m3 concrete per year, if ash replaces 20% of cement by weight. By applying the techniques of cleaner production, for the offered production scheme a significant reduction of water consumption in the enterprise was achieved by returning water from technological processes after filters and by utilization of rain water. These measures allowed reducing water extraction by 75%.

For the heat supply of the factory local boiler house is used. For the reduction of CO_2 emissions wood pellets will be used. Heat energy is used only for the communal needs.

A production of the concrete blocks is carried out during the warm months (from April to the end of October) it allows avoiding the energy consumption needed for drying of the concrete block. The main electricity consumers are mixers and forming molds. In order to reduce the consumption of electricity from grid, it is possible to install solar photovoltaic panels and wind turbine.

In order to evaluate the project from an economic point of view following economic indicators was calculated: NPV (net present value), IRR (internal rate value) and PI (profitability index). A sensitivity analysis for the project was performed in function of three parameters: capital costs, price for raw materials and price for final product. The results of sensitivity analysis are shown in Fig. 1.

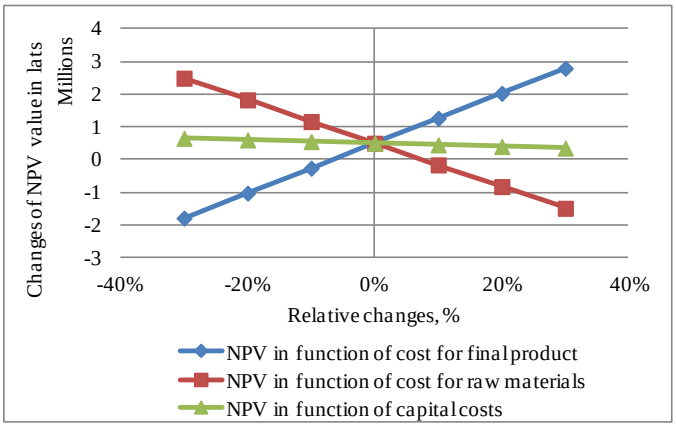

Fig. 1. The results of sensitivity analysis

Economic lifetime for the project is considered 10 years.

IV. Conclusions

1. A production of concrete block by using wood ash is one of the typical solutions for implementation of cleaner production. A utilization of the ash for the current production line does not require a major capital investment and reduces a cost of final product.
2. In the content of the economic evaluation a cash flow within the project lifetime was elaborated, a value of NPV=503546 lats, IRR=21%, PV=1003746 lats and PI=2.01 was stated. Investment project with a NPV positive value, IRR value (21%) is higher than the cost of capital (13.23%) and PI ≥ 1 (2.01) shows that project is reasonable from economic point of view.
3. The results from the sensitivity analysis shows that the highest degree of flexibility for NPV value is for the amount of capital costs, but for the costs of raw materials and production costs is lower. This conclusion points out the importance of the market research before project implementation.

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Negative CO_2 Emissions through Carbon Capture and Storage Processes in Biomass Energy Plants

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Keywords **– biomass, energy production, CO_2 emissions, carbon capture and storage.**

I. Introduction

Negative effects of the greenhouse gases to the environment have stimulated scientists for searching of new technological instruments in mitigation of CO_2 emissions in the atmosphere. According to the United Nations Framework Convention on Climate Change [1] biomass, while used for production of electricity and heat, is considered as CO_2 free fuel and therefore biomass energy production technologies are widely used worldwide to minimize CO_2 emissions in the atmosphere. Another way to stabilise and reduce greenhouse gas emissions in the atmosphere is the use of carbon capture and storage technologies (CCS).The CCS system includes the capture of CO_2 emissions from the flue gases emitted as a result of the energy production process, the processing, transportation and injection of the gases in geological reservoirs. Most of the projects implemented on CCS worldwide are geared towards CO_2 emission capture from large-scale fossil fuel power stations, which are founded on the high CO_2 emissions factors from fossil fuels and on economic considerations. Nonetheless, technically it is also possible to accomplish CCS also for small scale and bio-fuelled power stations.

The aim of the research is to analyse the impact of integration of CCS systems in biomass electricity production plants in Latvia to national CO_2 emissions.

II. Methodology and Assumptions

The analysis calculation models that are interrelated: enginner-technical calculation model, economic calculation model and climate estimation model and are created with the support of a dynamic linear programming method. The algorithm of the model used in the work is shown in Figure 1.

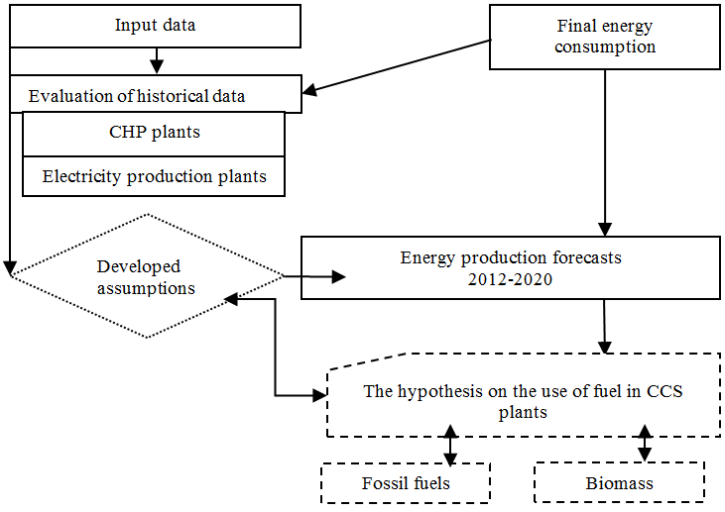

Fig.1. Model of the algorithm of the energy supply sector with CCS systems

The development of the energy sector prognosis in the work is looked at through three possible scenarios:

- **Scenario A** – energy production is dominated by fossil fuel energy sources without;
- **Scenario B** – energy production is dominated by fossil fuel energy sources, however from the year 2015 CCS technologies are introduced in the existing and planned fossil fuel energy sources with an installed capacity over 20 MW.
- **Scenario C** – energy production is based to the maximum on the use of renewable energy sources and all energy sources (existing and planned) with an installed capacity over 20 MW (regardless of the type of fuel used for production – fossil or biomass fuels) are installed with CCS technologies from 2015.

III. Results

Biomass electrical power stations with CO_2 capture are currently at an early stage of development and have characteristically high energy consumption for CO_2 capture, which reduced the total operational efficiency of the energy system to 30–43%. Thus biomass combustion technologies with CCS stimulate greater increase of energy consumption per produced energy unit (see Fig.2).

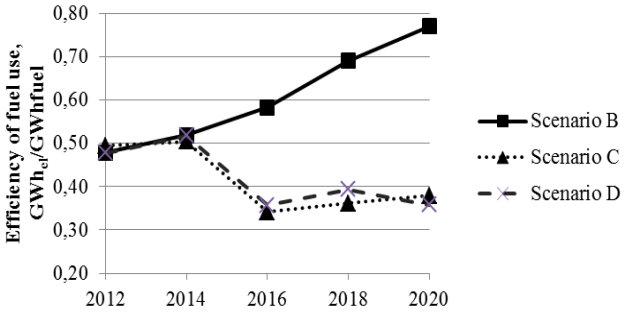

Fig.2. Efficiency of fuel use for electricity production at fossil and biomass power plants with CCS systems

The introduction of CCS technologies has an affect on the ranges of the electricity tariff, but cannot influence the trends in tariffs – usually the costs of electricity in systems with CCS conform to the price distribution of the standard stations of the same fuel type. A fall in the tariff in the biomass model (in comparison with the fossil power station with CCS) occurs when additional costs for introduction of CCS do not exceed the income from the sale of assigned quotas. In the fossil fuel models, a reduction in tariffs is possible when the costs for introduction and use of CCS do not exceed the amount of money which the energy producer invested in the purchase of emission quotas before commencing storage of CO_2 emissions.

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Bioplastic cleaner production and economical calculation

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***Keywords* – polylactide, bioplastic, cleaner production**

I. Introduction

Bioplastic (polylactide) is mainly produced from starch obtained from potatoes, corn, sugar beets and other plants. Bioplastics are used to replace oil-based plastic in production of products such as plastic bags and bottles. Since the demand for bioplastic products is increasing every year, therefore the study of cleaner bioplastic production and its opportunities is being carried out in Latvia.

II. Methodology

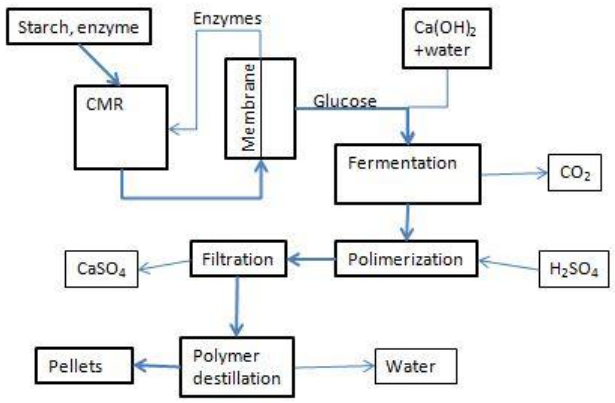
The first task is identification of technological process to create improved and cleaner production process, reduce polluting processes, find utilization opportunities for by-products and waste on the same site or by selling them to the other companies and to minimize energy consumption. The priority is renewable and reusable resources and avoidance of fossil materials and resources. Chemical reactions takes place during the production, therefore production unit shall select appropriate processes, which are simple, safe, energy efficient and raw materials that leave minimal pollution after the processes. The second part of the study is economic estimation for establishment of such facility in Latvia. [1]

III. Production process

Production begins with the acquisition of glucose from starch. Technology chosen for this process is continuous membrane reactor (CMR) for starch sacharization occurring in the presence of glicoamylase enzyme. This technology uses a very small amount of enzymes that promote cleaner production.[2]

Fig.1 Bioplastic production sheme

The by-product CO_2 gas from fermentation should be used



in the processes of carbonated drink production, therefore it is sold to another company. During filtration, the by-product $CaSO_4$ can be used as a gypsum in construction or additive E-516, used in food production. At distillation the by-product is waste water, which has to be cleaned and returned to the manufacturing process, where there is no need to completely clean the water, for example, mixing $Ca(OH)_2$ with water, to reduce the total water consumption. In order to avoid buying the package for pellets, part of the mass is immediately directed to the production of membrane, further used as packing bags for pellets. [3]

Production capacity in this study has been calculated on 1600 t/year. For CO_2-neutral solution is chosen chips cogeneration plant, because the priorities are local and renewable energy. Such facilities would require 3.4 MW (11,000 tons of wood chips/year). In case of a surplus of electricity, it can be sold in the national electricity grid. If their own production is not enough, it is possible to use locally installed wind turbines for additional electricity use.

Since the main raw material for bioplastics is starch (renewable resource) the manufacturing process ensures CO_2-neutral life-cycle in nature and therefore the establishment of such facilities in Latvia should be promoted. If cleaner production is choose as a priority, the production of bioplastics creates no significant adverse effects on the environment and the process can be further improved. Cleaner production can be promoted by the BAT (Best Available Technology) principle and the plant and employees management using ISO 14001 standards.

IV. Economical calculation

Economic evaluation of this project is based on building construction and manufacturing process technology costs and the cost of providing 10 years of manufacturing process. During the calculations assumptions of costs, there were taking into account the estimated potential value that is variable in time. Production inflow is income from selling of end product (1500 Ls/t) and by-products. Three main indicators of economic justification were calculated – NPV (net present value), IRR (internal rate of return) and PI (profitability index). Indicators show that the project is economically justified and can pay off in 4 years.

Sensitivity analyses of the NPV, where variables are prices, total capital investment and raw material price fluctuations from -30% to +30% ranges, were performed. Price of the product changes NPV relatively more (94%) than capital investment and raw material price changes (12% and 22%).

The economic calculation shows that the implementation of the project is justified in Latvia. Bioplastics have potential uses in Latvia in collaboration with local manufacturers of various goods and exporting the product, which would contribute to increasing GDP.

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Materials Science and Applied Chemistry

Materials Science

Strength of a Three-Dimensional Polymer Structure Acrylic Bone Cement and Dry Compact Bone Bond

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***Keywords* – Shear stress, bond strength, dry compact bone, acrylic cement.**

I. Introduction

Implant service life in the living bone tissue is depending essentially on biomechanical properties of the bone- cement interface. Two-component acrylic bone cement based upon poly (methyl methacrylate)-methyl methacrylate (PMMA-MMA) system as grout is used for orthopedic surgery to anchor prosthesis mechanically and to transfer of service loads by occupying irregular void between artificial material implant and spongy or/and compact bone tissue. Classically linear polymer structure cements formed from pre-polymerized PMMA beads and polymerization MMA monomer liquid have some well – known disadvantages, such as to high polymerization temperature, large volumetric shrinkage, brittleness and insufficient lifetime [1,2]. This general servant for prostheses fixing is not type of glue that holds implant and bone due to adhesion between the two different materials.

Cross-linked three-dimensional polymer structure acrylic bone cement is elaborated in the RTU [3] with reduced maximum exothermic polymerization temperature, low shrinkage and adhesion ability to bone tissue.

In the present study adhesive properties of elaborated bone cement to dry compact bone tissue are experimentally investigated carrying out push-out tests on implant-cement-bone model systems after different periods of storage. The bone bonding strength or a*nchoring* ability of the cement to bone is calculated from test data as ultimate shear stress in the bone-cement interface.

II. General Model And Bone Cement

Bone-cement-implant model systems were created to investigate the adhesive properties of elaborated three-dimensional polymer structure acrylic bone cements to bone.

48 compact bone blocks 30×30 mm were sawed from bovine femoral diaphysis. 10 mm hole was drilled in the bone block perpendicularly to bone central axis. Tempered alloy steel socket-set screws M6 are used in models as implants to make more resistant cement-implant interfaces. Set screws were fixed into the bone blocks with elaborated poly (methyl meth acrylate-2-ethylhexyl methacrylate)-ethyl meth acrylate acrylic acid tri (ethylene glycol) dimeth acrylate [P(MMA-EHMA)-EMA-AA-TEGDMA] bone cements.

III. Push-Out Test

Push-out tests were carried out after 1, 2, 24, 120 hour and one year storage of samples in dry condition using the universal testing machine Instron 4301 with PC control. The set screws were pushed out at a rate of 1 mm/min and the axial load-displacement relationships were registered. During push out test all failures occurred in bone-cement interface. Set screws fitted with cement rings were pushed out from bone blocks. Bonding strength between compact bone tissue and bone cement is evaluated from push-out test load-displacement data.

Numerically the bond or a*nchoring* strength between compact bone tissue and bone cement is determined as maximal shear stress of bonded interface during a push-out test. The shear stress is calculated in a classical manner, expressed as the axial load over the no cracked area of the coupled bone-cement interface.

IV. Results

Experimental results show that elaborated P(MMA-EHMA)-EMA-AA-TEGDMA acrylic bone cement acts as multi-component adhesive.

Of course bone cement mechanically fills some pores of the bone surface and hold materials together by interlocking, due to low shrinkage. It is not only mechanical adhesion in the compact bone-cement interface, as the bonding strength between compact bone tissue and cement essentially depends on time of storage. Ultimate shear stress reached maximal mean value 14 MPa after 1 day and remains permanent after 5 days dry storage. Strength of a three-dimensional polymer structure acrylic bone cement and dry compact bone bond in age of 2 hours is mean 86% from top value. Unfortunately bonding shear strength decreased twice from top value after 1 year dry storage.

There is a need for bioactive cement. To prolong bond service time existing cement composition can be transformed to bioactive cement by the adding biodegradable polymers or others various additives in the bone cement components.
Determination of the bond strength for the cements gives a possibility to identify the material with more suitable biomechanical compatibility to bone tissue.

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Influence of Mg-substitution on the Characteristics of Hydroxyapatite Powders

Liga Stipniece, Kristine Salma-Ancane, Natalija Borodajenko, Dmitrijs Jakovlevs,
Guna Krieke and Liga Berzina-Cimdina (*Riga Technical University*)

Keywords **– hydroxyapatite, β-tricalcium phosphate, magnesium, substitution, wet chemical precipitation.**

I. Introduction

The synthesis of new substituting materials mimicking natural bone still remains interesting objective of the technological research. Hydroxyapatite (HAp) is one of the most used calcium phosphate compound as bone graft substitute in hard tissue implants and as material for bone-tissue engineering application, due to its excellent biocompability. In considering cationic substitutes, magnesium (Mg) is one of the most important bivalent ions associated with biological apatite. Enamel, dentin and bone contain, respectively, 0.44, 1.23, and 0.72 weight% of Mg [1]. The preparation of synthetic Mg-substituted hydroxyapatite is of great interest for developing of artificial bone substitutes, which are characterised by high bioactivity [2]. According to the literature, the incorporation of Mg in synthetic HAp is limited (between ~2.0 and ~29.0 weight % of Mg).

II. Materials and Methods

In this work pure HAp and Mg-substituted hydroxyapatite (Mg-HAp) powders were synthesized by wet chemical precipitation of homogenous starting suspension of $Mg(OH)_2/Ca(OH)_2$ and H_3PO_4 solution. The starting slurry of $Mg(OH)_2/Ca(OH)_2$ was prepared by dissolving (100-x) weight% CaO and x weight% MgO (where x in range of 0.1-20.0 weight%) powder mixture in distilled water, and milled in the planetary ball mill to obtain a homogeneous suspension. An aqueous solution of 2.0 M H_3PO_4 was added dropwise to obtained homogenous $Ca(OH)_2/Mg(OH)_2$ suspension under continuous stirring. The synthesis media temperature was continuously monitored and adjusted to 45°C. The pH was stabilized at 8.7 to 9.0 during process. All precipitates were aged in mother liquor at room temperature for ~20 h, vacuum filtered, and finally dried in oven at 105°C for ~20 h (as-synthesized samples). The obtained powders were sintered at 900, 1100 and 1300°C for 1 h to verify thermal stability of HAp and Mg-HAp products.

The influence of different amounts of Mg substitution on thermal stability, phase and chemical composition, morphology, and microstructure of synthesized and sintered Mg-HAp powders was evaluated by the following analytical techniques: differential thermal analysis (DTA), X-ray diffraction (XRD), and Fourier transform infrared spectroscopy (FT-IR), field emission electron microscopy/energy dispersive X-ray spectroscopy (FE-SEM/EDS). Crystallite sizes of as-synthesized and sintered powders were calculated using Scherer's equation.

III. Results

After synthesis and thermal treatment obtained XRD and FT-IR analysis did not show presence of $Mg(OH)_2$ and MgO in Mg-substituted hydroxyapatite products, which indicate complete Mg^{2+} ions incorporation into the HAp structure.

Through phase and chemical composition analysis was determined that the as-prepared powders were Mg-HAp products with different amount of Mg (0.21-4.72 wt%) incorporated into HAp structure. Mg concentration of Mg-HAp products is increasing by increasing the MgO content in $Ca(OH)_2/Mg(OH)_2$ suspension (Fig. 1).

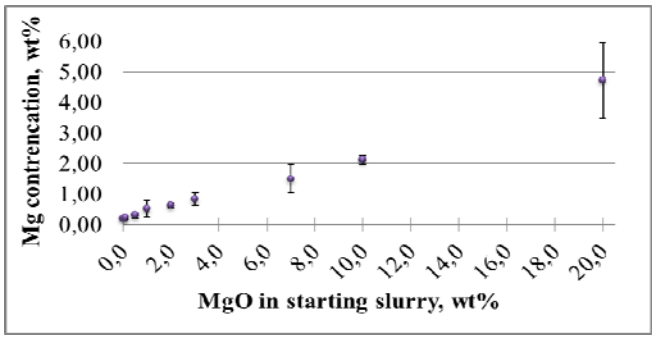

Fig.1. Mg concentration in HAp and Mg-HAp samples sintered at 1100°C for 1 h determined by FE-SEM/EDS analysis

FE-SEM confirmed that the HAp powder consisted of agglomerates of nanosized needle-like crystallites and Mg-HAp powders consisted of agglomerates of nanosized plate-like crystals. Mg incorporation into the HAp structure does not change the crystallite size of the as-synthesized and thermally treated products.

After sintering Mg-HAp partial transformation to Mg-substituted β-tricalcium phosphate (whitlockite, Mg-β-TCP) has been occurred. The volumic fraction of whitlockite increased with Mg content accompanied by decreased thermal decomposition temperature.

IV. Conclusions

Mg-substituted hydroxyapatite with variable amount of Mg incorporated into structure was synthesized by wet chemical precipitation. It has been evidenced that substitution of Mg in the HAp affects as-synthesized powder particle morphology, and thermal stability. Thermal stability of Mg-HAp samples decreased while increasing the Mg content.

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Calcium phosphate implant materials for regenerative medicine

Liga Berzina-Cimdina (*Riga Technical University*)

***Keywords* – calcium phosphate, biomaterials, bioceramics, *in vitro*, *in vivo*.**

I. Introduction

Calcium phosphate materials are the most often used and researched materials for bone regeneration. Long term research at RTU Riga Biomaterials Innovation and Development Centre (RBIAC) and collaborating institutions has shown that bone regeneration depends not only on material type (ceramic, cement, glass ceramics) and calcium phosphorus ratio, but also on the way these materials have been processed.

II. Discussion

There are many factors affecting properties of calcium phosphate implant materials. Research in RBIAC has shown that both calcium-phosphate ratio (besides other factors) of materials and quality of starting materials (presence of different admixtures) affect both synthesis of calcium phosphate starting material and tissue response.

Synthesis of stoichiometric hydroxyapatite (starting material for hydroxyapatite ceramic) as well as hydroxyapatite with defined calcium deficiency (starting material for biphasic calcium phosphate ceramics) is has been conducted using innovative approach. By varying synthesis pH and temperature (but not monitoring stoichiometry of reagents) it will be possible to synthesize high quality hydroxyapatite without impurities and defined calcium-phosphate ratio in large volumes suitable for industrial scale [1].

In RBIAC mechanically stable calcium phosphate ceramics with interconnected pores with size appropriate for bone tissue ingrowth and simultaneous large pore volume have been developed. The developed method utilizes viscous calcium phosphate ceramic powder suspension with ammonium carbonate. Upon drying the suspension ammonium carbonate forms gas bubbles in the ceramic green body [2]. The developed method is cheaper compared to other methods producing similar ceramics (e. g. 3D printing).

Phosphate-niobate glass ceramics (with calcium component) have been developed in RBIAC. The said system has been researched to find glass-forming compositions. The influence of processing parameters on crystalline phase forming in glass ceramics has been researched [3].

Various types of calcium phosphate materials are shown to have differences in biological properties. For example, sintered hydroxyapatite ceramics have 100 to 150% osteoblast cell attachment and proliferation compared to control material in *in vitro* tests, phosphate-niobate glass ceramics – up to 200%, other calcium phosphate materials show more moderate cell attachment and proliferation, for example, around 50% for α-tricalcium phosphate cements. There are also differences observed in specific protein expression (that is involved in bone regeneration and inflammation regulation) after 3 month implantation in rabbit bone tissue.

Calcium phosphate cements are implant materials that can be implanted as liquids or pastes and will harden inside the bone tissue. A composition of cement has been developed that allows cement also to be injected, but also allows rapid setting after implantation. It has been made possible to control setting time of the cement by varying composition of cement liquid phase [4].

Use of polymer materials to make calcium phosphate-polymer composites offers additional possibilities. For example, it has been shown that coating porous ceramic implants (intended for both bone tissue regeneration and drug release) with biodegradable polymers allows to control drug release rate from implants [5]. The polymer coating also modifies tissue response to the implant.

III. Conclusions

Synthesis protocol and quality of starting materials is of great importance for synthesizing hydroxyapatite and other calcium phosphates that are used to construct implant (e. g. cements, ceramics).

By controlling processing parameters when constructing the implant it is possible to obtain suitable properties – mechanically stable ceramics with interconnected pores, cements with short setting time, glass ceramics with variable phase composition.

Biological response is different for various types of calcium phosphate implant materials.

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Acknowledgment: Latvian Academy of Science the Latvian State Research Program "Development of innovative multifunctional materials, signal processing and information technology for competitive science-intensive products" project No. 4 "New materials and technologies for evaluating biological tissue, and replacement", VPP 7813.

The Impact of Mixing and $Ca(OH)_2$ Suspension Concentration on Hydroxyapatite Synthesis

Marina Sokolova, Andris Putnins and Imants Kreicbergs (*Riga Technical University*)

***Keywords* – Mixing, hydroxyapatite synthesis, wet chemical precipitation method.**

I. Introduction

Hyroxyapatite (HAp) is one of the most used implant materials in the reconstructive surgery to repair damaged hard tissues. HAp has excellent biomaterial properties due to its similarity to the inorganic component of the bone matrix.

The wet precipitation synthesis method of HAp is a heterogeneous reaction – HAp crystals are forming on $Ca(OH)_2$ particle surface. Such condition requires particular attention to mixing in the reaction vessel [1], [2].

II. Materials and Methods

A. HAp preparation

The wet precipitation process of HAp is based on the following reaction:

$$10Ca(OH)_2 + 3H_3PO_4 \rightarrow Ca_{10}(PO_4)_6(OH)_2 + 18H_2O$$

This method is characterized by low cost and easy application in industrial production, and that the only by−product is water, though the calcium phosphates phase composition is found to be highly depended on the changes in technological parameters. The synthesis process used to prepare HAp powder in this work is described in following illustration (Fig.1.).

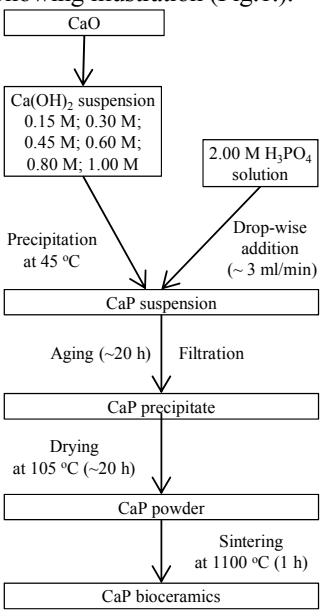

Fig.1. HAp preparation process

B. Experimental setup

Synthesis was carried out in 2 liter volume. For different mixing conditions two types of impellers were used: an anchor stirrer and a pitched blade turbine (PBT). The impeller characteristics are provided in Table I.

TABLE I
DIAMETER AND SPEED OF THE USED IMPELLERS

Impeller type	Diameter, mm	Speed, rpm
Anchor	140	120
PBT	61	290

C. HAp powder characterization

Fourier-transform infrared spectroscopy (FT-IR) was used to determine the various functional groups in the sintered calcium phosphate samples. X−ray diffractometry (XRD) was used to analyze phase composition of obtained bioceramics samples.

III. Results

By varying the concentration of suspension and mixing conditions, different phase compositions were obtained (Table II). HAp was found to be stable up to 1100° C when the $Ca(OH)_2$ suspension concentration was from 0.15 M to 0.45 M and impeller type was anchor, but with PBT HAp was observed if the $Ca(OH)_2$ suspension concentration was in the 0.15 M and 1.00 M range.

TABLE II
SYNTHESIZED PRODUCT PHASE COMPOSITION

Impeller	$Ca(OH)_2$ suspension concentration	Product
Anchor	0.15 M; 0.30 M; 0.45 M	HAp
	0.60 M; 0.80 M 1.00 M	HAp + β-TCP
PBT	0.15 M; 0.30 M; 0.45 M; 0.60 M; 0.80 M; 1.00 M	HAp

Experimental observations showed that using the PBT impeller $Ca(OH)_2$ particles are suspended through suspension volume which increases the mass transfer surface and reduces the formation of local concentration gradients which leads to unwanted by−products as β-TCP.

IV. Conclusions

Mixing has significant impact on the phase composition of the calcium phosphate product by wet precipitation synthesis method. With improved mixing it is possible to obtain up to 50 % more product mass in the same volume by using increased concentration $Ca(OH)_2$ suspension.

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Acknowledgment: This work has been supported by the European Social Fund within the project "Multidisciplinary Research in Biomaterials Technology of New Scientist Group",No.2009/0199/1DP/1.1.1.2.0/09/APIA/VIAA/090, (PVS ID 1380).

Lignin-based Polyelectrolyte Complexes and their Advanced Application

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***Keywords* – lignin-based polyelectrolyte complexes, adhesive, soil conditioner, surface tension regulator, lignocellulosic surface modifier.**

I. Introduction

Lignin constitutes one of the main renewable organic resources on the earth. Soluble lignins in the form of lignosulphonate and kraft lignin as by-products of the pulp and paper industry are obtained from commercial spent pulping liquors. They are low-cost, environmentally friendly and biodegradable polymers. Current annual global production of such type of lignins in pulp mills amounts more than 50 million tons, which approaches the whole production of the plastic industry. The dualism of the soluble lignin, combining the properties of polymer and electrolyte, gives the material the possibility to interact with synthetic or biopolyelectrolyte macromolecules (opposite charged, same sign charged, amphiphilic, etc.) in aqueous, aqueous-salt and aqueous-organic media with the formation of lignin-based interpolyelectrolyte complexes (LPCs). The conducted studies [1-3] have allowed establishing the basic relationships and the mechanisms of interactions of lignins, obtained by different delignification methods and derived from the various species of wood, with the different polyelectrolyte-partners in aqueous solutions, to determine the LPCs structure and its features as well as to study the LPCs properties for their advanced practical application.

II. Objects and Methods

Commercial and laboratory softwood and hardwood lignins such as lignosulphonate, kraft lignin and soda lignin were used. Polyelectrolytes-partners such as poly(dimethyldiallyl ammonia chloride), poly(dimethylaminoethylmethacrylate), poly(ethylenimine), copolymer of dimethylaminoethyl-methacrylate and methacrylamide, chitosan and poly(acrylic) acid were applied for obtaining the LPCs. Temperature of the interaction was varied from 20°C to 60°C. Preparation mode included mixing of solutions of lignin and polyelectrolyte under defined conditions (pH, ionic strength, concentration, temperature, time, etc.). Functional analysis, potentiometry, conductometry, turbidimetry, liquid chromatography, speed sedimentation, laser light scattering, electrophoresis, spectroscopy, viscometry, surface tension, etc. were employed for investigation of the LPCs.

III. results and Discussions

Usually, the obtaining of the LPCs proceeds spontaneously in aqueous media at room temperature, at normal pressure, and without using of any catalysts. The reaction between water-soluble lignin ($Lig^- A^+$) and strong poly(oligo)cation (P^+B^-) can be represented schematically in the following manner:

$$(Lig^- A^+)_x + (P^+B^-)_x \rightarrow (Lig^- P^+)_x + x\ A^+ + x\ B^-$$

The formed lignin-based polyelectrolyte complexes may be both stoichiometric and nonstoichiometric, water soluble, colloidal or water insoluble, depending on different factors such as the structural peculiarities of lignin and polyelectrolyte-partner, position and strength of their acidic/basic functional groups, accessibility of these groups, conformation of the polyelectrolyte chains, as well as on the molar mixing ratio, concentration, ionic strength, temperature, etc. The polyelectrolyte complexes can also exist both in aqueous solution and a solid state. The main reason of a structural stability of the LPCs to the action of various environmental factors is gained by the existed cooperative system of intermacromolecular linkages between the lignins and the polyelectrolytes, having an entropy nature. The character of these linkages can be different; besides of the ionic bonds, donor-acceptor, hydrophobic and covalent linkages play important role in primary and secondary stabilization of the LPCs particles.

The found regularities as well as the peculiarities of polymer structure of the studied LPCs were the basis for obtaining the new lignin-based polymeric products. The presence of the hydrophilic and hydrophobic blocks in the LPC structure gains its pronounced adhesive affinity to soil and lignocellulosic particles. This allows recommending them as a soil conditioner for improving agricultural and forestry soils, a dust suppresser for decreasing dust concentration on unpaved roads, an environmentally friendly adhesive for obtaining thermo-insulating boards, a modifier for lignocellulosic surface functionalization, etc. On the other hand, the amphiphilic nature of the non-stoichiometric LPCs gain their surface activity at the different interfaces and allows to use them in the quality of polymeric surfactant, emulsion stabilizer and interface surface tension regulator in polymeric composite materials.

IV. Conclusions

The modification of soluble lignins by interaction with cationic polymers for obtaining the interpolyelectrolyte complexes on their basis in aqueous-containing media can be regarded as one of the perspective environmentally friendly, energy saving methods for the development of the new inexpensive effective functional polymeric products based on technical lignins, the by-products of wood chemical and mechanical processing.

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The Study of the Synthesis of Nanosized Refractory Carbides by Carbothermal Reduction of Precursor Gels

Ilmars Zalite, Anita Letlena and Laila Cera *(Institute of Inorganic Chemistry)*

Keywords **– refractory carbides, nanosized powders, synthesis, properties.**

I. Introduction

The carbides of the transition metals – Ti, Zr, Hf – are important ceramic materials used for high-temperature applications, due to their superior mechanical and electrical properties at elevated temperatures [1, 2]. These materials exhibit high strength, good chemical, corrosion and oxidation resistance.

It has been proved that in many cases properties of nanostructured materials differ from those for materials produced from conventional coarse-grained polycrystals with the same composition. One of the ways to get materials with fine-grained structure is application of nanoparticles as a raw component in the compacting process [3].

Recently different methods of synthesis are used for production of nanopowders – hydrolysis, hydrothermal synthesis, pyrolysis, co-precipitation method, sol-gel method, high energy milling, microwave synthesis, plasma synthesis etc. Our research is focused on the investigation of chemical processing routes to obtain nanosized powders of carbides with a narrow particle size distribution.

In the present study, four refractory carbides - TiC, NbC, TaC and SiC - have been produced by carbothermal reduction of a precursor prepared by sol-gel process. The phase structure, crystallite size, morphology and specific surface area of the synthesized powders are investigated by XRD, SEM and BET respectively.

II. Experimental results

Binary hydrogels, in which the oxide gel and a pyrolysable organic compound are combined, were prepared as precursors for synthesis of corresponding carbides.

For TiC fabrication Ti isopropoxide, sucrose and acetic acid (Ti : C = 1 : 3.7) were used. Sucrose was dissolved in warm acetic acid (T ~ 80 °C) and cooled to the room temperature. Ti isopropoxide was slowly added and stirred approximately for 3h. The left acetic acid was evaporated at 80 °C.

For NbC fabrication Nb(Ta) hydroxide was precipitated from a solution of $NbCl_5$($TaCl_5$) (0.01 mol) in dilute HCl using ammonia. The hydroxide was washed, then suspended in water (at 0 °C) and treated with H_2O_2. After 1 h Nb(Ta) peroxo acid had formed. Excess of H_2O_2 and water was removed by heating at 80 °C and then sucrose solution was added.

All the gels were dried at 100 °C – 110 °C, grinded and sieved through sieve, then heated in Ar flow with the heating rate of (300 – 350) °C/h until 1400 °C and treated for 1 h – 2 h.

The XRD patterns of the above-mentioned carbides produced at optimal conditions (molar ratio of gel-derived C to Me, heating rate, sintering temperature and heat-treating time) show the presence of intensive carbide lines and only traces of oxide phases.

In the case of TiC, the molar ratio of gel-derived C to Ti greater than 1:1 is used for synthesis. It results in elevated content of free C. In return, the final product does not contain the oxide phase. SEM pattern shows a grain size about 100 nm.

The precursor for SiC synthesis (Si particles covered by the layer of C) was prepared by the coat-mix processing. Si particles were mechanically mixed with phenolic or epoxy resin in a definite proportion and than thermally treated in Ar flow. At 1500 °C liquid Si reacts with C forming SiC.

The results show that at an appropriate molar ratio of resin-derived C to Si high purity SiC can be produced. The colour of the powder is light grey, indicating that the free carbon content is low.

III. Conclusions

Transition metal (Ti,Nb,Ta) and silicon carbides have been successfully synthesized from different starting materials by sol-gel and coat-mix (SiC) processing accomplished by heat-treatment at 1400-1500°C. In all cases nanosized carbide powders of high purity are obtained.

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TABLE I

PROPERTIES OF SYNTHESIZED CARBIDE NANOPOWDERS

Compound	SSA, m^2/g	d_{50}*, nm	Chemical analysis , wt.%					Phase composition	Crystallite size, nm
			Me	O	N	C_{total}	C_{free}		
TiC	45	25-30	76.6	1.7	0.1	21.0	3.6	TiC	40-45
NbC	20-25	30-40	86.4	1.6	0	11.4	2.2	NbC	50-55
TaC	18-20	35-50	91.7	0.9	0	6.9	1.0	TaC	50-55
SiC	25-30	55-65	68.2	1.8	0	29.4	0.8	β-SiC	12-15

* **d_{50}** - average particle size, nm, calculated from SSA

The Effect of Starting Materials on Properties of Nanosized SiAlON Ceramics

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Keywords **– sialon, nanocomposite, pressureless sintering, mechanical properties.**

I. Introduction

The ceramic materials on the basis of Si_3N_4 including sialons are characterized with outstanding mechanical properties (hardness, bending strength etc.) at temperatures up to 1400 °C, and good wear and corrosion resistance. The diffusion velocity and the length of diffusion distance are of great importance for compacting of covalent compounds, for example sialons. The diffusion distance can be decreased by using nanocomponents for production of compact material.

The aim of this investigation is on the example of two sialon compositions find the effect of material starting components on sintering, structure, phase composition and properties of sialon materials.

II. Experimental results

Two α-sialon composites: $Y_{0,33}Si_{10,5}Al_{1,5}O_{0,5}N_{15,5}$ (composition 1) and $Y_{0,5}Si_{9,5}Al_{2,5}O_{1,0}N_{15,0}$ (composition 2) obtained by the mechanical mixing of separate Si_3N_4, AlN, Al_2O_3, Y_2O_3 nanocomponents (series A) or previously prepared Si_3N_4 - 27 wt.% AlN nanocomposite with Al_2O_3 and Y_2O_3 additives (series B) were used for research. Starting nanopowders were made by the plasma chemical synthesis [1].

Pure Si_3N_4 nanopowder is typical of particles of irregular form with the average particle size of 30-40 nm and the specific surface area of powder (SSA) of 50-70 m^2/g (dependent of obtaining regime). Powder consists of α- and β-Si_3N_4 (mainly in the ration 1:1) and the X-ray amorphous part. Depending oh the SSA the content of X-ray amorphous phase is in the range between 60 to 80 wt.%. Nanopowders of Al_2O_3 consists mainly of δ-, θ- Al_2O_3 phases, Y_2O_3 contains 30 wt.% of cubic and 70 wt.% of monoclinic phase.

Samples of sialon ceramics were made by the methods of pressureless sintering. Samples were pressureless sintered under nitrogen atmosphere up to 1700 °C with a heating rate of 10 °C/min and a dwell time of 2 hours.

Sintering temperatures of materials obtained from nanopowders are significantly lower than those for materials of sub-micron industrial powders [2]. Our research shows that essential for material formation is also the choice of starting nanocomponents. For example, replacing different Si_3N_4 and AlN nanopowders by the plasma-synthesized Si_3N_4-AlN nanocomposite (both of the same composition and dispersity), the sintering temperature of sialon decreases for approximately 100 °C. The same fact has been observed in the case of sialons of other composition in the all range of existence of α- sialons and near it.

The differences in material sintering process are related to the peculiarities of formation of used nanopowders: when Si_3N_4-AlN nanocomposite is produced in plasma, a lot of chemical interactions have been occurred already during producing of his composite: sialon phases possessing lower sintering temperature and less viscosity have been formed (for example, $Si_{1,8}Al_{0,2}O_{1,2}N_{1,8}$). Therefore the sintering of samples obtained from Si_3N_4-AlN nanocomposite occurs at lower temperature than for samples obtained from individual nanocomponents.

With the increase of the density also the hardness of material raises, reaching for the samples of Si_3N_4-AlN nanocomposite the maximum value in lower temperature (Table 1).

III. Conclusions

It was determined that sintering temperature decreased significantly, if Si_3N_4-AlN nanocomposite was used as one of the components. But the increased amount of α- sialon phase and higher hardness are characteristic for materials obtained from separate Si_3N_4, AlN, Al_2O_3, Y_2O_3 nanocomponents.

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Acknowledgment: The research was made due to financial support of the European Structural Funds (Project No. 2009/0215/1DP/1.1.1.2.0/09/APIA/VIAA/082)

TABLE I

CHARACTERISTICS OF SAMPLES (RELATIVE DENSITY, D %, AND HARDNESS,HV_{10},GPA)OBTAINED BY THE PRESSURELESS SINTERING

No.	m*	n*	1600 [°C]		1700 [°C]		1750 [°C]	
			d	HV	d	HV	d	HV
1A	1,0	0,5	95,7	16,5	97,8	18,2	97,4	17,9
1B			96,5	17,5	97,0	17,6	97,2	17,4
2A	1,5	1,0	89,3	14,9	97,3	18,3	96,6	18,4
2B			96,9	15,6	96,8	16,5	96,8	17,2

* - here "m" and "n" are parameters from the general formula $Y_{m/3}Si_{12-(m+n)}Al_{m+n}O_nN_{16-n}$

Biobased Natural Fiber Reinforced Green Composites

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Keywords **– biodegradable polymers, natural fibers, thermoplastic starch, mechanical strength.**

Nowadays, the use of natural fibers as reinforcement in polymer composites has received an increased attention due to their availability in large quantities, renewability, low cost, light weight, sufficiently good mechanical properties and biodegradability [1].

The present study was focused on the development of specific class of bio-composites denoted as "green composites" where bio-based polymers serve as matrix for natural fiber reinforcement and both of them are derived from renewable resources and are fully biodegradable [2].

The basic idea of our research was selection, optimization and comparison of distinct matrix materials from renewable resources and assessment of their suitability for designing of natural fibers reinforced green bio-composites.

Two kind of modified thermoplastic matrix materials were used:

- thermoplastic starch (TPS) based systems;
- blends of biodegradable biopolymers – poly (vinyl alcohol) (PVA) and microbially produced polyhydroxybutyrate (PHB).

The formation process of hemp fiber (industrial hemp fiber Bialobrzeskie – Poland brand cultivated in Latvia) reinforced composites was performed by suspension casting technique from waterborne matrix systems.

Influence of matrix compositions on the main characteristics of the obtained bio-composites was ascertained. All reinforced bio-composites were made with 30 wt. % of 3 mm long hemp fibers which were optimized earlier [3].

The best results in terms of mechanical strength for TPS based bio-composites were ensured by addition of PVA ($\sigma_t \sim$ 23 MPa, $E_t >$ 500 MPa); using matrix of PVA and PHB blends – by incorporation of native starch ($\sigma_t \sim$ 39 MPa, $E_t >$ 900 MPa) which could be explained by structure similarity of hemp and starch containing functional groups be able to interaction.

DSC measurements of individual PVA and PHB powders show that these biopolymers are thermodynamically incompatible. However, combined in a film, components express more complex thermal behavior – in accelerated temperature change rate variable PHB and PVA matrix interaction can be achieved.

It should be noted that presence of PHB in the composition of polymer matrix and surface hydrophobic treatment of reinforced composites diminished moisture absorption. Use of TPS based matrix and native starch additives facilitates biodegradation process in soil.

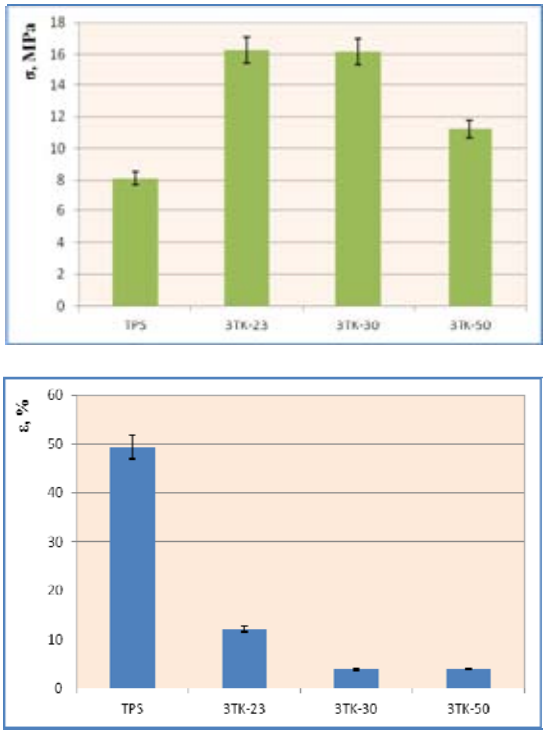

Fig.1. Tensile strength (σ_t) and elongation at break (ε) of TPS based hemp fiber reinforced biocomposites 3 – fiber legth, mm; 23, 30, 50 – hemp content, wt.%; K – hemp fiber;

Summary of obtained results testify that variety of designed ecologically-sound waterborne polymer matrix systems offer scope for development of biodegradable hemp fiber reinforced green composites with controllable mechanical characteristics and biodegradability.

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Hemp Fibres Containing Linear Low Density Polyethylene Composites Exploitation Properties

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Keywords **– hemp fibres, linear low density polyethylene, composites, exploitation properties.**

I. Introduction

Natural vegetable fibres and their textile waste are perspective reinforcements for polymers, for example, polyolefins modification. These composites are environmentally friendly innovative materials and their applications are defined by a low cost and density, as well as unlimited recourses with fast ability of reproduction in nature. Technological properties of these composites allow to process materials with traditional polymer processing methods. Our first investigations [1], showed perspective of composites based on linear low density polyethylene (LLDPE) with flax, cotton or hemp fibres as reinforcements.

In this paper results of investigations of exploitation properties: tensile strength, modulus, elongation at break, microhardeness, water resistance and fluidity of LLDPE and hemp fibres composites are presented.

II. Materials and methods

As polymer matrix was used LLDPE grade LL 6201 (MFI=50g/10min.). Modifiers were three kinds of hemp fibres grown in Poland (Bialobrzeskie-PL) and Latvia (Bialobrzeskie LV-1 and "Purini" LV-2). Hemp fibres (length up to 1mm) content in composites were in range from 10 to 40 wt.%. Composites were prepared by mixing of components on two rolls mills, then cooled, granulated and pressed in 1mm thick sheets from which were cut off specimens for tensile tests. Fluidity was estimated by MFI method ($T=190^0$ C, P=2.16 kg). Microhardeness (MH) was examined by Vickers M41 at load 200g. Water exposure experiments were done at room temperature ($+23^0$C).

III. Results and discussion

For all kinds of hemp fibres their chemical compounds, kinds and amount of admixtures, physical-mechanical properties: tensile strength, length of fibres, linear density and other properties were checked. It was found that the smallest amount of admixtures (4.5%) and smallest linear density (23.4 cN/tex) have fibres LV-2, but the highest amount of admixtures (6.3%), the longest fibres length (medium 289 mm) and the greatest tensile strength (35.1 cN/tex) have PL hemp fibres. Chemical compound of fibres differ. For PL hemp fibres are observed the greatest amount of cellulose fibres (70.5%), pektins (1.6%) and moisture content (9.6%). In the contrary LV-2 fibres have the smallest amount of cellulose (64.2%), pectins (1.4%) and moisture (9.2%), but hemicellulose (23.8%) and lignins (8.0%) are more. Investigations of composites tensile properties showed that for all kinds of fibres optimal content are 30 wt.%. Fibre reinforcement increase LLDPE matrix composites tensile strength two times and reach 21.8-25.8 MPa. The highest increase of tensile modulus (up to three times) were observed for composites containing PL hemp fibres (E_t=1485 MPa). Elongation at break dramatically decreased at filler content 10 wt.% and then changed little with increase of fibre amount and practically were similar for all composites. This fact shows that influence of fibres on LLDPE macromolecules movability are similar and therefore deformation ability of materials are the same. Practically all composites with 30 wt.% filler content maintain good technological properties. MFI measurements gave values of 1g/10min. for PL and 2 g/10min. for LV-1 which is sufficiently to process these composites with traditional polymer processing methods. Necessary to note that composites containing fibres with more admixtures have lower fluidity (PL) and composites with 40 wt.% fillers lose possibility to flow at MFI measured conditions. Microhardeness experiments revealed increase of material hardeness with increase of fibres content up to 40 wt. %. in all cases. The greatest MH values are reached for systems with PL fibres 40 wt.% (76.4 MPa). Here we can see correlation between MH values and compound of hemp fibres. PL hemp fibres contain more cellulose fibres and rough particles of admixtures which could promote increase of MH of materials. As expected water resistance experiments gave results which are typical for natural fibres containing composites. Water absorption of system increased with increase in fibres amount. During 240 h quantity of absorbed water reach 10.8-12.1% and at this time we had not managed to reach equilibrium values.

IV. Conclusions

Exploitation properties investigations of composites based on LLDPE/hemp fibres showed that all used fibres can be successfully utilized for preparing composite materials.

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Investigation of Possibility to Regulate Boundary Processes in Composite Material Made from Scrap Tires and Polymer Binder

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***Keywords* – scrap tires, polymer binder, modification, adhesion, hardness.**

I. Introduction

One of the most perspectives directions of used tire recycling is combination of scrap tires with polymer binder and a production of composite materials[1].

The present work must be considered as sequel to previous investigations[2, 3]. It is an investigation of possibility to regulate the boundary processes in composite material made from scrap tires and polymer binder. The modification of rubber crumb was realized by means of treatment with inorganic acid and alkali in order to improve adhesion between rubber and polymer binder.

The compressive stress and compression modulus of elasticity at 10% deformation, Shore C hardness, tensile strength and elongation at break and impact strength as well as apparent density of composite material in correlation with its composition as well as adhesion between rubber and polymer binder were investigated.

The results showed possibility to achieve significant changes in mechanical properties of composite material by adaptation of selected rubber crumb modification methods and therefore regulation of boundary processes in close correlation with the composition of material.

II. Experimental

Mechanically grinded at ambient temperature, modified and non-modified rubber crumb, obtained from used tires with particle size from 0.2 till 7.0 mm and polyurethane type binder with selected reactivity, were used in order to produce composite material's samples. Different compositions of rubber crumb and polymer binder (from 8 till 23 wt.%) were used.

Samples of composite material were prepared under constant and definite conditions: formation temperature (17-22^{0}C), molding pressure (0.004 MPa), curing time (24 h) and relative air humidity (20–40 %).

Chemical modification of rubber crumb with 96% sulphuric acid and alkali (10 %) at selected treatment time was used in order to estimate possible intensification of adhesive interaction between polymer binder and rubber particles.

In order to determine changes of rubber surface energy before and after modification wetting properties (Contact wetting angle Θ° of water droplet on rubber surface) of solid rubber samples were examined. Special samples were prepared in order to examine strength of adhesive bonding between the polymer binder and modified rubber surfaces. For this purpose Peel test (90°, speed 50 mm/min) was used according to LVS EN 28510-1.

The apparent density AD (kg/m^3) of composite material was determined according to LVS EN 1602. Shore C hardness was investigated by using Shore durometer (Type C; ISO 7619, ISO 868). Mechanical properties of composite material (compressive stress at 10% deformation and compressive modulus of elasticity) were determined by using testing apparatus Zwick/Roell7020 according to LVS EN 826. In the tensile mode of loading ultimate tensile strength and elongation at break for specially prepared samples with definite dimensions were determined according to LVS EN ISO 527-3. In order to determine impact strength (impact energy) of samples *Zwick IPM- 8* testing aparatus was used.

III. Results and Discussion

Chemical modification of rubber crumb showed significant changes of apparent density comparing to composite material's samples prepared at the same conditions where non-modified rubber crumb was used. This partially can be explained because of the essential changes in a particle size distribution of rubber crumb after chemical modification.

The present experiment showed that Shore C hardness increases comparing to the composite samples where non-modified rubber crumb were used probably due to destruction of double bonds on the rubber's surface and consequently loss of their elasticity. Besides to that, more similar shape of rubber particles after chemical modification was observed.

The chemical modification of rubber surface with sulphuric acid and alkali was carried out mainly in order to investigate subsequent changes of adhesive interaction (bonding) between rubber and polymer binder on mechanical properties of composite material.

Experimental results of peel test for specially prepared samples showed that chemical modification of rubber surface really promotes adhesive bonding for selected samples and therefore peel strength increases due to more active interaction between components of the adhesive joints. Adhesive interactions between rubber particles and polymer binder have significant influence not only on mentioned above properties of composite material (Shore hardness and peel test results).

Testing results in tensile and compressive modes of loading of composite material also demonstrated direct impression of rubber crumb modification on selected properties mostly due to intensification of boundary processes.

IV. Conclusions

The results showed that the selected properties of composite material are highly dependent of rubber crumb treatment with sulphuric acid and alkali because intensification of the boundary processes.

Investigated methods of the modification of rubber crumb could be recognized as useful in purposeful improvement of composite material's mechanical properties

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Preparation and Characterisation of PEO/SiO_2 Nanocomposites with Addition of TEOS Binding Agent

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Keywords **– hybrid, nanocomposite, polyethylene oxide, TEOS.**

I. Introduction

Reinforcement of polymers with a second organic or inorganic phase to produce a polymer composite is very common in the production of modern plastics. Polymer materials are usually reinforced by miscellaneous fillers (glass fibers, other inorganic materials) to improve mechanical properties [1]. Such materials are widely used in diverse areas including transportation, construction, electronics and consumer products.

Inorganic objects or particles have long been used as reinforcing fillers in polymer systems because of low cost and the improved some mechanical properties of the resulting polymer composites. All other parameters being equal, the efficiency of a filler to improve the physico-mechanical properties of a polymer system is sensitive to its degree of dispersion in the polymer matrix. Until recently, silica SiO_2 particles could be dispersed only on microscale, ie. in these composites, the polymer and the filler are not homogenously dispersed on a nanometer level. Nowadays polymer nanocomposites represent a radical alternative to these conventionally composites [1,2].

It need to be stressed, that, nowadays, preparation of polymeric nanocomposites with finely controlled structure at different hierarchy levels, especially, at nanoscale, remains as one of the very promising ways of properties modification in the field of the polymer composite technology science [1-3].

Many approaches are used to achieve necessary material engineering characteristics. Thus, tremendous improvement can be achieved with the addition of different nanofillers. Nanocomposites can be processed by different methods from solution, emulsion and melt states.

Thereof, polymer hybrid nanocomposites with several TEOS and SiO_2 content were investigated. SiO_2 are chosen for one of potential nanoscale reinforcing additives. There second continuous phase of the considerable interest for preparation of engineering material with enhanced properties is TEOS due to the formation of spatial network structure and *in situ* development of nanoparticle in the polymer matrix.

The present paper consists of novel designed polymer composite samples with different filler percentage composition, using PEO as matrix and the additives - tetraethylorthosilicate, silica nanoparticles and lithium chloride. Nanocompositions were prepared by solution blending by the use of mechanical and magnetic mixing and additional dispersion with ultrasound. As a result, preparation method's and filler concentrations showed influence onto nanocomposites spectral effects, tensile strength, microhardness and electrical properties.

Prepared mixtures were solution casted to develop thin films for further investigations. Strength, deformation, microhardness and electrical conductivity characteristics are investigated. Relationships of preparation, structure and properties are discussed.

II. Results and Discussions

It is found that TEOS interact favorably with the polymer host as polyethylene oxide. Hybrid organic-inorganic nanocomposites produced by dispersing TEOS and addition of SiO_2 into a polymer matrix exhibit enhanced physical and chemical properties in relation to the neat polymer matrices. The addition of a few weight percent of SiO_2 increased the modulus and the strength by over 100% for some prepared hybrid systems. Significant increases in the thermal stability, degradation temperatures and decrease of vapour permeability, in comparison to the neat polymer material, were noticed.

Considered dependency of overall properties on the microstructural features, the structure and morphology of studied hybrid materials of polymers mixed with layered silicates were also examined.

The experimental results show:

1. FTIR spectorgraphs of the TEOS and SiO_2 nanoparticles containing samples confirmed the presence of amorphous silica glass.
2. Use of TEOS link-agent greatly increases the mechanical performance of samples, caused can be formed the polymer matrix, TEOS and fillers links.
3. The Young's modulus of nanocomposites increases proportionally with filler concentration, which is caused with high mechanical properties nanoscale objects were entered into PEO.
4. The presence of lithium ions impairs the mechanical properties of prepared due to plastification effect. However, lithium ions containing compositions greatly increases its conductivity.
5. Microhardness values of all samples, except for samples with the presence of lithium, are increased proportionally with increasing filler content.
6. It is accepted, that TEOS forms dielectric shield around the filler particles, which impairs the conductivity of samples

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Crushing of mineral particles by control of their kinetic energy

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***Keywords* – Centrifugal crusher, kinetic energy, grindability.**

I. Introduction

The present work describes the results obtained using a specially designed centrifugal crusher with rotation frequency control. The particles are accelerated by the rotating disc of the crusher and they escape having obtained a specific kinetic energy. This work provides the mathematical model that enables one to calculate the velocity and the kinetic energy of the particles at the moment they escape from the disc and crush on the opposite, vertical wall. Crystalline limestone, marly limestone and serpentines of different size fractions are crushed at different energy inputs and the size distribution of the products is used to draw conclusions and also compare the grindability of the rocks tested.

II. Description of the Crusher

The equipment used is a locally made centrifugal crusher described in detail by D. Stamboliadis [1]. It consists of a horizontal rotating disc, 500 mm in diameter, surrounded by a homocentric, cylindrical cell 900 mm diameter. The disc rotation axis is vertical and is linearly and directly connected to the axis of an electric motor through a cobbler. The rotation frequency of the motor and consequently of the disc is controlled by an inverter in the range of 700 to 2500 rpm.

Fig.2. Internal view of the crusher

III. Calculation of the Kinetic Energy

The calculation of the kinetic energy of the particles at the moment they escape from the disc is presented in this paragraph and is based on Newton's laws. The specific kinetic energy (J/kg) of the particles is calculated by equation (15) and depends only on the disc diameter D (m) and the rotation frequency N (Hertz)

$$E = (\pi \cdot D \cdot N)^2 \qquad (15)$$

IV. Materials Used

Three different materials are used, namely 1) crystalline limestone, 2) marly limestone and 3) serpentine. The mineralogical and chemical composition of the samples is detected by the XRD and XRF methods while their structure is examined by microscopy.

V. Technical Proceedure

Each material is classified into size fractions of very narrow size range 16-22.4 mm, 8-11.2 mm, 4-5.6 mm, 2-2.8 mm and 1-1.4 mm. Each size fraction is crushed in the crusher at different rotation frequencies 750, 1000, 1500, 2000 and 2500 RPM. The products are classified into size fractions using screens with a ratio 2.

VI. Experimental Results

The cumulative mass % passing of the products, from the same feed size, produced at different energy inputs ais plotted in the same figure versus the screen size. These figures show the effect of energy on the product size. The relative size is defined as the ration of a screen size of the product to the maximum screen size in the feed. In the next series of figures the cumulative mass % passing of the products, for the same energy input, produced from different feed sizes is plotted in the same figure versus the relative size. These figures show the effect of feed size on the size of the product for the same energy input.

The comparison between the different rocks materials used is done in figures where the cumulative mass % passing is plotted for a particular feed size and a particular energy input versus relative size for the different materials.

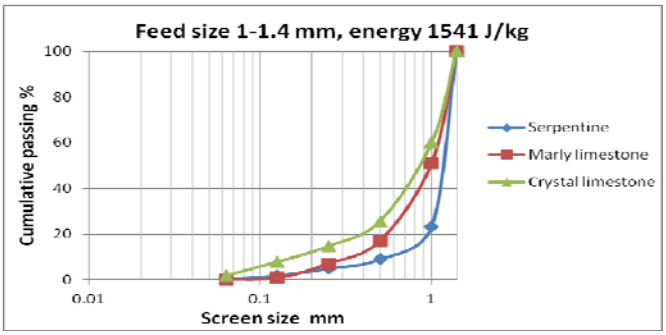

Fig.9. Comparison of the materials

In Figure 9, presented above, the feed size is 1-1.4 mm and the energy input 1541 J/kg. In this case marly limestone breaks faster than crystalline limestone and serpentine.

VII Discussion and Conclusions

In this chapter the results are discussed and some conclusions are made. Finally some propositions are made for further work that has to be the quantitative mathematical modeling of the results presented here in a qualitative form .

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Porous Corundum and Mullite Ceramics

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***Keywords* – porous ceramics, alumina, corundum, mullite.**

I. Introduction

One of the methods for producing porous materials is application of chemical reactions, e.g., oxidation of organic compounds (combustible additives) or use of aluminium (Al) in the aerated concrete technology. It was found that aluminium's reaction with water can be used to produce porous material on the basis of kaolin and alumina (Al_2O_3) [1]. This method is similar to the aerated concrete technology and is based on the fact that very fine Al particles can react with water in alkaline medium (pH>8) at a room temperature. The chemical reaction is described by the following equation:

$$2Al + 6H_2O \xrightarrow{pH>8} 2Al(OH)_3 + 3H_2 \uparrow . \qquad (1)$$

During the reaction evolves the hydrogen gas. This gas forms metastable pore structure in a proper range of suspension's viscosity. Pore structure fixes during solidifying process. This reaction is catalyzed both by kaolin, and γ-Al_2O_3.

The advantage of this technology is possibility to produce items of complex shapes with high apparent porosity (up to c.a. 70%). Moreover, the reaction products are not harmful to the environment and to the material properties.

The initial aim of the research was to develop porous heat insulating material on the basis of mullite. Kaolin was used as the main raw material. It serves also as a binding agent in the green samples. It is also possible to produce pure corundum ceramics; however, in this case organic binder must be used. Corundum has good thermal stability and corrosion resistance at high temperatures. Mullite has good thermal shock and creep resistance.

With this method it is possible to produce materials with various compositions on the basis of Al_2O_3 without addition of kaolin Material properties can be tailored with addition of SiO_2, ZrO_2, TiO_2, MgO etc.

In this paper are described some properties of porous corundum and mullite ceramics depending from the used raw materials. The investigated materials are produced by slip casting technology and using chemical reaction for pore forming.

II. Materials and Methods

To prepare samples were used α-Al_2O_3 (mean particle diameter (MPD) 3 μm) and γ-Al_2O_3 (MPD 80 μm). For mullite forming were used various raw materials – kaolin ($Al_4(OH)_8[Si_4O_{10}]$, d_{50} 1.5 μm), chemically pure amorphous SiO_2 (MPD 1 μm and 0.5 μm), SiC (MPD 80 nm) and Si_3N_4-Al_2O_3-Y_2O_3 (91%-6%-3%) (MPD 74 nm) nanopowders. Powders were mixed with distilled water (up to 39 wt%). If kaolin is not added, organic binder (e.g., sodium salt of carboxymethylcellulose) must be used. Pore forming agent is Al paste (MPD 10-15 μm). Samples were sintered at temperatures up to 1750°C and characterized by using hydrostatic weighing, DTA, XRD, SEM, mercury porosimetry and three point bending test.

III. Compositions' Effect on the Properties of Materials

It is possible to produce materials with compositions varying from pure corundum to prevailing mullite phase by slip casting combined with previously described pore forming method.

A. Effect of Al_2O_3 type and particle size on the properties of the material

It was found that materials' properties (especially mechanical strength, apparent porosity and bulk density) are affected by particle size, particle size distribution of the raw materials and the polymorphic modification of Al_2O_3. Only γ-modification of alumina has catalytic effect on hydrogen evolving reaction. When using α-Al_2O_3 (MPD 3 μm) and γ-Al_2O_3 (MPD 80 μm) apparent porosity increases and mechanical strength decreases by increasing amount of coarser particles.

B. Options for mullite forming and mullite's influence on the properties of the material

The properties of the material are significantly affected by the ratio of corundum and mullite phases and the compounds for mullite forming. If for mullite forming is used kaolin, as an undesirable phase forms crystobalite. This phase has negative effect on the material properties because it forms glassy phase at temperatures above 1700°C.

The effect of the amount and type of the SiO_2 source on the material properties is ambiguous. If SiC and Si_3N_4 nanopowders are used mechanical strength of the material increases up to four times (from c.a. 2 MPa to c.a. 11 MPa for corundum ceramics and for the material modified with itria and alumina doped Si_3N_4, respectively). The bending strength of the samples modified with amorphous SiO_2 depends on the amount of the added SiO_2. If the amount of the added SiO_2 exceeds c.a. 7 wt%, the bending strength is lower than that of pure corundum samples. Almost in all cases formation of mullite phase decreases the bulk density. The exception is in case when the nanopowders are used as the silicon source for the mullite formation.

Formation of mullite in the most cases decreases the total shrinkage of the material. Exception is when the kaolin and silicon containing nanopowders are used.

IV. Summary

There are many opportunities in the regulation of the properties of porous corundum and mullite ceramics. It is possible to adjust strength, bulk density and other properties by varying the particle size distribution of the raw materials, the ratio of mullite and corundum and by selecting different types of raw materials for the mullite forming, e.g., kaolin, SiO_2 with various particle sizes or compounds which oxidize and form SiO_2.

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Effect of Curing Conditions on the Mechanical Properties of Alkali Activated Material

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Ilze Vircava (*Latvia University of Agriculture*).

Keywords **– Alkali activation, illite-based material, mechanical strength, inorganic polymers.**

I. Introduction

Alkaline activation is a chemical process in which a powder material of an alumosilicate nature is mixed with an alkaline activator to produce a paste that is able to set and harden in a short time [1,2]. The reaction process of this system is characterized by dissolution of alumino-silicate oxides and followed by the polymerization reaction of those dissolved species, in the presence of alkali ions for charge balancing in framework cavities nearby AlO_4 constituents. The reaction produces SiO_4 and AlO_4 tetrahedral frameworks linked by shared oxygens as polysialates or polysialate-siloxo or polysialate-disiloxo depending on the SiO_2/Al_2O_3 ratio in the system [3]. The connection of tetrahedral frameworks is occurred via long range covalent bonds. Thus, geopolymer structure is perceived as dense amorphous phase comprising of semi-crystalline 3-D alumino-silicate microstructure. It is three-dimensional CaO-free alumino-silicate binder obtained using inorganic raw material having pozzolanic properties such as some aluminosilicate natural minerals or clays [4].

The aim of this study was to investigate effect of curing conditions on the mechanical properties of alkali (6M KOH) activated illite clays of Latvia. The results of compressive strength were explained by means of Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD).

II. Results and Discussion

Three Quaternary clays of Latvia with different Si/Al ratio were used for material synthesis. Results of chemical composition show that Si/Al ratio varies from 2,7 (clay K1), 3,5 (clay K2) and up to 4,0 (clay K3). All clays were characterised by X-ray diffraction analysis showing that the basic clay mineral is illite with some content of kaolinite. Besides all clays contain more or less carbonates, such as calcite and dolomite, but clay K3 – plagioclase as well. Clays are more or less rich in quartz.

Compressive strength measurements are widely used as an indicator to assess the success of inorganic polymer technology. This is due to the low cost, simplicity as well as due to the fact that strength development is a primary measure of the utility of these materials in various applications [5]. Curing took place at different temperatures (20, 40, 60 80 and 100 ^{0}C) in order to enhance structural bonding and then the hardened (7 up to 28 days) products were subjected to compressive strength testing (table 1).

The general trends observed from Table 1: mechanical strength of alkali activated clays are greatly dependent on (1) raw material and (2) curing conditions. During the alkali attack of the alumosilicate material containing clays, an initial nucleation phase takes place where the alumosilicate species are dissolved. When the nuclei reach a critical size, they start to crystallize, but this is a very slow process so it may be completed after a definite time depending on clay composition. Depending on the different SiO_2/Al_2O_3 ratio in the used clays decreases the initial rate of hardening.

TABLE I
COMPRESSIVE STRENGTH OF MATERIALS

Raw material	Curing temperature, ^{0}C	Compressive strength, MPa	
		7 day hardening	28 day hardening
Clay K1	20	5.0	10.0
	40	10.5	20.0
	60	16.6	38.0
	80	34.0	42.0
	100	50.0	65.0
Clay K2	20	0	12.2
	40	4.8	13.6
	60	7.6	11.1
	80	5.3	9.5
	100	5.0	8.2
Clay K3	20	0	6.0
	40	4.0	7.6
	60	4.1	7.8
	80	4.2	9.8
	100	4.2	12.0

It was observed that the best results after 28 day hardening showed K1 clay, where SiO_2/Al_2O_3 ratio is 2,7. Compressive strength of alkali and thermally activated materials decreases with the increasing of this ratio in the used clays

FTIR-spectra showed the differences among absorption frequencies for the untreated clays and activated ones and are a good indication of the transformations taking place during synthesis of geopolymer materials. X-ray diffractograms of hardened materials showed the presence of a low broad 2θ (18-25^o) peak band with a high intensity indicating the formation of the amorphous alumino-silicate phase of inorganic polymer material [6].

It can be stated that factors such as the presence of K_2O/Na_2O and CaO in the original clays, curing/thermal treatment had a significant correlation with the obtained compressive strength.

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Synthesis, Properties and Applications of Magnetic Iron Oxide Nanoparticles

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Keywords **– magnetic nanoparticles, iron oxides, sol-gel coatings.**

I. Introduction

Systems made of iron oxides nanoparticles, have an enormous potential towards applications in several areas such as magnetic recording technology, pigments, catalysis [1], biosensors, drug delivery, magnetic resonance imaging etc. It is well known that magnetite is a naturally occurring ferrite mineral with magnetic properties and has an inverse spinel structure [2].

II. Experimental

A. Materials

The following chemical precursors were used for magnetite synthesis: $FeCl_3 \cdot 6H_2O$ (Aldrich, 98%), $FeSO_4 \cdot 7H_2O$ (Aldrich), and ammonia solution (Chempur, 25%).

B. Method

Magnetic nanoparticles Fe_3O_4 were prepared using coprecipitation method [5]. An argon flux was used to deoxygenate water to prevent Fe^{2+} oxidations. A coprecipitation in alkaline media starting a mixed $FeSO_4 \cdot 7H_2O/FeCl_3 \cdot 6H_2O$ solution with a molar ratio of $Fe^{2+}/Fe^{3+} = 0.5$ (10 ml 0.0125 M Fe^{2+} and 20 ml 0.0125 M Fe^{3+} in 200 ml distilled water). 50 ml of 1 M aqueous ammonia were added (pH 10). After precipitation the iron oxide nanoparticles were washed with ethanol. Particles were then dried at 45°C for 24 h.

C. Characterization

The as-prepared Fe_3O_4 nanoparticles were characterized with various instruments such as scanning electron microscopy (SEM), X-ray diffraction (XRD), differential thermal analysis (DTA) and Fouries transform infrared spectroscopy (FTIR).

III. Results

A. X-ray power diffraction

Figure 1 shows the XRD pattern of the sample, which is quite identical to pure magnetite, indicating that the sample has a cubic crystal system. The mean particle diameters were also calculated from the XRD pattern [6] according to the linewidth of the (3 1 1) plane refraction peak using Scherrer Eq. (1):

$$D_C = \frac{k\lambda}{b\cos\Theta}. \quad (1)$$

The estimated average size of the Fe_3O_4 nanoparticles is about 10 nm.

B. SEM image of Fe_3O_4 nanoparticles

Figure 2 shows the SEM image of the Fe_3O_4 nanoparticles. According to the SEM images, the agglomeration is very strong. The agglomeration is due to the Van der Waals force between the particles.

C. FTIR spectra of Fe_3O_4 nanoparticles

Figure 3 shows FTIR spectrum of Fe_3O_4 nanoparticles. The characteristic absorption of Fe_3O_4 was at 594.08 cm^{-1} relates to Fe-O bond [7].

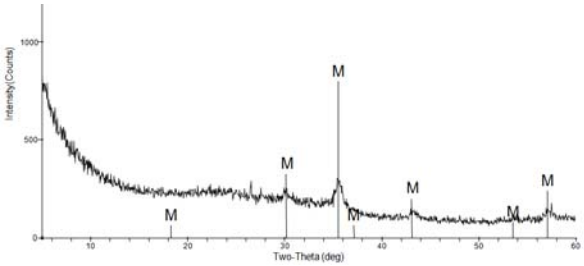

Fig.1. XRD pattern of Fe_3O_4 nanoparticles.

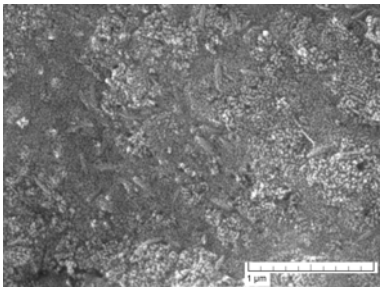

Fig.2. SEM micrograph for Fe_3O_4 nanoparticles.

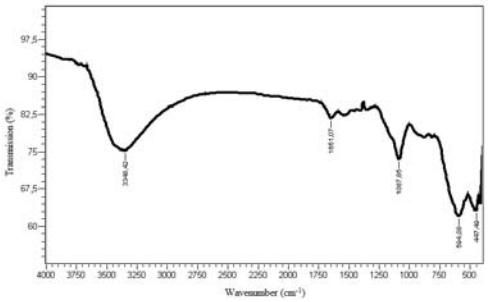

Fig.3. FTIR spectrum of Fe_3O_4 nanoparticles.

IV. Conclusion

Magnetite nanoparticles were synthesized by coprecipitation method. XRD results indicante that the average size of particles was 10 nm and that particles are purely Fe_3O_4 nanoparticles. The presence of magnetite functional groups has been confirmed through FTIR spectrum.

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Porous Mullite Ceramics Doped with WO_3

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Keywords **– Mullite-corundum, tungsten oxide, alumina, kaolin, porous refractory ceramics.**

I. Introduction

Ceramics based on alumina (Al_2O_3) and silica (SiO_2) have such properties as high refractoriness, high bending strength and high creep resistance, good chemical and thermal stability. Mullite ($3Al_2O_3{\cdot}2SiO_2$) phase is the important stabile crystalline phase in the alumosilicate system. Therefore, mullite ceramics with high porosity serve as a heat insulator and filters, as well as can be used in constructional and thermal engineering. Our porous mullite ceramics were obtained by slip casting of suspension of raw materials. The metallic aluminium paste is used as pore forming agent [1]. The WO_3 additive influences on the properties of mullite ceramics [2].

II. Experimental Procedure

A. Raw materials and Characterization

Commercially available Al_2O_3 (*Nabalox, Germany*): α-Al_2O_3 (d_{50}=4 μm) and γ-Al_2O_3 (d_{50}=80 μm), kaolin (*MEKA, Germany*) (with SiO_2 -56.2 wt%, Al_2O_3-31.0 wt%, Fe_2O_3-0.29 wt%, kaolinite 72 wt%, quartz 21 wt%, illite 7 wt%), pure SiO_2 (d_{50}=6.94 μm), WO_3 (d_{50}=5 μm) powders were used as the starting materials. Aluminium paste (*Aquapor 9008*) was used as the pore former. Distilled water was needed for creation of raw materials suspension.

Mullite stechiometric compositions is $3Al_2O_3{\cdot}2SiO_2$, therefore Al_2O_3 and SiO_2 were in 2.57:1 ratio in all samples. In all compositions of samples α-Al_2O_3 and γ-Al_2O_3 were used in the ratio 1:3. The quantity of kaolin was 30 wt%. The weight percentage of WO_3 additive was 5% of dry raw materials mass. Water content in the suspensions was 38-40 wt%, aluminium paste was 0.18 wt% in all samples.

B. Preparation of the Samples and Testing Method

The technological method of the sample preparation included three main processes. First of them was preparation of suspension of raw materials with following adding of suspension of Al paste. Slip casting of final suspension in the mould, pore formations and solidification of the suspension were the second stage. The third process was the drying of the samples (24 hours, T=50°C) and sintering at the necessaries temperatures (1200°C, 1300°C, 1400°C and 1500°C, holding time - 1 hour).

Important moment of our method was the pore forming. It was achieved by hydrogen elimination as a result of the chemical reaction of Al with water [1, 5]. A more detailed process of obtaining of the samples described in the full version of article and represented on the Fig. 1.

In our work we analyzed phase compositions of samples, as well as such parameters as shrinkage, bulk density, porosity, thermal and mechanical properties of ceramics. For these we used the XRD analysis, differential thermal analysis, pore size distribution by Hg porosimetry, hydrostatic weighting and thermal shock by rapidly changes of temperatures (from 1000°C to 20°C). The elastic modulus of the samples after 1st, 2nd, 3rd, 5th, 6th, 8th and 10th cycle of thermal shock was measured with nondestructive acoustic method called the impulse excitation technique, also as destructive method was used three point bending strength.

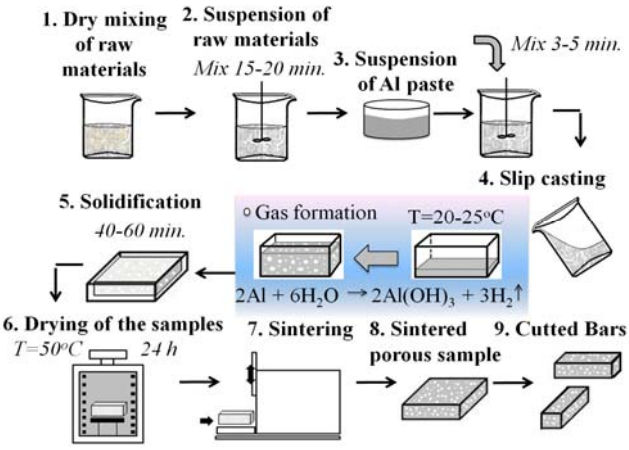

Fig.1. Scheme of technological process of ceramics preparation

III. Results and Discussions

The results of analysis and tests showed, that the exothermal DTA peak at 995.56°C corresponded to mullite formation. This temperature of mullite formation is lower compared to the samples without WO_3 additive, which were investigated in our previous works. The mullite was the predominant phase; corundum phase also was in these samples. Phase of aluminium tungsten oxide was in different quantities in all samples. Bulk density for all samples was about from 1.06 to the 1.24 g/cm^3. Shrinkage is 1% and 1.50% for samples fired at the 1200°C and 1300°C, but it increased after 1500°C and 1600°C, became 5.23% and 6.61%, respectively. Porosity and mechanical properties of samples also were determined in our work.

IV. Conclusions

The mullite is the main phase in all materials that were sintered at the different temperatures. Usage of WO_3 additive decreased the temperature of mullite's formation, the bulk density and shrinkage, but increased porosity of samples.

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The Development and Investigation of Properties of new Finishing Material Composition for Window Opening

Jekaterina Kucinska, Inna Juhnevica (*Riga Technical University*) and Baiba Migliniece (*SIA SAKRET*)

Keywords **– dry mix, finishing material, portlandcement, polymer additive, lightweight foamed glass filler.**

I. Introduction

Nowadays, common flat or home renovation cannot be made without dry mixes. They are irreplaceable in high quality building and finishing works, using modern technologies and design solutions.

II. Experimental

In the experimental part is described the process of the acquisition of new window openings cement-based finishing material, using organic and polymer additives, as well as lightweight foamed glass filler. New cement-based finishing material physicochemical properties, such as: compressive and flexural strength, full and capillary water absorption, thermal insulation properties, and pore distribution were investigated.

A.Materials

Following basic raw materials: cement (CEM I 42,5 N), limestone flour, lime, cellulose ether, two polymer additives (copolymer of ethylene, vinyl laurate and vinyl chloride; copolymer of vinyl acetate and ethylene), sand and lightweight foamed glass filler (tab.1) were used.

B.Methods

In the window openings finishing material production was successfully used by dry mix production technology. There were measured by the bulk, pore content and fluidity of the fresh mortar. X-ray diffraction analysis (XRD) were made and FT-IR spectrum taken of the acquired samples.

TABLE I

THE COMPOSITION OF NEW FINISHING MATERIAL FOR WINDOW OPENING

Components	**Quantity, mas%**
CEM I 42,5 N	40,0
Sand (0-1 mm and 1-2 mm)	18,6
Limestone flour	2,7
Lime	10,0
Organic complex	0,3
Cellulose ether	0,2
Polymer additives	1,2
Lightweight foamed glass	27,0

III. Results

C. Full and capillary water absorption

The level of the full absorption of the water almost achieved 50%. In such material there is a high open pore amount, which ensures good thermal insulation properties (Fig.1.).

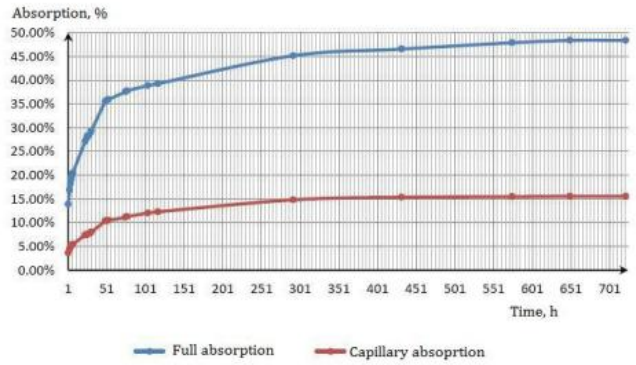

Fig.1. Full and capillary water absorption of new material

D. FT-IR spectrum of new finishing material

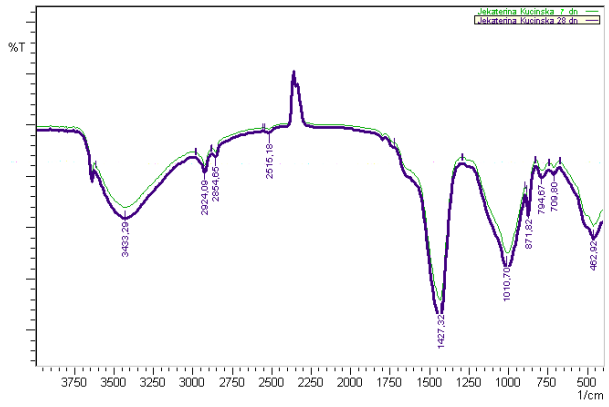

Fig.2. FT-IR spectrum of new material

FT-IR spectrum represents the number of absorption bands. The wide intense band at 3433,29 cm^{-1} is characterized by H-O-H stretch vibrations. Characteristic absorption bands for silicate materials were obtained. The Si-O-Si asymmetric strain vibration and the Si-O-Si valence vibrations were identified by the absorption bands at 462 cm^{-1} and 1010 cm^{-1}. The absorption band at 2924 cm^{-1} corresponds to CH vibrations in the CH_2 group, which indicates the organic and polymer additives presence in the resulting material [1,2].

IV. Conclusions

The developed dry compound composition could be used in window opening finishing works.

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Low-temperature Hydraulic Binders for Restoration Needs

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Keywords **– restoration, hydraulic components, low-temperature binder, Roman cement.**

I. Introduction

In the late 19th/ early 20th century in Europe the main type of hydraulic binders used in architecture were low-temperature natural cements – Roman cements. They were produced from clay containing carbonatic rock by firing at low temperature (800-1200°C) and fine grinding. This binder was characterized by fast setting and good durability.

In Latvia, in contrast to other parts of Europe, dolomitic Roman cement was produced. However, since the middle of 20th century its production has been stopped and earlier craft techniques have been forgotten.

Nowadays, there is a necessity for compatible material for restoration needs. Wide research has been done in Central Europe to bring back historic material and technology. The investigation of dolomitic Roman cement has started recently.

The aim of this work is to synthesize a binder from artificial dolomitic Roman cement. It was carried out in the frame of ERDF Project „Elaboration of Innovative Low Temperature Composite Materials From Local Mineral Raw Materials" (N° 2010/0244/2DP/2.1.1.1.0/10/APIA/VIAA/152).

II. Methods of Research

Chemical and mineralogical compositions of raw materials and synthesized binders were established by: 1) full chemical analysis (carried out according to EN 196-2 and *A Laboratory Manual for Architectural Conservators*); 2) XRD (Rigaku Ultima + with CuK_{α}); 3) DTA/TG (SETARAM SETSYS Evolution – 1750).

A. Experimental Procedure

For the synthesis of hydraulic low-temperature binder local raw materials - Quaternary and Devonian period clay and dolomite were used. Both the chemical and phase composition of the raw materials was analyzed. Clay content (13 – 30 %) in mixtures closely conforms to chemical composition of dolomitic marl, which was original raw material for Roman cement.

Specimens were prepared by weighing the requisite amounts of raw materials - clay and dolomite - and homogenizing the mixture in dry state. Plate samples were shaped by semi-dry pressing, dried and fired in the temperature range of 750-950ºC. Natural dolomitic marl was treated at the same conditions.

Development of phases in obtained material depending on production temperature has been investigated. Hydration processes within 28 days have been observed. Chemical and phase composition has been compared in fired natural dolomitic marl and synthesized mixtures.

B. Raw materials

The chosen raw materials are dolomite powder mixed with Quaternary and Devonian period clay with carbonate content 23 % and 3 % accordingly.

Chemical analysis of dolomitic marl showed that it contains 80 % carbonates (mostly dolomite) and the rest 20 % are clay minerals and quartz.

III. Results and Discussion

The results of XRD analysis showed that crystalline phases of synthesized compositions after firing were equal to crystalline phases in dolomitic marl fired at the same temperature. The main crystalline phases were quartz (SiO_2), calcium oxide (CaO), dicalcium silicate ($2CaO{\cdot}SiO_2$), magnesium oxide (MgO), tricalcium aluminate ($3CaO{\cdot}Al_2O_3$) and gehlenite ($2CaO{\cdot}Al_2O_3{\cdot}SiO_2$).

The formation of cement minerals – tricalcium aluminate and dicalcium silicate – is the base for development of hydraulic properties. In synthesized mixtures they are detected after firing at temperatures higher than 800°C. When Devonian clay is used, crystallization of cement minerals appears already at 750°C.

It is approved by chemical analysis, that the amounts of active SiO_2, Al_2O_3 and Fe_2O_3 in synthesized compositions fired above 850°C temperature were the same as in commercially used Roman cement.

The main difference in the mineralogical composition of historical Roman cement and synthesized mixtures after firing is notable in the content of free lime – there is more of it in synthesized mixtures.

Temperatures higher than 900°C were inappropriate for synthesis of dolomitic Roman cement, because of the formation of inactive MgO (periclase) which hydrates slowly and can cause damage in material.

IV. Conclusions

Dolomitic Roman cement is characteristic to Latvia in contrast to rest of Europe, where calcitic Roman cement was applied for the construction of buildings in late 19th/early 20th century.

Compatible binder to historical dolomitic Roman cement has been obtained from dolomite-clay mixtures containing Quaternary as well as Devonian period clay.

The amount of active hydraulic components – SiO_2, Al_2O_3 and Fe_2O_3 – in synthesized mixtures was the same as in commercially used Roman cement. They play the major role in development of hydraulic properties of binder.

Temperature of 800-850°C has been chosen as optimal for synthesis of hydraulic binder from mixture of clay and dolomite similar to natural dolomitic Roman cement.

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Cluster Embedding Method with Non-Orthogonal Wave Functions for Quantum-Chemical Simulation of Nanodevices

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Keywords **– embedded molecular cluster model, non-orthogonal wave functions, time-dependent DFT, quantum transport theory, current in nanodevices.**

I. Introduction

Creation of nanodevices is rapidly developing field of science and technology. To design nanodevices we should be able to perform theoretical modeling of them. One of approaches for theoretical description of nanodevices is quantum transport theory developed by Gross with co-workers [1-3]. This approach is based on time-dependent density functional theory (TDDFT) and cluster model.

When we theoretically describe nanodevice we have to treat the whole quantum system as two subsystems: small finite fragment of the system containing nanodevice (cluster) and the rest of the system containing electrodes. Problem "cluster in the field of the rest of system" is successfully solved in the frameworks of embedded molecular cluster (EMC) model [4] with *orthogonal* wave functions. We have proposed modified EMC model [15-18] treating cluster embedding problem in the frameworks of one-electron approximation with *non-orthogonal* wave functions.

Our present aim is further development of cluster embedding method with non-orthogonal wave functions for quantum-chemical modeling of processes in nanodevices. We will generalize our cluster embedding method on the case of DFT Kohn-Sham approach. After this generalization we will study possibility to combine our cluster embedding method with TDDFT approach of Gross et all [1, 2] for quantum-chemical treatment of processes in nanodevices.

II. Cluster Embedding Equations

Our cluster embedding scheme [15-19] is based on Hartree-Fock (HF) method. In the last years HF one-electron equations are rarely used. Calculations usually are carried out in the frameworks of density functional theory (DFT) with one-electron Kohn-Sham equations [20, 21]. Besides that, for theoretical modeling of nanodevices we want to apply quantum transport theory based on DFT. Therefore, we should find cluster embedding equations our variation procedure gives when we use DFT Kohn-Sham approach.

Total energy of many-electron system described by non-orthogonal one-electron wave functions on the both HF and DFT Kohn-Sham levels may be written in the same way. Varying expression for the total energy and analyzing our variation procedure we demonstrate [22] that our cluster embedding method based on HF calculation scheme is [1] compatible with DFT Kohn-Sham calculation scheme. Cluster embedding equations remain the same if instead of Fock operator we use Kohn-Sham Hamiltonian. Therefore, there exists possibility to combine our cluster model (with non-orthogonal one-electron wave functions) and quantum transport theory based on time-dependent DFT.

III. Quantum Transport Theory and Cluster Model

We applied EMC model for theoretical study of transport phenomena in quantum systems combining our cluster embedding method with TDDFT following ideas of Gross et all [1, 2]. Our goal is method for theoretical treatment of processes in nanodevices including calculation of electrical current and other significant for electronics properties.

Method of Gross implies that wave functions of nanodevice central part are orthogonal to the wave functions of the electrodes. We have show previously [22] that approach for electric current calculation developed for orthogonal wave functions may be applied for non-orthogonal wave functions if we transform initial equations assuming that overlaps between wave functions are small ($S^2 \ll S$). Therefore, using this assumption we may combine our cluster embedding method with approach of Gross et all. It gives us possibility to calculate electric current in nanodevices.

IV. Summary and Conclusions

We have treated possibility to combine our cluster embedding method [15-19] with approach for electric current calculation proposed by Gross with co-workers [1, 2]. This approach is developed for orthogonal wave functions. We have demonstrated that it may be used for electric current calculation in the case of non-orthogonal wave functions, too.

We may conclude that embedded cluster model with non-orthogonal wave functions is applicable for quantum-chemical modeling of nanodevices.

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Nanocones Formation on p- and n-type Silicon by Laser Radiation and their Properties

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Keywords **– Laser radiation, silicon, photoluminescence, nanocones.**

I. Introduction

Nowadays, nanostructures are one of the most investigated objects in semiconductor physics, especially due to Quantum confinement effect in quantum dots (0D), quantum wires (1D) and quantum wells (2D) [1]. A cone possesses the following unique properties: a small cone is a quantum dot – 0D and a long one is a quantum wire – 1D with the gradually decreasing diameter from the base till the top of the cone. Where radii of cone are equal or less than Bohr' radius of electron, exciton or phonon Quantum confinement effect takes place. It is very challenging task to control doping in nanostructures. In this paper we show a new way to form nanocones and control P atoms doping in silicon by Nd:YAG laser irradiation.

II. Results and Discussion

Nanocones were formed on n-Si (P) (111) with SiO_2 layer and on p-Si (B) (100) with indium tin oxide layer.

Samples were irradiated by pulse Nd:YAG laser with wavelength λ=532 nm and pulse duration 10 ns on X-Y scanning stage. Fig. 1. shows photoluminescence spectra of SiO_2/n-Si structure. Photoluminescence intensity decreases by increasing intensity of laser irradiation. We propose that decrease of PL intensity is related to nanostructure doping with phosphorus [2].

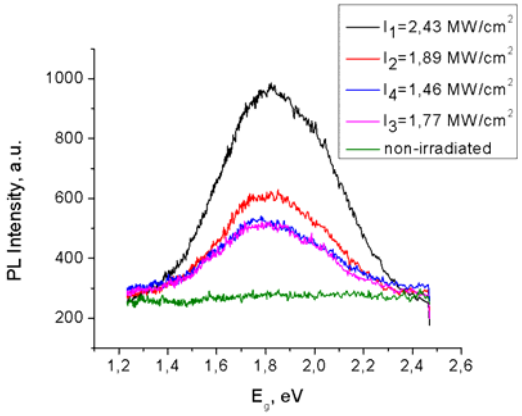

Fig.1. Photoluminescence spectra of SiO_2/n-Si structure: before and after irradiation by the Nd:YAG laser with 4 intensities.

Photoluminescence spectra of the ITO/p-Si structures with the maxima visible part of spectra obtained after laser irradiation at intensities of 1.13 MW/cm^2 and 2.83 MW/cm^2 are shown in Fig. 2. Position of the observed photoluminescence maximum compared with the bulk Si shows a significant "blue shift". The maxima of the photoluminescence at visible part of spectra are explained by presence of the Quantum confinement effect in the top of nanocones. Fig.3 shows AFM image of nanocones formed by laser radiation.

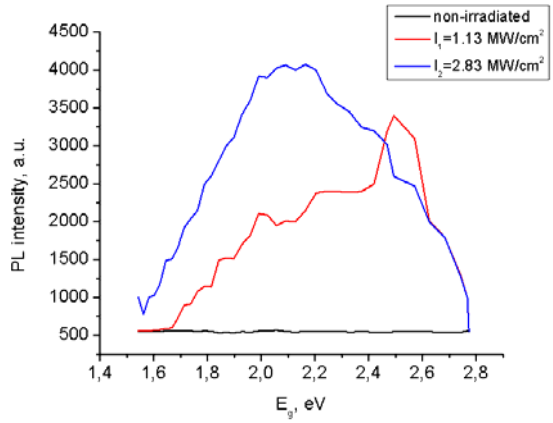

Fig.2. Photoluminescence spectra of ITO/p-Si structure: before and after irradiation by the Nd:YAG laser with two intensities

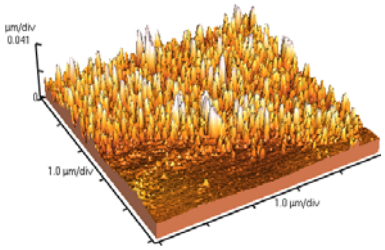

Fig.3. AFM image of border between p-Si structure with nanocones and smooth non-irradiated surface.

Nanocones formation mechanism is characterised by 2 stages:

At the **first stage** generation and redistribution of intrinsic point defects and impurities in temperature gradient field takes place, which is caused by strongly absorbed laser radiation [3].

In the **second stage** formation of nanocones on the irradiated surface of a semiconductor due to mechanical plastic deformation of the top layer enriched by interstitials and relaxation of the mechanical compressive stress arising between top layer and buried layer enriched by vacancies takes place

III. Conclusions

1. Photoluminescence intensity decreases by increasing intensity of the laser irradiation. It can be explained by nanostructure doping of phosphorous.
2. "Blue shift" of PL spectra in p-Si (B) we explain by Quantum confinement effect in nanocones

IV. References

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Mechanisms of p-n Junction Formation in Intrinsic Semiconductor by Laser Radiation

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Roberts Rimsa (*Riga Technical University*)

Keywords **– Laser radiation, p-n junction, Ge.**

I. Introduction

P-n junction is the most important component of many semiconductor devices. Thermodiffusion, ion implantation and molecular beam epitaxy are only a few methods to form a p-n junction. The main drawback for these methods is high cost of equipment. Therefore this equipment is not available for small and medium companies. A possibility of p-n junction formation by laser radiation was shown in several semiconductors: p-Si, p-CdTe, p-InSb, p-InAs, p-PbSe and p-Ge. Different mechanisms have been proposed to explain the nature of inversion of conductivity type: impurities' segregation, defects' generation, amorphization and oxygen related donor generation. However, the proposed mechanisms have many flaws and even contradictions; therefore the mechanism of p-n junction formation by laser radiation (LR) is not clear until now. The aim of the work is to show a new possibility of p-n junction formation in intrinsic elementary semiconductor by LR without any impurities and to propose the new mechanism of p-n junction formation.

II. Results and Discussion

We assume that, the intrinsic defects play the main role in formation of p-n junction. For this reason i-Ge crystal was irradiated by Nd:YAG laser with different energy of quantum. In experiments i-Ge single crystals with $N_A = 7.4 \times 10^{11}$ cm^{-3} and $N_D = 6.8 \times 10^{11}$ cm^{-3} s were used. Samples were prepared by mechanical polishing with diamond grease followed by chemical treatment with CP-4 etching solution. To form a p-n junction, nanosecond Nd:YAG laser with wavelengths λ_1 = 1064 nm, λ_2= 532 nm and λ_3= 266 was used. Measurements of I-V characteristics were done by soldering 99% Sn and 1% Sb alloy electrical contacts directly on the irradiated surface of i-Ge and the opposite side. I-V characteristics of i-Ge samples before and after irradiation different intensities of Nd:YAG laser with wavelength 266 nm and different laser intensities are shown in Fig.1.

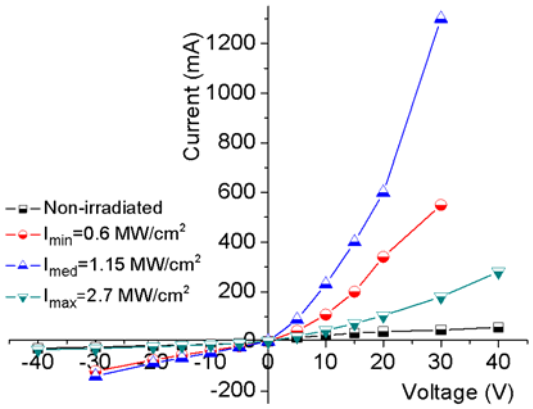

Fig.1. I-V characteristics of non-irradiated and irradiated i–Ge sample by Nd:YAG laser with λ=266 nm

Increase of rectification ratio (RR) of I-V characteristics with intensity of the laser radiation, energy of laser radiation quanta and numbers of pulses were observed in this experiment (see Fig.2). Moreover, this process takes place in threshold manner, it means, RR is non-monotonic function on laser radiation intensity. These results are explained by damage of p-n junction at threshold intensity (I_{th}) due to formation of nanocones.

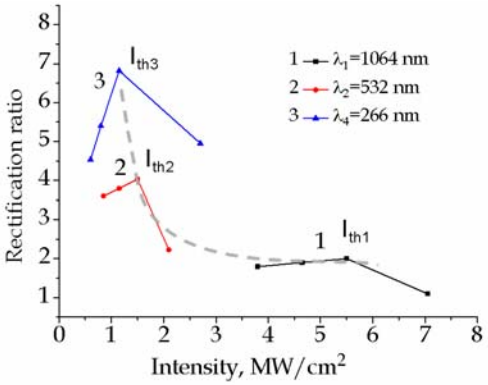

Fig.2. Rectification ratio as a function of irradiation intensity of Nd:YAG laser for different wavelength of the laser radiation and 350 laser pulses.

The mechanism of this phenomenon is explained by generation and redistribution of intrinsic point defects in temperature gradient field, which causes strongly absorbed LR. The redistribution of defects takes place because interstitial atoms drift towards the irradiated surface, but vacancies drift in the opposite direction – in the bulk of semiconductor according to Thermogradient effect [1]. Since interstitials in Ge crystal are of n-type and vacancies are known to be of p-type [2], a p-n junction is formed.

III. Conclusions

For the first time we have proved that the mechanism of p-n junction formation in semiconductor is caused by generation and redistribution of intrinsic point defects in temperature gradient field induced by LR. Increase of rectification ratio of p-n junction with the increase of LR intensity is typical for Thermogradient effect; therefore this effect has the main role in p-n junction formation.

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Improvement of CdZnTe Crystal Quality by Laser Radiation

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Ernesto Dieguez and Hakima Bensalah *(Universidad Autonoma de Madrid)*

***Keywords* – CdZnTe, Nd:YAG laser, Te inclusions, gamma ray.**

I. Introduction

Cadmium zinc telluride (CdZnTe) semiconductor crystals have been shown to be the most promising materials for x-ray and γ-ray detection [1, 2]. However, the yield of high quality crystal is still limited by some important problems. Several researchers have shown a possibility to improve crystal quality by CO_2 laser irradiation [3, 4]. This method has disadvantages, such as long processing time, about 100 h, and damage of crystal surface. The improvement of the quality of CdZnTe crystal was observed after irradiation by Nd:YAG laser with 3.6×10^4 pulses. The leakage current of CdZnTe detector decreases by 40%. The enhancement of energy resolution of CdZnTe detector, especially at low energies, takes place after irradiation by the laser. This effect is explained by small defect precipitation on to Telluride (Te) inclusion due to thermogradient effect around it.

II. Experiments and Discussion

In this research CdZnTe crystal is grown by vertical gradient freezing method using the high-purity Cd, Zn and Te: 7N materials and doping with 3 ppm of Indium characterized by high concentration of non-controllable impurities and Te inclusion is used.

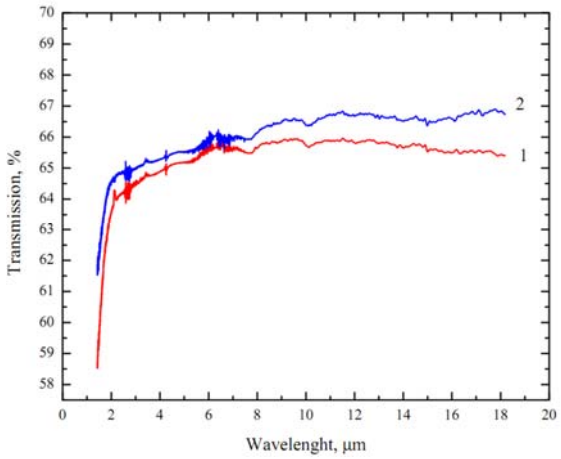

Fig.1. FTIR spectra of CdZnTe samples VGF27101035-62-1 before (red curve) and after irradiation (blue curve -3.6×10^4 pulses) by the Nd:YAG laser

Shallow impurities have strong influence on electrical conductivity of semiconductor and leakage current of radiation detector. Infrared transmission microscopy was used to characterize CdZnTe samples, particularly concentration of Te inclusions. Single crystals $Cd_{1-x}Zn_xTe$ have been irradiated by the Nd:YAG laser with the following parameters: wavelength λ = 1064 nm, pulse duration τ=3 ns, intensity 6.6 MW/cm^2. Treatment by laser was carried out at room temperature and atmospheric pressure. CdZnTe samples were irradiated by Nd:YAG laser and afterwards current voltage (I-V) characteristic measurements were performed. I-V characteristic measurements showed that sample resistivity is rising after irradiation by 3.6×10^4 laser pulses and the dark current is decreasing by 40%.

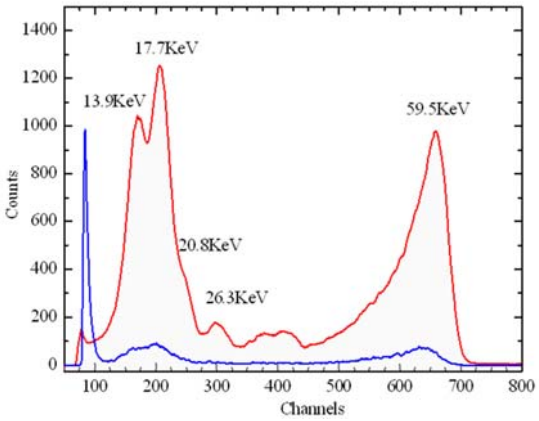

Fig.2. ^{241}Am gamma-ray spectrum obtained with CdZnTe detector before (blue curve) and after irradiation (red curve) by Nd:YAG laser at intensity I = 6.6 MW/cm^2.

After reaching specific number of pulses, saturation effect can be observed. It means that no more changes of CdZnTe sample resistivity were observed. FTIR spectra of CdZnTe showed that after irradiation by the laser transparency of the crystal is increased (Fig.1). To characterize sample as radiation detector γ-ray spectroscopy measurement was used. Measurements of γ-ray spectroscopy of CdZnTe crystal irradiated by the laser have shown the improvement of the energy spectral resolution (Fig.2). It can be concluded the quality of CdZnTe crystal is improved.

III. Conclusions

1. The possibility to increase of $Cd_{0.9}Zn_{0.1}Te$ crystal quality after irradiation by Nd:YAG laser was shown.
2. Improvement of CdZnTe crystal quality is explained by segregation of defects on to Te inclusion due to gradient of temperature around it.

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Laser Processing of CdZnTe, its Optical and Electrical Properties

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Ernesto Dieguez *(Universidad Autónoma de Madrid)*

Keywords **– Laser, CdZnTe, optical properties, electrical properties, defects.**

I. Introduction

Cadmium zinc telluride (CdZnTe) compound semiconductor crystal has been shown to be one of the most promising materials for X-ray and γ-ray detectors [1]. This material gained interest due to its ability to work as room temperature radiation detector. However, the high yield production of quality crystals is still a challenge both for scientists and engineers. It is due to presence of defects in grown crystals: Te inclusions, crystal twins, dislocations, grain boundaries and other defects.

Several researchers have shown a possibility to improve crystal quality by using CO_2 laser processing [2]. The disadvantages of this method are long processing time - about 100 h and damage of the crystal as a result of laser irradiation.

We have studied the influence of infrared laser radiation on CdZnTe crystal electrical properties and radiation detector parameters. CdZnTe has low optical absorption coefficient in infrared region of spectra. Therefore, laser radiation is absorbed mostly by Te inclusion and point defects.

II. Experiments and Discussion

In our experiments we have used $Cd_{1-x}Zn_xTe$ x= 0.1 single crystals grown by High-Pressure Vertical Zone Melting method. Nd:YAG laser with the following parameters: wavelength λ = 1064 nm, pulse duration τ = 3 ns, power P = 1.0 MW was used. Irradiation of the crystals was carried out with intensity I=5.0 MW/cm^2 and maximum number of the laser pulses 28.8×10^4. To characterize the change of CdZnTe crystal lattice quality after irradiation by laser, infrared transmission spectroscopy (FTIR) was used.

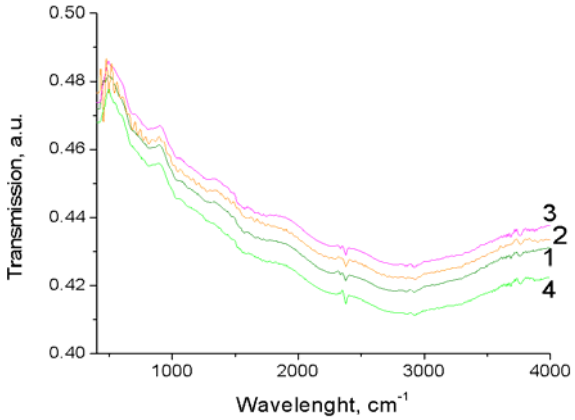

Fig.1. FTIR spectra of CdZnTe samples before (curve 1) and after irradiation (curve 2 - 7.2×10^4 pulses curve 3 - 21.6×10^4 pulses curve 4 - 28.8×10^4) by the Nd:YAG laser.

Experiments were carried out at room temperature, in atmospheric pressure and humidity 60%. FTIR spectra of non irradiated and irradiated samples by the laser with deferent radiation doses are shown in figure 1. After reaching 7.2×10^4 laser pulses the transition of the crystal is decreasing, which can be explained by damage of crystalline lattice due to prolonged exposure to laser radiation.

Current voltage (I-V) characteristic measurements showed that sample resistivity is rising after irradiation with 7.2×10^4 laser pulses by 45%, as shown in figure 2. After reaching specific number of pulses, saturation effect can be observed. It means that CdZnTe sample resistivity does not change significantly with increasing of number of pulses.

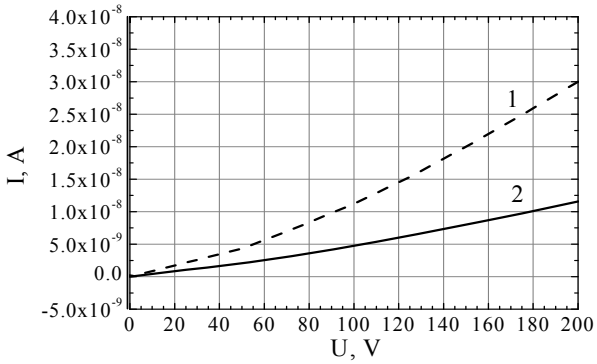

Fig.2. The I-V characteristics of CdZnTe crystal before (1) and after irradiation (2) by the laser at intensity I = 5.0 MW/cm^2 and pulses number 7.2×10^4.

Increase of CdZnTe samples electrical resistivity is explained by presence of gradient of temperature around Te inclusions [3]. Gradient of temperature arise in the crystal due to absorption of the laser radiation by Te inclusions. As a result small inclusions and interstitial impurities drift to the maximum of temperature, towards the biggest Te inclusions, where they dissolve and precipitate [4].

III. Conclusions

Infrared Nd:YAG laser radiation reduces CdZnTe sample leakage current by 30% and increase transparency in infrared region of spectra by ~2% due to precipitation of impurities .

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Acknowledgment: This work has been supported by the European Social Fund within the project «Support for the implementation of doctoral studies at Riga Technical University».

Bolometric Photoresponse of Polymer/ Nanostructured Carbon Composite

Kaspars Ozols and Maris Knite (*Riga Technical University*)

Keywords **– carbon, nanocomposite, bolometric sensor.**

I. Introduction

Attempts to utilize polymer/carbon nanoparticle composites for use in optoelectronics are being made (e.g., single-walled carbon nanotubes are being used as polymer fillers)[1,2,3]. Polyisoprene/nanostructured carbon (PNC) composites show large resistance change effect as mechanical strain is applied[4]. Therefore, it was expected that PNC composites also could show bolometric photoresponse.

In this study, bolometric photoresponse measurements of PNC composites containing carbon black (CB) filler irradiated by a laser beam of different wavelengths were conducted.

II. Samples and Experiment

A. Samples

PNC samples were manufactured from PaleCrepe natural rubber (with curing ingredients) and high structure CB Degussa™ Printex™ EX-2 using Rondol™ hot press. Electrical contacts were created using Electrolube™ Silver Paint. The area of sample to be irradiated was matched with the diameter of laser beam (2.2 mm). The thickness of samples was 0.2 mm. Several series of samples containing different amount of CB were created.

B. Experiment

The measurement setup was as follows. The sample was connected through the wiring to the data acquisiton unit Agilent 34970A which measured the electrical resistance. The sensitive area of measured sample was cyclically irradiated by a laser beam. Semiconductor 532, 650 and 980 nm continuous wave lasers were used as light sources. Exposure time to the beam was 30 s. After the irradiation the beam was "switched off" with a shutter for 30 s. Then the cycle was started again. To monitor the laser beam power Ophir Nova II laser power meter was used.

III. Results and Discussion

PNC samples containing 6 phr of CB, which is in the percolation transition region for CB concentration, showed a maximum relative resistance change $\Delta R/R_0$ under the same light intensity. At the same time, these samples showed more resistance noise. Since PNC samples containing 8 phr of CB showed high relative resistance change and small electrical resistance noise in the same time, they were chosen for series of different experiments.

Measurements with samples containing 8 phr of CB showed that relative resistance change effect is considerably larger when the sample is irradiated with 532 nm laser beam compared to 980 nm laser beam. One illustration of PNC composites' relative resistance change graph for different laser radiation wavelengths is given in Fig.1. It can be seen that the sensitivity of the sample is approximately 1.8 times larger to green light than to infrared light. The reason for such a difference in sensitivity could be in the different ability of PNC composite to absorb light of different wavelengths.

From additional measurements conducted it is known, that at the same laser beam intensity (12.4 mW/mm^2) when samples with increased thickness (1 mm vs regular 0.2 mm) are irradiated the exposure time to achieve maximum $\Delta R/R_0$ is approximately twice as long than for thin samples. This indicates that the resistance change effect has a thermal or mainly a thermal origin. The mechanism of laser beam induced resistance increase in PNC composite is as follows: thermo-optically induced matrix expansion causes exponential reduction of tunnelling currents between carbon nanostructures in the composite, thus, the resistance of composite increases[4].

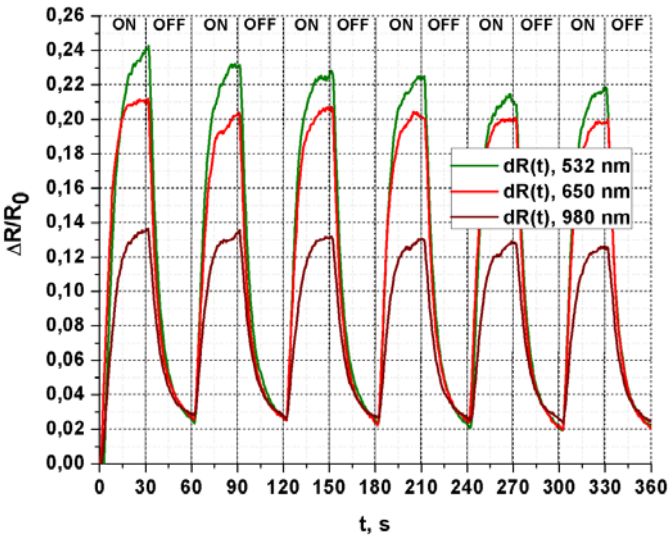

Fig.1. Relative resistance change of PNC composite containing 8 phr of CB irradiated by 532, 650 and 980 nm laser beam with same intensity (12.4 mW/mm^2).

IV. Conclusions

PNC samples containing 8 phr of CB have shown that the largest sensitivity from three laser wavelengths used is achieved in case of 532 nm light. Experiments with samples with increased thickness indicate that the resistance change effect mostly is caused by thermal expansion of the polymer matrix. To estimate possible photoconductivity effect, precise surface temperature measurements should be conducted.

V. References

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Anisotropy of Holograms in Molecular Azochromophore Films

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Keywords **– holography, light polarization, photoinduced anisotropy, molecular azochromophore films.**

I. Introduction

Elementary holograms-holographic gratings (HG) in molecular glassy azochromophore films synthesized in RTU exhibit strong recording light polarization dependence as revealed by our experiments described in this paper. This means that photoinduced anisotropy (PA) takes place in these films. Direct PA measurements by a novel holographic method have been performed and photoinduced birefringence is measured. Molecular azochromophore films with strong PA can be used for production of polarization holographic optical elements and for optical information recording with polarization multiplexing.

II. Samples and Methods

HG recording was carried out in the following films: **8a** or 3-(4-(bis(2-(trityloxy)ethyl)amino)phenyl)-2-(4-(2-bromo-4-nitrophenyl) diazenyl)phenyl)acrylonitrile , **11** or 4-((2-bromo-4-nitrophenyl)diazenyl)-N,N-bis(2-(triphenylsilyloxy) ethyl)benzenamine, and **16** or 2-(ethyl(4-((2-nitro-4-triphenyl)diazenyl)phenyl)amino)ethyl-4-((4-bis(2- (trityloxy) ethyl)amino)phenyl)diazenyl)-3-nitrobenzoate**.** HG with the period of 2 μm were recorded and read out either by 532 nm or by 633 nm laser light with two equally strong with common intensity of 1.2 – 1.5 W/cm^2 . Linear *s*-s , *p-p*, *s-p,*and circular-elliptical CE-1 and CE-2 recording beam light polarizations were used. The first-order self-diffraction efficiency (SDE) was continuously measured as the function of exposure time and stored in the PC memory.

PA was studied in {4-((4-nitrophenyl)diazenyl)-N-(4-((4-nitrophenyl)diazenyl)phenyl)-N-(2-trityloxy)ethyl) benzene-amine (shortly **K-D-24**), 4-((2-chloro-4-tritylphenyl)diazenyl)-N-(4-((2-chloro-4-tritylphenyl)diazenyl)phenyl)-N-(2-(trityl-oxy)ethyl) benzene amine (shortly **K-D-25**), 4,4'-(2-(trityloxy)ethylazanediyl)bis(4,1-phenylene)bis(diazene-2,1-diyl)dibenzonitrile (shortly **K-D-32**) films. HG were recorded by two equal *p*-polarized 532 nm laser beams, and they were continuously read out by a circularly polarized 633 nm laser beam. The diffracted beam was split in *s*-polarized and *p*-polarized beams by a polarization beam splitter, and the diffracted powers, P_s and P_p , were measured and stored in PC enabling the determination of diffraction efficiencies η_s and η_p. PA was characterized by PA contrast $A = (\eta_s - \eta_p)/(\eta_s+\eta_p)$. Measurements were done in both transmission and reflection modes.

III. Results

Samples **8a** and **11** with the simplest chemical structure were the most efficient at 633 nm , and sample **8a** was the most efficient at 532 nm. Self-diffraction efficiency (SDE) up to 45% was achieved in **8a** with *p-p* polarized recording beams at 633 nm. Linear *p-p* polarizations were the most efficient at 633 nm whereas CE-1 polarizations were the best at 532 nm. It was found that light polarization changes in the process of diffraction depend on chemical composition, wavelength and exposure time. Pure vector gratings with SDE up to 25% were recorded in **8a** rotating a linear polarization by 90^0 (Fig.1).

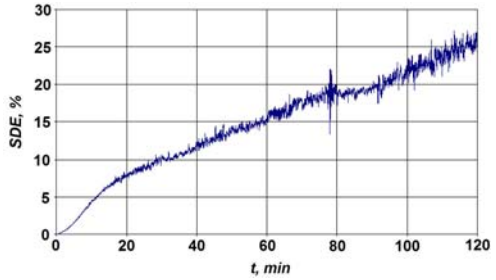

Fig.1. SDE exposure time dependence for the sample **8a** in the case of *s-p* recording beam polarizations at 633 nm.. Such HG can be recorded only in the case of PA.

PA exhibited markedly different kinetic behaviour in transmission and reflection modes. There was a negative minimum in transmission mode in all samples (Fig.2), and a growth with oscillations up to saturation in reflection mode. The highest PA was found in **K-D-24** film in transmission mode (A=-0.23) and in **K-D-25** film in reflection mode (A=0.49). Holographic recording efficiency and PA do not correlate.

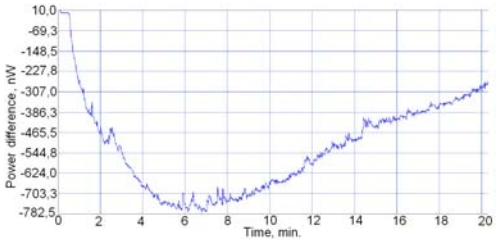

Fig.2. Diffracted power difference $P_s - P_p$ (nW) versus time (minutes) in the case of **K-D-25** sample. Transmission mode.

Basing on Kogelnik's theory and our measurements we have calculated the photoinduced refractive index changes, Δn_s and Δn_p , corresponding to the measured diffraction efficiencies η_s and η_p. Maximal absolute values of Δn_s=0.124 and Δn_p=0.116 were found in the case of K-D-32. Thus the birefringence value $n_s - n_p = \Delta n_s - \Delta n_p$ as high as 0.24 is possible if the signs of Δn_s and Δn_p are opposite. We believe that this is the case because matter polarization increases in the direction perpendicular to $\boldsymbol{E_p}$. and decreases in the $\boldsymbol{E_p}$ direction.

IV. Conclusions

The observed anisotropy of holograms as well as PA of molecular glasses can be explained by polarization-dependent photoinduced volume processes including *trans-cis* photoisomerization , chromophore orientation and photodegradation, and mechanical stress modulation. Surface relief HG recording and polarization-dependent reflection are responsible for PA in reflection mode.

Role of Hydrogen Bonds in the Crystal Structure of Benzyltrimethylammonium Bis(citrato)borate Monohydrate $[(C_6H_5CH_2)N(CH_3)_3][(C_6H_6O_7)_2B]\cdot H_2O$

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Keywords **– Interactions of hydrogen bonds, proton transfers process, quaternary ammonium cations, and boron coordination compounds.**

I. Introduction

In recent years, the interest has growth to boron-containing compounds as corrosion inhibitors and reactive flame retardants [1]. Fire retarding action of the boron-containing retardants is increased with the introduction of nitrogen atoms in their composition. This is why the amine salts of boron coordination compounds have the wide application in the practice. However, the theoretical investigations concerning the atomic structure of the complicated boron ionic intermolecular complexes have been performed insufficiently.

II. Discussion

The quaternary ammonium (aminium) salt of borodicitric acid – benzyltrimethylammonium bis(citrato)borate monohydrate $[(C_6H_5CH_2)N(CH_3)_3][(C_6H_6O_7)_2B]\cdot H_2O$ (I) has been synthesized for the first time. The monocrystals of the mentioned compound were grown and their crystal structure was studied by the X-ray method. Crystals of I are triclinic, space group $P\ \bar{1}$, a = 10.0832(2) Å, b = 11.1232(3) Å, c = 11.9617(3) Å, α = 84.874(1)°, β = 73.520(1)°, γ = 85.550(1)°, Z = 2, $R1$ = 0.0485.

The crystal structure is composed of a quaternary ammonium cations, where hydrogen atoms are replaced by organic radical groups, univalent spiran-type bis(citrato)borate anions and crystallization water molecules. The structure of the complex anions $[(C_6H_6O_7)_2B]^-$ is usual.

The title compound represents a cooperative interaction of hydrogen bonds in proton–transfer process involving crystallization water molecules. In crystals two complex anions (KA^I, KA^{II}) and two molecules of water form the centrosymmetrical dimers (Figure).

The 12-membered ring is fastened by the hydrogen bonds that are near to linear (O(11)...H(11)...O(1W) 160(3)º and O(1W)–H(1WA)...O(12) 176(3)º). In the hydrogen bond O(11)...H(11)...O(1W) the proton of the carboxyl group is considerably shifted to the water molecule ((O(11)...H(11) 1.36(2) Å, H(11)...O(1W) 1.26(2) Å). The transfer of the proton $H(11)^+$ from the proton donor – the hydroxyl group O(11)H(11) to the proton acceptor – oxygen atom $O(12)^-$ of the carbonyl group has been realized in the ring involving the water molecule. The trend of the water molecule to form the shorter (strong) hydrogen bond (2.795(3) Å) with the proton–acceptor rather than with the proton–donor (2.857(3) Å) has been realized. The similar interatomic distance values are characteristic of the hydrogen bonds involving the oxygen atoms in the ionic intermolecular complexes.

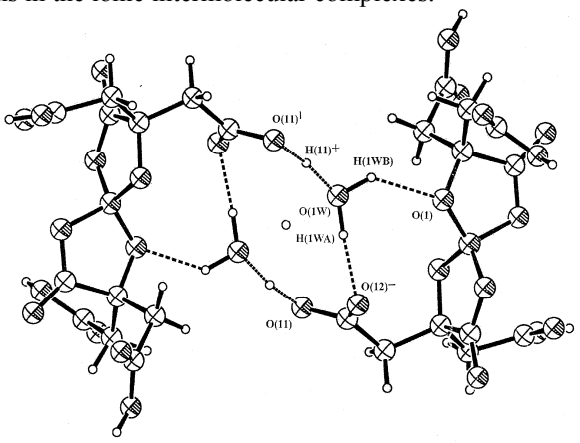

Fig.1 Structure of the ionic molecular complex dimers $(KA^I)...H^+...H_2O...O(12)^-(KA^{II})$

The ionic molecular complex dimers in the crystals are combined into the three-dimensional framework by the system of hydrogen bonds. Five asymmetrical hydrogen bonds of the type O–H...O (O...O 2.588(2) – 2.795(2) Å) have been formed in the compound I. All the active hydrogen atoms of the complex anion and water molecules are employed in the formation of the hydrogen bonds in the structure of I. The quaternary ammonium benzyltrimethylammonium cations do not participate in the formation of hydrogen bonds.

The participation of the oxygen atoms in the hydrogen bonds leads to the systematic increase of the length of the individual bonds C–O (+ 0.01 Å) and C=O (+ 0.02 Å). The influence of hydrogen bonds to the length of the B–O bonds is less expressed (≤ 0.01 Å), nevertheless it is systematically reveled in the structures of borodicitric acid salts.

The crystal chemistry data concerning the nine earlier investigated crystal structures of the salts of borodicitric acid with alkyl- and aryl-substituted ammonium cations [2] have been compared.

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Graphite Oxides by Oxidation of Graphite Flakes

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***Keywords* – graphite flakes, oxidation, graphite oxide.**

I. Introduction

Chemically modified graphene has being intensively studied due to many possible applications in sensors and energy converters, in units of photonics and biomedicine [1]. The most suitable method for large scale production of the chemically functionalised graphene includes graphite oxidation, exfoliation and reduction reactions [1,2]. The degree of the oxidation substantially varies depending on the starting material and oxidation protocol. The graphite oxidation is commonly incomplete and the searching for procedures giving the higher yield of graphene oxides under relatively mild conditions is a topical problem for the moment. In this work we would like to present the results of the chemical oxidation of graphite flakes. The FTIR, NIR spectroscopies and XRD analysis were used for investigation the obtained samples.

II. Experimental

The graphite flakes and the other reagents were purchased from "Sigma-Aldrich" and used without further purification. Single Layer Graphene, Graphene Nanoplatelets, Graphite Oxide, Carboxyl Graphene and Single Layer Graphene Oxide were purchased from "ACS Material, LLC" for comparison with synthesized samples. IS-spectra were recorded on "Perkin-Elmer Spectrum 100" spectrometer by use of Universal ATR (Attenuated Total Reflectance) accessory with 3 bounce. NIR spectra were recorded on "Perkin-Elmer Spectrum 100N" spectrometer by use of NIRA accessory part. The X-ray powder diffraction (XRD) patterns were recorded on a „Rigaku Ultima+" difractometer using the monochromatic CuKα radiation. The experimental data were collected at a scanning speed of 4^o/min.

Synthesis of graphite oxide.

Method A. $NaNO_3$ (1.5 g) and graphite flakes (3 g) were added to the ice cooled H_2SO_4 (70 ml). The mixture was cooled to 0 ^oC, and then during 2 h $KMnO_4$ (9 g) in 2 portions was added to the mixture by stirring. The whole process was continued at room temperature for 120 h. After that the distilled water (140 mL) by cooling was dropwise added to reaction mixture. Then H_2O_2 (6 mL, 30%) was dropwise added to the obtained suspension during 30 min. After stirring for 2 h at room temperature, the resultant mixture was filtered using a porous glass filter and the obtained precipitate was washed with distilled water till the salts and sulfuric acid have been washed out (probe with $BaCl_2$ solution). The acquired sample A1was dried on air at room temperature for 5 days.

Method B. Similar to method A, but only $KMnO_4$ (9 g) were added in 4 portions during 2 h. The acquired sample B1was dried on air at room temperature for 5 days.

The other samples A2 and B2 were obtained in water by the ultrasonication of the samples A1 and B1. The ultrasonication was made during 2 hours for the sample A1 and during 0.5 h for the sample B1 by immersing the "Hielscher UP200S" 200W 24 kHz into a round bottom flask with 75 mL of distilled water containing 0.5 g of samples A1 and B1 respectively. The 50% irradiation power was used. After 24 h the resultant solution was filtered through a microporous filter (0.5 μm) and the water was evaporated at room temperature during 5 days.

III. Results and Discussion

As it is shown in Fig. 1 the chemically oxidation caused the essential exchange of the XRD patterns of the above mentioned graphite flakes. The samples A1, A2, B1 and B2 (Fig. 1) all have a new intensive peak at 2θ ~ 10.5 ^{o} together with the weak peaks at 26.6, 44.6 and 54.7 ^{o} which are the characteristic peaks of graphite structure.

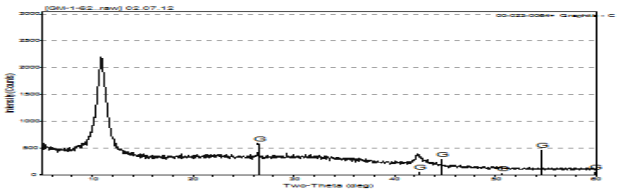

Fig.1. The XRD patterns of sample A1.

The intensive peak at 2θ ~ 10.5 ^{o} corresponds to a layered structure with an interlayer distance higher than 0.8 nm. If we consider that the intensities of the peaks are approximately proportional to the sample contents, we can evaluate that the content of graphite in the samples A1, A2 and B1 it was approximately 6%, however in sample B2 less than 2%. Evaluation of the mean size of the crystallites showed that the sonication during 0.5 h did not cause a noteworthy effect, but sonication during 2h considerably reduced the mean size of the crystallites. The FTIR and NIR spectral data confirmed the presence of OH, C=O, C=C, C-O and C-O-C groups in all the synthesized samples. The sample B1 has the highest content of O-H groups.

IV. Summary

Although the obtained graphite oxides have a layered structure, the interlayer distance is remarkably increased and OH, C=O, C-O and C-O-C functionalities have been appeared. Regardless of the little difference in the oxidation processes the obtained samples are different. The addition of $KMnO_4$ during the oxidation process in many little portions is to be prefered for obtaining near-complete oxidations products. Ultrasonication of grafite oxides can be used for the exfoliation of these samples, but the results depend on the duration of the process and the power of the applied ultrasound.

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Pre-exfoliation of Graphite Flakes by Sonication in Organic Media

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***Keywords* – graphite, pre-exfoliation, ultrasonification.**

I. Introduction

The chemical functionalization of graphene is used for the stabilization of graphene sheets, increasing the solubility and tuning the electron-donor and electron-acceptor properties of the honeycomb lattice electron system [1]. The most suitable method for large scale production of chemically functionalised graphene includes graphite oxidation, exfoliation and reduction. The degree of oxidations substantially varies depending on the starting material and the oxidation protocol. The graphite oxidation commonly is an incomplete and it is necessary to vary the procedures in order to have a higher yield of graphene oxides under relatively mild conditions. In this work the effect of pre-exfoliation of graphite flakes by ultrasonification in different organic media is investigated by use of UV-Vis, FTIR, NIR and XRD analysis.

II. Experimental

The graphite flakes and other reagents were purchased from "Sigma-Aldrich" and used further without purification. IS-spectra were recorded on "Perkin-Elmer Spectrum 100" spectrometer by use Universal ATR (Attenuated Total Reflectance) accessory with 3 bounce. NIR spectra were recorded on "Perkin-Elmer Spectrum 100N" spectrometer by use of NIRA accessory part. UV-Vis absorption spectroscopic studies were performed with "LAMBDA 650" spectrometer with diffuse reflection accessory. For the dilution of samples the magnesium sulphate was used. The X-ray powder diffraction (XRD) patterns were recorded on a „Rigaku Ultima+" difractometer using the monochromatic CuKα radiation. Experimental data were collected over the 2θ range of 3- 90° at a scanning speed of 4°/min. Pre-exfoliation of graphite flakes was made during 4 hours by immersing of "Hielscher UP200S" 200W 24kHz into a round bottom flask with 50 mL of liquid, containing 1 g of graphite flakes. The 50% irradiation power was used. The resulting graphite nanoplatelets were washed with acetone, and then dried in the oven at 80 °C for 12 h.

III. Results and Discussion

The simple pre-exfoliation of graphite by ultrasonication method taken in formic and acetic acids before the oxidation improves the synthesis of graphene-like materials [1, 2]. It is well known that the acoustic cavitation in liquids during the ultrasonification process can produce localized hot spots with temperatures as high as 5000 °C and pressure of about 500 atm and so can provide the exfoliation of graphite [3]. In order to obtain some new information about the pre-exfoliation effect we made the ultrasonification of graphite flakes (GF) in formic acid (FA), acetic acid (AA), trifluoroacetic acid (TF), methyl benzoate (MB) and dimethylformamide (DMF). Only in DMF a stable dispersion was obtained compared to all the other samples where the precipitation of media was observed.

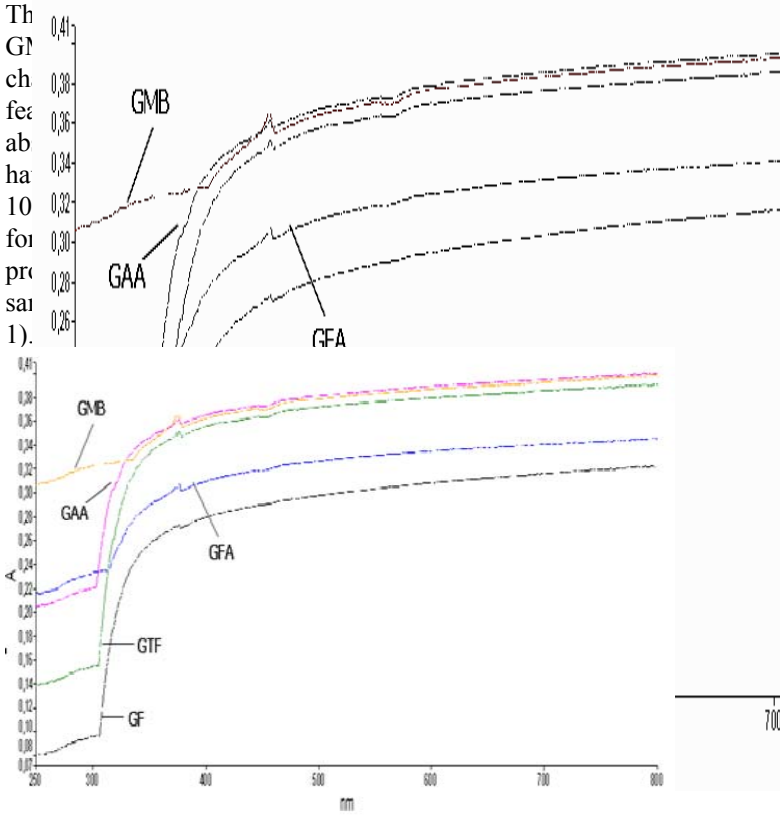

Fig. 1. The diffuse reflectance spectra of investigated samples

Surprisingly, the spectral data of GMB were the most diverse; therefore the pre-exfoliation in methyl benzoate may have the largest effect and could be used for synthesis of graphene-like materials.

IV. Summary

Ultrasonification of graphite flakes in organic media does not cause a remarkable change of structure features but it could create some localized defects in their π-electron structure and that could work as seed points for the further oxidation process. Ultrasonification in methyl benzoate could be the most effective method of pre-exfoliation.

V. References

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Ketonization of Benzyl Butyrate Over Zinc Chromite Catalyst

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Keywords **– Benzyl butyrate, zinc chromite catalyst, ketonization, cross-ketonization.**

I. Introduction

The studies of ketonization reactions are most often conducted on metal oxide catalysts, although a lot of other ketonization catalysts are also well known. Thus, we successfully managed to ketonize aliphatic alcohols, aldehydes, acids and esters over zinc chromite type catalysts [1]. The ketonization of ethyl acetate, propyl propionate and butyl butyrate at 300-400 °C temperature has been thoroughly researched [2]. Examples of cross-ketonization of aromatic and aliphatic esters may be found in literature [3]. Production of dipropyl ketone from butanol has been implemented also on an industrial scale.

II. Results and Discussion

Ketonization of butyl butyrate over chromite catalyst at 300-400 °C temperature range showed that the maximum yield of dipropyl ketone was 77 mol%, and this result was reached at a temperature of 350 °C, using a flow-through system with 35 ml of catalyst, diluting the ester with water (1:2 molar ratio). At low temperatures (300 °C), butanol (33 mol%), butyric acid (14.5 mol%) and butyric aldehyde (2.7 mol%) were found. Raising the temperature, the yields of butanol and butyric acid decreased to 5.6 and 3.2 mol%, respectively, at 350 °C. If the temperature was increased to 375 °C, acetone (1.6 mol%) and methyl propyl ketone (15.4 mol%) were also formed.

Some similarities with the process of butyl butyrate ketonization may be seen in case of benzyl butyrate, but there are also differences. Our studies of benzyl butyrate ketonization were carried out diluting the compound with water at 300-390 °C using a flow-through mini-reactor with 2 g of zinc-chromium oxide spinel type catalyst. The reaction products have been analyzed using GC/MS method.

The ketonization of benzyl butyrate also starts with hydrolysis of ester:

$$PhCH_2OOCPr + H_2O \rightarrow PhCH_2OH + PrCOOH$$

At the temperature of 300 °C, the hydrolysis product – benzyl alcohol (32%) and the dehydrogenation product – benzaldehyde (29%) were found in the reaction mixture:

$$PhCH_2OH \rightarrow PhCHO + H_2$$

Toluene, the product of benzyl alcohol hydrogenation, appears at 330 °C (5%) and increases up to 15% at 390 °C:

$$PhCH_2OH + H_2 \rightarrow PhCH_3 + H_2O$$

As for the ketones, there were found dipropyl ketone (12% at 360 °C and 15% at 390 °C) and propyl phenyl ketone (8-24% throughout the temperature range 300-390 °C):

$$PhCH_2OOCPr + H_2O \rightarrow PhCOPr + CO_2 + 2H_2$$

$$2PhCH_2OOCPr + H_2O \rightarrow PrCOPr + CO_2 + 2PhCH_2OH$$

The amount of impurities grows increasing the reaction temperature. Among these may be mentioned dibenzyl (1-2% at 360-390 °C), dibenzyl ether (20-4% at 300-390 °C), butenyl benzenes (1-5% at 300-390 °C) and many other negligible impurities (total of 1-20% at 300-390 °C).

TABLE I

SOME PRODUCTS OF BENZYL BUTYRATE KETONIZATION AT 360 °C, THEIR RETENTION TIMES R (MIN), MOLECULAR MASS M, AND QUANTITY (MASS %)

Product	R	M	mass %
Toluene	4.25	92	9.7
Dipropyl ketone	6.10	114	12.2
Benzaldehyde	7.74	106	24.9
Benzyl alcohol	8.99	108	12.1
Butenyl benzenes	9.07, 9.49	132	1.6
Propyl phenyl ketone	12.40	148	13.7
Dibenzyl	15.98	182	1.0
Dibenzyl ether	17.45	198	8.0
Phenyl benzoate	18.84	212	5.8

Our previous investigations have shown that chromite catalysts in the presence of water vapor can effectively ketonize aliphatic alcohols, aldehydes, acids and esters. Many authors have also found that on oxide surfaces these compounds form carboxylate structures, which can be regarded as adsorbed acyl radicals. Their formation on the catalyst surface can be represented by the following scheme, depending on the type of starting material for ketonization:

$$R\text{-}CO\text{-}X \rightarrow R\text{-}CO + X, \quad \text{where } X = H, 3H, OH \text{ or } OR'$$

The first step of alcohol ketonization is the dehydrogenation to aldehyde; in the case of esters – hydrolysis to the alcohol and acid. It has been established that water molecules also dissociate on the catalyst surface. The reaction mixtures contain fragments of the starting compound molecules and of water molecules, which undergo recombination yielding both ketones and a variety of by-products. Such dissociative-associative ketonization reaction mechanism proposed by us [4] is also confirmed by theoretical calculations of the reaction using the semiempirical quantum chemical calculation method AM1. Also, the ability of oxide catalyst surface to easily exchange hydrogen atoms and hydroxyl groups, *i.e.*, their high mobility, testifies in favor of above considerations. The ketonization and cross-ketonization reactions proceeding with benzyl butyrate, as well as the composition of by-products reaffirm the correctness of such a mechanism.

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Synthesis and Structure of Palladium 2,4-Dimethyl-8-Selenoquinolinate

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Sergey Belyakov and Andrey Tokmakov *(Latvian Institute of Organic Synthesis)*

Keywords **– Palladium 2,4-dimethyl-8-selenoquinolinate, palladium coordination compounds, synthesis of 8-selenoquinolinates, X-ray diffraction structural analysis.**

I. Introduction

In the course of study of the complexing activity of 8-hydroselenoquinoline and investigation of the nature of chemical bond metal-selenium in the five-membered metal-containing ring, the internal complex palladium 2,4-dimethyl-8-selenoquinolinate $Pd[C_9H_4(CH_3)_2NSe]_2$ (**I**) has been synthesized.

II. General regulations

The complex $Pd[C_9H_4(CH_3)_2NSe]_2$ is formed in reaction of palladium chloride aqueous solution with 2,4-dimethyl-8-selenoquinoline in turn obtained by reduction of 2,2',4,4'-tetramethyl-8,8'-diquinolyl diselenide with hypophosphorous acid.

The single crystals are grown in the chloroform solution. Crystal data for **I**: Monoclinic, space group $P2_1/n$, $Z = 4$, a = 9.0092(4), b = 16.3290(7), c = 14.1073(6)Å, β = 106.710(2)°, V = 1987.7(2)Å^3, R=0.0499, wR2=0.1242 for 4495 reflections (diffractometer Bruker-Nonius KappaCCD, λMoK_α).

The crystal structure of the complex **I** is formed by neutral asymmetric molecules $Pd[C_9H_4(CH_3)_2NSe]_2$ in which the central atom palladium is connected bidentally (Se,N) with two 2,4-dimethyl-8-selenoquinoline ligands. The presence of methyl groups in the position 2 of the ring in the ligand molecules causes the steric hindrance to the formation of such planar symmetric *trans*-complexes as palladium 8-selenoquinolinate $Pd(C_9H_6NSe)_2$ (**II**) [1]. This leads to the structure of palladium coordination polyhedrons to *cis*-square (2Se+2N). The square (2Se+2N) occurs to be somewhat tetrahedrally distorted. The diagonal angles SePdN amount to 163.1(1) and 163.0(1)°. Dihedral angle between the SePdN / SePdN coordination plane is 159.8(1)°.

The Pd – Se bonds (2.355(1) and 2.359(1)Å) are covalent and occur to be somewhat shorter train the corresponding bonds in the complex **II** (2.404 Å). The transition of *trans*-(complex **II**) to *cis*-coordination (complex **I**) causes the weakening of the Pd – N bond (compare 2.162(5) and 2.159(5) Å (**I**), 2.065 Å (**II**)). The values of the chelate angles 84.45(14) and 84.65(13)° are practically equal. Valence bonds C – Se (1.909(6) and 1.893(5)Å correspond to the sum of the covalent radii of the atoms.

The steric hindrance that occurs due to the 2-methyl groups in the ligands is compensated by flexures of the five-membered metal-containing rings along the Se … N line. The dihedral angles between the SePdN and SeCCN planes are 22.6(1) and 156.5(1)°. The dihedral angles between the practically planar quinoline rings amounts to 39.4(1)°.

The results obtained in this and earlier experiments allow to consider that:

-In the analogous complex 8-selenoquinolinate and 8-mercaptoquinolinate of the typical transition metal - palladium – the change of the ligand atom S→Se causes the changes in the molecular and crystal structure, and the complexes are isostructural.

- The occurrence of the methyl group in position 2 in the 8-hydroselenoquinoline ligand in the complex **I** as well as in the complex $Pd[C_9H_5(CH_3)NS]_2$ **(III)** [3] causes the changes of the both molecular and crystal structure: the planar centrosymmetrical complexes **II** possessing the centrosymmetrical *trans*-square environment (2Se+2N) of the palladium atom are crystallized in the spatial group $P\bar{1}$, but asymmetrical complexes **I** and **III** possessing the angular disposition of the quinoline rings and insignificant tetrahedrally distorted dislocated *trans*-square vicinity (2Se(S)+2N) of the palladium atom - in the spatial group $P2_1/c$,
respectively.

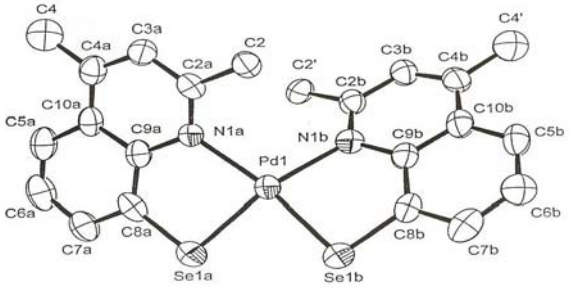

Fig.1. Molecular structure of $Pd[C_9H_4(CH_3)_2NSe]_2$

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Quantum Chemical Investigation of the Geometric and Electronic Structure of the 3-Amidino-2-Brombenzanthrone. Absorption and fluorescent spectra prediction.

Artur Yanichev, (*Riga Technical University*), Georgii Kirilov, *(Daugavpils University),* Sergey Belyakov and Mendel Fleisher *(Latvian Institute of Organic Synthesis)*

Modern fluorescent technology has a large practical significance in solving many problems of science, medicine and industry. The goal of this paper is a theoretical investigation of geometrical structure, electronic properties and absorption and fluorescent spectra prediction for 3-Amidino-2-Brombenzanthrone (N'-(2-Bromo-7-oxo-7H-benzo[de]anthracen-3-yl)-N,N-dimethyl-formamidine(**1**)).

The synthesized compounds were identified on the basis of spectral data and elemental analysis. X-Ray diffraction of the single crystals of this substance was performed in order to obtain objective detailed information about geometric structure of the title compound. The new compound ($C_{20}N_2H_{15}OBr$) crystalizes in the monoclinic $P2_1/c$ space group.

In addition to the crystal structure from the X-ray experiment, the molecular geometry, vibrational frequencies, atomic charge distribution, and frontier molecular orbital (FMO) analysis of the title compound in the ground state and a conformational analysis of the isolated molecule has been carried out. As a result, of the conformational analysis, two equilibrium states, characterized by the position of substitute to the plane of the molecule, were found. To find the transition state between equilibrium states the intrinsic reaction coordinate method has been used for which coresponding torsion angle was taken. The results of the optimized molecular structure are presented and compared with the experimental values. Atomic charge distribution, molecular electrostatic potential, dipole moment and bond orders have been calculated. Using this data the reactivity of the molecule has been predicted. Absorption and fluorescence spectra were predicted using a computational model, which was described in literature [1]. This model is based on a part of the Jablonsky diagram and includes explicit geometry optimization of the S_0 and S_1 electronic states in different solvents (water, ethanol, benzene). To compute the corresponding $S_0 \rightarrow S_1$ absorption transition energy single point calculation of the S_1 energy at the S_0 geometry has been calculated. The positions of the fluorescence maxima are calculated as vertical singlet transition energies $S_1 \rightarrow S_0$ at the optimized geometry of the S_1 species. To account for the solvent effect Conductor-like Solvent Model (COSMO) was used [2]. All the calculations were carried out by the semiempirical PM6 method using the MOPAC2009 program [3]. Calculations of the molecular geometry at the S_1 excited states were carried out using the keyword OPEN(2,2) and including configuration interaction using the microstate formalism. Varying the number of configurations, the optimal result, that reproduces the experimental data with the best accuracy, has been found. Solid state quantum-chemical calculations by the PM6 method were performed on a model of the macrocell consisting of (1×1×1) unit cells of the crystal of compound **1** using the translational vectors of the unit cell Tv and the keyword MERS(1,1,1) for the solid state with energy normalization coefficient GNORM = 1.0. The parameters of the unit cell in the single crystal (a = 12.162, b = 9.869, c = 13.263 Å, α = 85.52, β = 103.61, γ = 92.68 °; V = 1541.85 Å^3, ρ = 1.634 g/cm^3) were obtained. The semiempirical quantum-chemical calculations of the model of the macrocell of the compound **1** agree well with the obtained X-ray crystallographic data.

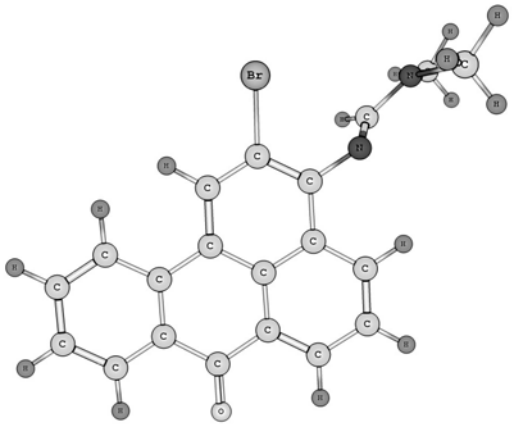

Fig.1 Optimized geometry of 3-Amidino-2-Brombenzanthrone, calculated by the PM6 method.

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Acknowledgement*:* This work was supported by ESF project No. 2009/0205/1DP/1.1.1.2.0/09/APIA/VIAA/152

Fluorescent Substituted Amidines of Benzanthrone: Synthesis and Spectroscopy

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Keywords **– benzanthrone derivatives, synthesis, spectroscopy, fluorescence.**

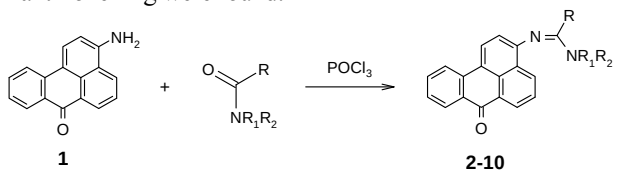
I. Introduction

Benzo[de]anthracen-7-one dyes have found many applications due to a whole range of colours and high thermo and photo stability. Many benzanthrone derivatives are strongly fluorescent and that is why widely used as a laser dye, daylight fluorescent pigment, and lipophilic fluorescent probe for biochemical and medicinal investigations.

From our previous works it is known that substituted N-benz-anthronyl amidines display an intense luminescence in solutions and solid state [1-3]. Herein, we presented the facile synthesis and characterization of N-substituted amidino derivatives based on benzo[de]anthracen-7-one. The optical properties of novel synthesized compounds have been investigated in the present work. Quantum chemical calculations were also presented, in order to investigate the electronic structures and properties of synthesized dyes.

II. Results and Discussion

The target dyes were synthesized in high yields by condensation of 3-aminobenzanthrone (**1**) with appropriate amides using $POCl_3$ as a condensation agent. This synthetic route is outlined in Scheme 1. The structures of prepared derivatives were determined by NMR spectroscopy, based on the analysis of H-H coupling constants and chemical shifts. In the ^1H NMR spectra of the dyes, the signals of appropriate alkyl group and multiplet signals (from δ 6.50 to 9.00 ppm) of aromatic protons of benzanthrone ring were found.



1 **2-10**

Scheme 1. Synthesis of benzanthrone N -substituted amidines **2-10**.

Table 1.

Benzanthrone N-substituted amidines **2-10**

Compound	R	R_1	R_2	Yield, %	M.p., °C
2	Me	H	Ph	52	244.2
3	H	H	Me	67	243.5
4	H	Et	Et	90	159.4
5	Me	H	4-MeC_6H_4	82	250.0
6	H	H	Ph	65	247.1
7	H	Me	Ph	92	226.5
8	H	H	H	80	250.8
9	Me	H	Me	87	81.9
10	H	H	Et	85	218.2

The obtained amidine derivatives are crystalline compounds colored from yellow to deep red. The reaction and purity of products were monitored by a thin-layer chromatography. IR, ^1H NMR, and mass spectroscopic studies confirmed the chemical structure of the new dyes **2-10**. The synthesized derivatives were characterized by their melting point, absorption, and fluorescence maxima. The photophysical properties of amidines **2-8** were investigated in various organic solvents with different dielectric constants (Figure 1).

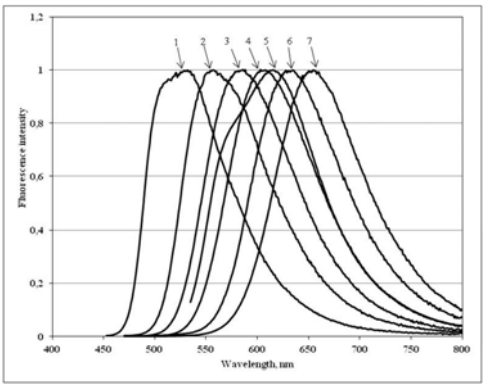


Fig.1 The normalized fluorescence emission spectra of dye **4** ($1x10^{-5}$ Mol L^1) in hexane (1), benzene (2), ethyl acetate (3), acetone (4), chloroform (5), DMSO (6), ethanol (7), respectively

All studied amidines showed a hypsochromic shift of emission maxima in chloroform solutions in comparison with amine **1** (627 nm). But in ethanol solutions a bathochromic shifts (for amidines **2** and **5**) or a hypsochromic shifts (for other amidines) are observed in comparison with amine **1** (659 nm).

The thermal stability is one of the key requirements for some practical applications. In order to gain more insight into these dyes, **5, 6**, **7** and **8** were subjected to the thermogravimetric analysis to investigate their thermal stabilities. The thermal stability studies were performed at a heating rate of 10°C/min. Above 330-400°C the thermogravimetric curves of these compounds show a major loss in weight, with decomposition temperatures at 338, 379, 402, 367°C for **5-8**, respectively. These results confirm that prepared dyes are thermally stable compounds.

III. Conclusion

The novel synthesized benzanthrone amidine dyes are thermally stable and exhibit a strong absorbance at 410-510 nm and an intense luminescence at 500-680 nm. This aimed dye displayed positive solvatochromic properties in various solvents having different polarity power. Such dyes can be utilized as suitable sensing probes for checking solvent polarity and determining colorimetric chemosensing effect.

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Quantum Chemical Investigation of the Interaction between Thiocyanate and the Human Carbonic Anhydrase II

Mendel Fleisher, Raivis Zalubovskis, Andulis Shmidlers and Daina Jansone (*Latvian Institute of Organic synthesis)*

Keywords **– carbonic anhydrase II, thiocyanate, inhibitor, PM6 method.**

Carbonic anhydrases (CAs) are zinc-metalloenzymes that catalyze the reversible hydration of carbon dioxide to form bicarbonate and the release of a proton. The CA reaction is involved in many physiological and pathological processes, including respiration and transport of CO_2 and bicarbonate between metabolizing tissues and lungs; biosynthetic reactions; calcification; and tumorigenicity. Many clinically used drugs have been reported to possess significant CA inhibitory properties [1]. A well known inhibitor for CAs is the thiocyanate. In order to investigate the interaction mechanism of thiocyanate with CA II, a detailed quantum chemical study using the semiempirical PM6 method [2] was carried out. The model system used in these calculations is based upon the crystal structure of human CA (Protein Data Bank code - 2CBA). This system includes a Zn^{2+} cation bonded to a HO^- group and three imidazole rings belonging to the three histidine residues His94, His96, and His119; the residues Glu106, Thr199, Thr200, His107, Arg246, Asn244, Gln92, and also 8 water molecules (Wat264, Wat265, Wat292, Wat318, Wat338, Wat359, Wat369, Wat389). Total number of atoms in the system was 243. The first step of the interaction of thiocyanate and CA occurs spontaneously (barrierless) with the heat of reaction ΔH = -23.7 kcal / mol. As a result of this process is the proton leaving from the thiocyanate, SCN^- anion formation, and a proton transfer through the hydrogen-bond network to the oxygen atom of residue Glu106. The total charge of the SCN particle is -0.954. Further calculations were carried out by the intrinsic reaction coordinate method, for wich the distance between the nitrogen atom of the SCN^- anion and the Zn^{2+} ion of the enzyme was taken. It was found three transition states (TS). The first of these have the activation energy *E*a = 3.5 kcal / mol, and is related with the repulsion of the water molecule Wat359 from the path of the anion. In the equilibrium state this molecule will occupy a position behind the SCN^- particle. The distance between the nitrogen atom of the SCN^- anion and Zn^{2+} is equal to 5.328 Å. The following TS occurs when the water molecule Wat318, linked by a hydrogen bond to the hydroxyl group bonded to Zn^{2+}, is replaced with the molecule Wat292. The activation energy for this process *E*a = 4.8 kcal / mol. In the equilibrium state the distance N-Zn^{2+} is equal to 4.320 Å. The third TS is characterized by the highest activation energy, equal to 8.2 kcal / mol. Distance N-Zn^{2+} is equal to 2.578 Å. In this case the hydroxyl group bonded to Zn^{2+} is converted into a water molecule as a result of capture a proton from the residue Thr199. After overcoming these TS, in the zinc coordination sphere begins the process of replacing the water molecule with the SCN^- anion, fixation of this anion, and reverse proton transfer from the residue Glu106 to residue Thr199. The heat of this reaction step is 26.3 kcal / mol. In the equilibrium state the Zn-N bond length is equal to 1.844 Å, and the appropriate bond order is equal to 0.639.

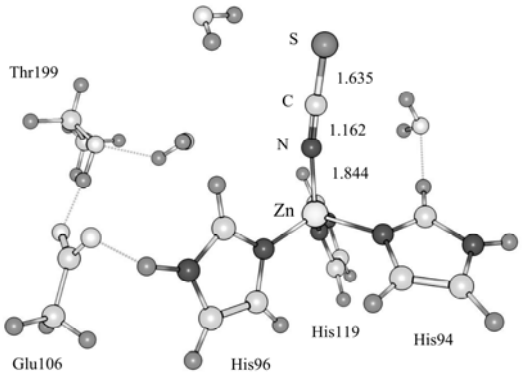

Fig.1. Schematic representation of the CA II inhibition mehanism by thiocyanate (bond lengths in angstroms)

The computational results provided a better understanding of the molecular interaction between the thiocyanate inhibitor and the CA II enzyme.

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Materials Science and Applied Chemistry

Chemistry and Chemical Technology

Trityloxyethyl and *tert*-Butyl Groups Containing Molecular Glasses of 4*H*-Pyran-4-Ylidene Derivatives with Light-Emitting and Amplified Spontaneous Emission Properties

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Keywords **– OLED, organic glass forming compounds, 2-*tert*-butyl-6-methyl-4*H*-pyran-4-one, fluorescent dye.**

I. Introduction

Dyes which make amorphous structure when deposited from volatile organic solvents and having good light-emission properties show potential in organic photonics. One of the methods for obtaining such molecular glasses from organic compounds is incorporation of trityloxyethyl groups in their molecules [1]. In our previous research we successfully obtained glass forming derivatives of pyranylidene using 2,6-dimethyl-4*H*-pyran-4-one as starting material. However, due to its two activated methyl groups, in further reactions with trityloxyethyl group containing aromatic aldehyde, a mixture of mono- and bis-condensation products were obtained, which separation was complicated [1-2]. Nevertheless, each of products was separated and purified, however their yields were low. Starting synthetic procedure from 2-*tert*-butyl-6-methyl-4*H*-pyran-4-one not only prevents this problem as only one activated methyl group is in its molecule, but also enhances the formation of amorphous structure of target compounds [3]. In this report we will describe our findings of trityloxyethyl group containing molecular glasses based on 2-*tert*-butyl-6-styryl-4*H*-pyran-4-one.

II. Synthesis and Physical Properties

Light-emitting amorphous glasses containing 2-*tert*-butyl-6-styryl-4*H*-pyran-4-ylidene fragment was synthesized according the scheme shown below and obtained in good yields up to 51% after separation and purification by liquid column chromatography. Compounds 1a-d were obtained from 2-*tert*-butyl-6-methyl-4*H*-pyran-4-one.

All glasses show good thermal stability with thermal decomposition temperatures from 264° to 318°C and glass transition values up to 158°C for DWK-1TB. Their physical properties will be discussed in detail during the conference.

III. Conclusions

The synthesized compounds ZWK-1TB, DWK-1TB, JWK-1TB and KWK-1TB, which contain trityloxyethyl and *tert*-butyl groups, form a glassy structure in the solid state from volatile organic solvents. By starting synthesis from 2-*tert*-butyl-6-methyl-4*H*-pyran-4-one, not only the yield of target compounds have been improved, but they also have better thermal properties compared to similar pyranylidene type compounds published previously by us [1].

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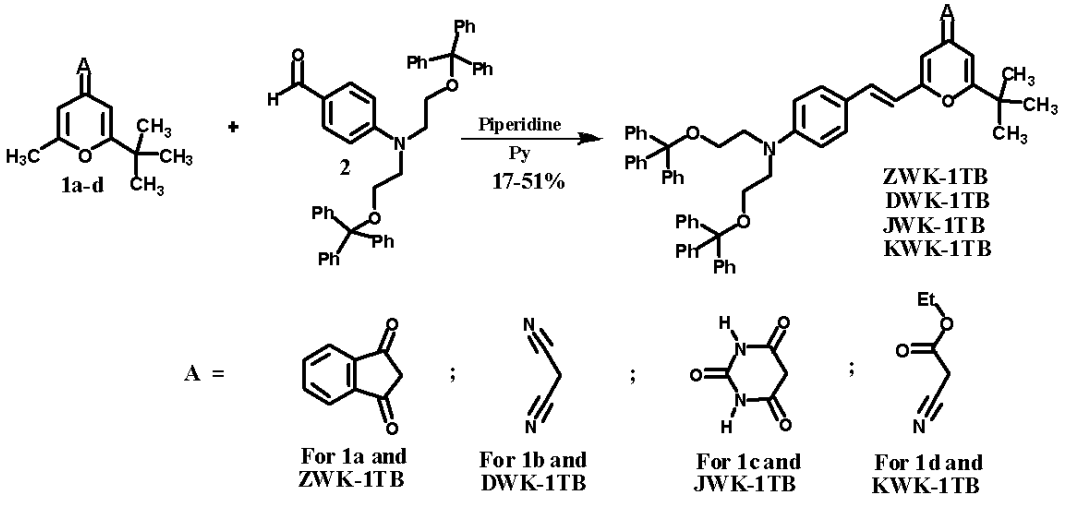

Use of Modular Approach to Obtain Molecular Glasses for Photonics: Triphenyl Moieties

Kaspars Traskovskis, Valdis Kokars (*Riga Technical University*), Andrejs Tokmakovs, Igors Mihailovs and Martins Rutkis (*Institute of Solid State Physics*)

Keywords **– NLO, azochromophore, organic glasses, DMABI**

I. Introduction

Small molecular weight amorphous phase forming materials is a new emerging class of electro optical materials. While general principles linking molecular structure and material thermal and amorphous phase stability characteristics remain unresolved, molecular glasses have several considerable advantages such as relatively simple synthesis and purification, increased chromophore density and well defined structure. A wide spread strategy for obtaining molecular compounds capable of forming stable glasses involves preventing the molecules from interacting together in a strong and directional fashion. In particular the presence of arene rich starburst structural fragments is successfully used to obtain such materials, where crystallization and aggregation process is hindered by sterical demands of conformationally rigid bulky substitutes or insufficient solid phase packing due to the shape of molecules. One of promising strategies for obtaining molecular glasses is the modular approach where a core molecule not capable of glass formation is further functionalized with building blocks preventing the crystallization. Substituents like N,N-diphenylhydrazone [1] and triazines [2] are successfully used to obtain amorphous materials.

II. Summary

In the given research a new modular approach to obtain molecular glasses for photonics applications is presented. Series of different compounds have been synthesized where polar chromophore core is further functionalized with triphenyl group containing moieties. The given functional group has large sterical demands and pseudo spherical shape what ensures that intermolecular forces between dipolar chromophores are less pronounced and this allows to obtain stable molecular materials useful for practical photonics measurements.

The molecular design of triphenyl moieties used in our study is given in Figure 1. Trityloxy and triphenylsilyl groups while providing glasses with good optical quality and having the advantage of relatively easy synthetic route are not chemically stable and are easily cleaved in acid or basic conditions. This motivated to search for different solutions of introducing the modifying groups in the molecule. This was successfully achieved by the use of 1,1,1-triphenylpentane fragment.

Non-linear optical (NLO) activity of the thin glassy films was confirmed after a corona poling procedure. The thermoplastic properties of materials were determined by the combination of differential thermal calorimetry and temperature induced decay of NLO response. The results show that the replacement of carbon with silicon in the triphenyl core has a conflicting impact on the properties of the investigated NLO active organic glasses. On the one hand, the amorphous phase formation favours the presence of a bulkier and conformationally less defined triphenylsilyl group which was most evident in the case of azochromophore containing compounds. At the same time this structural element reduces the thermal stability of polar order in corona poled films.

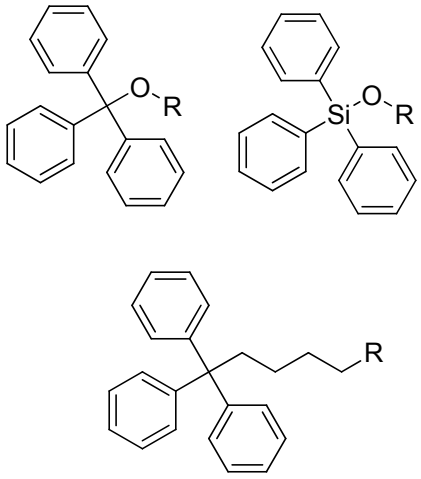

Fig.1. Triphenyl building blocks used in obtaining molecular glasses.

Compared trityloxy and triphenylsilyloxy fragment containing molecular glasses, the compounds containing 1,1,1-triphenylpentane fragment show slightly reduced thermal sustainability of accentric order in polled films but at the same time nonlinearity of materials is greatly increased. These effects can be attributed to increased mobility of chromophore core in those compounds.

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Chemical Interesterification of Rapeseed Oil with Ethyl Acetate using *t*-Butanolic Potassium Butoxide

Zane Sustere and Valdis Kampars (*Riga Technical University*)

Keywords **– chemical interesterification, ethyl acetate, rapeseed oil.**

I. Introduction

In biodiesel production the by-product of the transesterification reaction is glycerol. In recent years much research has been aimed at improving biodiesel synthesis by interesterification with methyl or ethyl acetate using both enzyme and chemical catalysts. Fatty acid methyl or ethyl esters (FAME or FAEE) and triacetin (TAG) are the main products in this process. This leads to a simplified downstream processes compared to conventional catalytic reactions as the mixture of FAME and TAG may be utilized as biodiesel, rather than FAME only. Moreover TAG has a much higher economic value than glycerol. Casas A. et al. studied interesterification process using methanolic sodium metoxide solution as a catalyst, but it also causes transesterification side reactions, which lead to a lower yield of TAG production than teoritical possible [1]. In the present work rapeseed oil interesterification with ethyl acetate was studied using the *t*-butanolic potassium *t*-butoxide solution (BuOK) as catalyst.

II. Experimental Procedure

The rapeseed oil and ethyl acetate were mixed and heated to 75°C in 3-necked flask, equipped with a reflux condenser, termometer and magnetic stirrer-heater. Then catalyst 0.8% of oil mass was added. Reactions were stopped after 60 minutes with stoichiometric amounts of phosphoric acid. Then solvents were distilled and the samples were filtered and stored in refrigerator.

Ester content was determined according to modified standard method EN 14103, using an Analytical Controls biodiesel analyzer (Agilent Tehnologies gas chromatograph 7890A) with flame ionization detector and HP Innowax capillary column (length 30 m; internal diameter 0.25 mm; film thickness 0.25 µm). To determine all glycerides and acetins, samples was prepared in accordance with the modified standard EN 14105 method. Characteristics of the capillary column used were: HT DB-5; 15 m; 0.32 mm; 0.1 µm. The column temperature program used: at 50°C 5 min, ramp up to 180°C at 15°C /min, up to 230°C 7°C /min, and up to 370°C 10°C /min, final temperature hold for 5 min.

III. Results

In addition to the FAEE and TAG, the reaction mixture may contain intermediates from interesterification – MADG (Monoacetyldiglyceride) and DAMG (Diacetylmonoglyceride), as well as intermediates from transesterification – diglyceride, monoglyceride and glycerol and some products from other side reactions, like transesterification of triacetin.

The process was studied using excess of ethyl acetate. The larger amount of ethyl acetate yielded larger content of final products in the reaction mixture, in agreement with reaction stoichiometry. The excess of ethyl acetate was increased to 1/36, larger values were not investigated, because of economical aspects. Increasing a molar ratio oil/ethyl acetate from 1/3 to 1/36, increased the ester content from 37.7% to 71.2% (wt%). TAG content increased from 1.1% to 13.1% (see fig.1), which is relatively close value to teoritical (19.1%) and which is almost 2 times more than in reaction using methanolic sodium metoxide. The triglycerides (TG) decreased from 7.2% to 0% and intermediates from interesterification – MADG from 11.4 to 1%, but DAMG content varied between 4.4 and 6.7%. So we can conclude that a large excess of ethyl acetate is required to obtain more final products of interesterification, and a molar ratio less than 1/18 is not sufficient to obtain total conversion of triglycerides and caused side reactions.

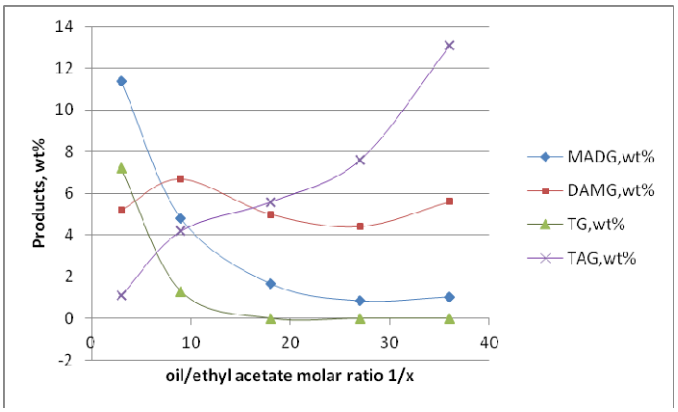

Fig.1. The variation of composition of reacton mixture with the excess of ethyl acetate

IV. Conclusions

The use of *t*-butanolic potassium *t*-butoxide solution allow to obtain almost 2 times more TAG than in reaction using methanolic sodium metoxide. A large excess of ethyl acetate is required to obtain more final products of interesterification, and a molar ratio less than 1/18 is not sufficient to obtain total conversion of triglycerides and caused side reactions.

V. References

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Acknowledgment: This work was financially supported by European Social Fund, Project "Scientific Group Supporting Latvian Activities of the European Strategic Energy Technology Plan", No.1DP/1.1.1.2.0/09/APIA/VIAA/027.

Crystal Structure of Flecainide Acetate

Dmitrijs Stepanovs and Anatoly Mishnev (*Latvian Institute of Organic Synthesis*)

***Keywords* – Flecainide acetate, Antiarrhythmic drug, X-ray crystal structure, Recrystallization.**

Flecainide (Fig. 1.) is antiarrhythmic drug [1]. The structure of flecainide acetate, *N*-(2-piperidylmethyl)-2,5-*bis*-(2,2,□2-trifluoroethoxy)benzamide acetate $(C_{17}H_{20}F_6N_2O_3)^+\cdot(C_2H_3O_2)^-$, was determined by X-ray crystallography. The compound crystallizes in a monoclinic system, space group $P2_1/n$ and cell parameters: a = 5.3304 (5) Å, b = 14.2568 (6) Å, c = 28.530 (1) Å, β = 93.08(4) °, Z = 4, V = 2420.0 (3) Å^3.

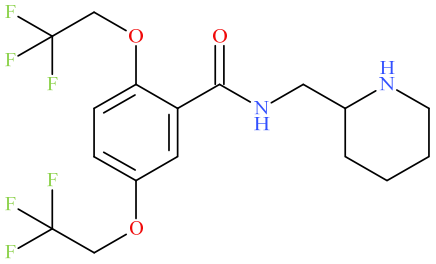

Fig.1. Molecular structure of flecainide

The reflection intensities were measured at 190 K on a Bruker Nonius KappaCCD diffractometer with graphite monochromatized Mo*K*a radiation (λ = 0.71073 Å). The data collection was performed using the KappaCCD Server Software [2], cell refinement – SCALEPACK [3], and the data were reduced by DENZO and SCALEPACK [3]. The structure was solved by Direct Methods (SHELXS-97 [4]) and refined anisotropically on F^2 values using SHELXL-97 [4]. All hydrogen atoms were positioned geometrically and refined with the riding model on the adjacent non-hydrogen atoms. Single crystals were grown from dimethylformamide by slow evaporation of solvent at 40 °C.

TABLE 1.
CRYSTAL AND EXPERIMENTAL DATA

Chemical formula: $(C_{17}H_{20}F_6N_2O_3)^+\cdot(C_2H_3O_2)^-$	
Formula weight = 474.40	T = 190 K
Crystal system: monoclinic	Space group: $P2_1/n$
a = 5.3304 (5)Å	
b = 14.2568 (6)Å	β = 100.651 (2)°
c = 28.530 (1)Å	
V = 2420.0 (3)Å^3	Z = 4
D_x = 1.456 g/cm^3	Mo K_α, λ = 0.71073 Å
μ(Mo K$_\alpha$) = 0.14 mm^{-1}	F(000) = 984
Crystal size: 0.30 × 0.35 × 0.05 mm	
No. of reflections collected = 11970, independent = 4842	
θ range for data collection: 1.6 to 27.5°	
$(\Delta/\sigma)_{max}$ = 0.065	$(\Delta\rho)_{max}/(\Delta\rho)_{min}$ = 0.35/-0.31 eÅ^{-3}
Final R indices [$I > 2(\sigma_I)$] $R1$ = 0.107, $wR2$ = 0.297	

Crystal structure of the title compound is shown in Fig. 2. The bond lengths angles are close to their standard values, except bond angles of piperidine ring due to disorder of atom C14 and high thermal vibrations of C15, C16, and C17.

The flecainide anion is protonated at atom N2. Structure has one intermolecular hydrogen bond N1–H1*A*···O3 and two intramolecular N2-H2*A*···O5 and N2-H2*B*···O4 (Table 2).

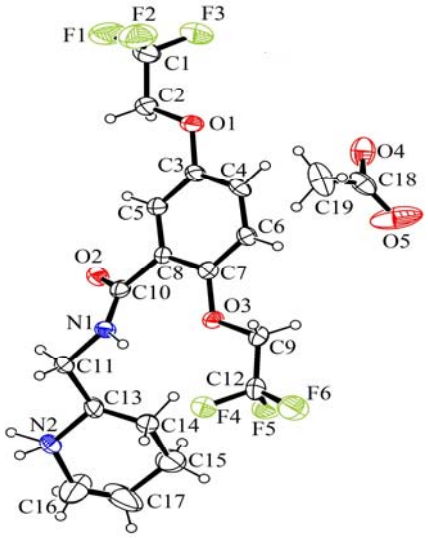

Fig.2. ORTEP-III drawing of flecainide acetate structure

TABLE 2.
HYDROGEN BOND GEOMETRY (Å, °)

D–H···A	D–H	H···A	D···A	∠ D–H···A
N1–H1*A*···O1	0.93	2.23	2.743 (4)	114
N2–H2*A*···O4	1.16	1.56	2.707 (5)	173
N2–H2*B*···O5	1.09	1.60	2.631 (5)	155

Both trifluoroetoxy groups and benzene ring lie almost on the same plane. In the crystal, by means of the hydrogen bonds, the molecules form chains along crystallographic axis *b* (Fig. 3).

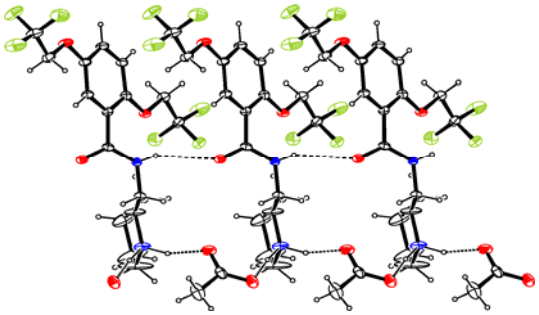

Fig.3. Formation of O4···H2*A*–N1– H2*B*···O5 hydrogen bond chains in the crystal structure

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Crystal Structure, Mechanochemical Preparation Possibilities and Stability of Some Isoniazid Cocrystals

Inese Sarcevica (*Latvia Institute of Organic Synthesis, University of Latvia*), Liana Orola (*University of Latvia*) and Sergey Belyakov (*Latvia Institute of Organic Synthesis*)

Keywords **– isoniazid, carboxylic acids, crystal structure, stability.**

Isoniazid is an antitubercular drug known to form cocrystals with acid compounds [1, 2]. The common O–H···N hydrogen bond between carboxylic group and pyridine N has been observed in most of these cocrystals. Isoniazid cocrystals with benzoic acid (1:1) and salicylic acid (1:1) have been synthesized and characterized by single-crystal and powder X-ray diffraction. Mechanochemical preparation possibilities of isoniazid in presence of ethanol and acetonitrile were performed by varying grinding time. Stability of cocrystals was evaluated by maintaining samples at 35 ºC and 75% RH for ten weeks.

The isoniazid–benzoic acid cocrystal was crystallized from ethanol/acetonitrile solution and prepared by liquid assisted grinding. This cocrystal crystallizes in the $P2_1$ space group. The crystallographic information about isoniazid cocrystals is given in Table 1.

Table 1.
Crystallographic data of isoniazid cocrystals with benzoic and salicylic acid

cocrystal	**Isoniazid – benzoic acid cocrystal**	**Isoniazid – salicylic acid cocrystal**
chemical formula	$C_6H_7N_3O{\cdot}C_7H_6O_2$	$C_6H_7N_3O{\cdot}C_7H_6O_3$
crystal system	monoclinic	monoclinic
space group	$P2_1$	$P2_1/n$
M_r	259.26	275.26
a, Å	25.815(1)	11.2953(3)
b, Å	3.8880(6)	3.7495(2)
c, Å	6.1323(6)	29.847(1)
α, °	90	90
β, °	88.416(4)	93.552(1)
γ, °	90	90
V, Å^3	615.3(1)	1263.84(5)
Z	2	4
μ, mm^{-1}	0.102	0.110
final R ($I>2\sigma$)	0.0623	0.0508
GOF	1.034	1.062

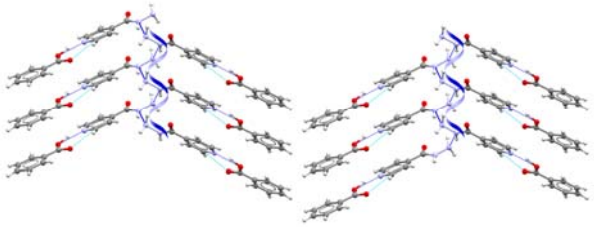

Fig.1. The herringbone arrangement and C(3) helices in the crystal structure of isoniazid – benzoic acid cocrystal.

Benzoic acid is hydrogen bonded to isoniazid pyridine N through O–H···N hydrogen bond to form an $R_2^2(7)$ ring motif [3]. The N–H···N bonds link hydrazide groups of isoniazid molecules to form a *C(3)* helix parallel to the twofold symmetry element (Fig. 1). All helices have the same handedness therefore this crystal structure of the isoniazid – benzoic acid cocrystal is chiral.

The isoniazid – benzoic acid cocrystal decomposed after four weeks at 35 ºC and 75% RH and the presence of starting compounds in the sample was detected by PXRD (Fig. 2.).

Isoniazid – salicylic acid cocrystal was prepared by liquid assisted grinding and slow evaporation from solution. Both methods produced the same product. The cocrystal crystallizes in the monoclinic space group $P2_1/n$.

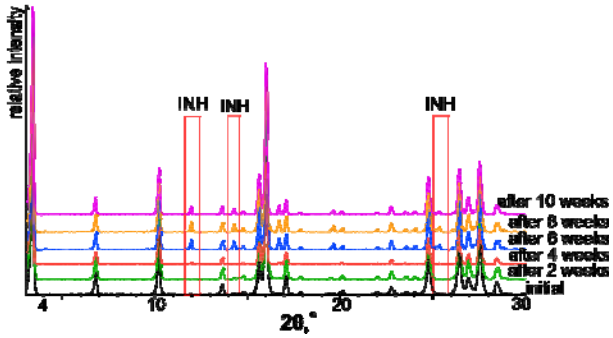

Fig.2. The decomposition of isoniazid benzoic cid cocrystal during the stability experiment period. Peaks corresponding to isoniazid designated by INH.

The acid group of the salicylic acid is O–H···N hydrogen bonded to pyridine N of isoniazid. An N–H···O interaction connects the isoniazid hydrazide group and the hydroxyl group of the acid.

The isoniazid moieties form chains by N–H···O hydrogen bonds and these chains are arranged as right handed and left handed helices shown in Fig. 2. A $R_4^4(26)$ graph set can be identified in the structure as a result of a hydrogen bonded ring formed by two isoniazid and two salicylic acid moieties. The π-π interactions (3.75 Å) between pyridyl rings of the isoniazid and benzene rings of the salicylic acid contribute to the stability of this structure.

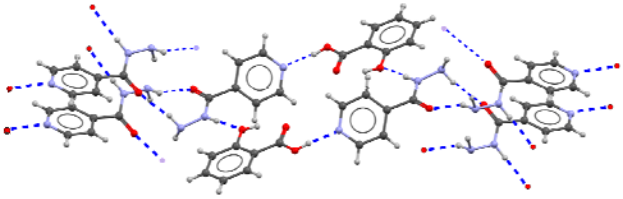

Fig.3. Hydrogen bonding in isoniazid - salicylic acid cocrystal

The stability experiments confirmed the stability of isoniazid – salicylic acid cocrystal over the investigation period.

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Glycerol Ethers from Glycerol and Alcohols

Modris Roze, Valdis Kampars, Kristine Teivena, Ilze Birska and Ruta Kampare (*Riga Technical University)*

Keywords **– Glycerol, isopropyl glycerol ether, *tert*-butyl glycerol ether, heterogeneous catalyst, etherification.**

I. Introduction

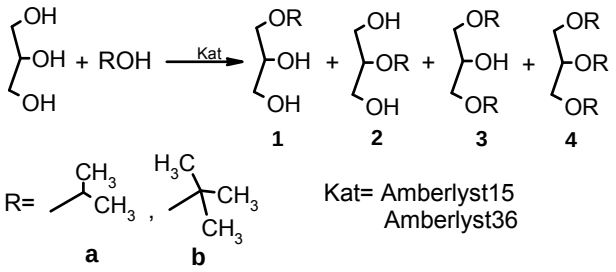
Biodiesel is fuel made from renewable resources such as vegetable oils or animal fats by transesterification. Biodiesel contributes less to global warming than fossils fuels due to the reduction of CO_2, CO and hydrocarbon emission from engines. It also decreases national dependence on imported fuels.

The main by-product in the production of biodiesel is glycerol, the quantity of which has increased considerably in recent years.

It is known that glycerol ethers could be used as fuel additives. These ethers are synthesized generally by etherification of glycerol with alcohols or isobutylene mainly in an autoclave reactor [1]. In this work we present some results of glycerol etherification by isopropanol and *tert*-butanol in the presence of heterogenic catalysts in ordinary flasks under reflux.

II. Results and Discussion

The synthesis reaction of glycerol ethers was performed in the presence of Amberlyst 15 or Amberlyst 36 as catalysts without solvent or in a toluene solution. The influence of catalyst concentration, mole ratio of alcohol/glycerol, microwave and ultrasonic irradiation was investigated. The samples of reaction products were analysed by thin layer or gas chromatography and structure was determined by NMR spectroscopy. Main products of reaction were 3-alkoxypropane-1,2-diol and 1,3-dialkoxypropane-2-ol.



With gas chromatography two additional compounds were found in small quantities 2-6%. These products could not separated, but we thought that its are 2-alkoxypropane-1,3-diol and 1,2-dialkoxypropane-3-ol.

In the isopropanol reaction with glycerol without solvent a glycerol conversion only 20-30% was obtained, but in the case of *tert*-butanol reaction - 30-45%. Attempts to increase glycerol conversion by microwave or ultrasonic irradiation failed in both cases. Irradiation sped up the reaction and the maximum glycerol conversation was achieved after 40- 50 minutes, after which the reaction stopped.

Water could inhibit the reaction, therefore the use of preliminary dried catalyst and alcohol was tried, but it increased the conversion of glycerol only insignificantly. Attempts to add water removing substances, such as molecular sieves, also did not give expected results and glycerol conversion fell.

Next, the reaction was performed in the presence of the water removing agent toluene. It was observed that addition of toluene to glycerol in the ratio 5-6: 1and the use of a Dean-Stark trap significantly increased the conversion of glycerol and yield of glycerol ethers. It was possible by increasing the reaction time to achieve almost full conversion of glycerol, but in this case the yield of glycerol ethers fell and instead oligoglycerols were formed in significant amounts (10-20%). According to the NMR investigations a mixture of different oligoglycerols was formed.

Best results were achieved with a catalyst (Amberlyst 36) concentration 5%, glycerol: *tert*-butanol: toluene ratio 1:3:6 and reaction time 3 hours. Glycerol conversation in this case was ~70% and the yield of 3-*tert*-butoxypropane-1,2-diol 60%. It was found that in the *tert*-butanol reaction with glycerol, the ratio of monoalkylglycerol: dialkylglycerol depends on catalyst concentration and reaction time. Increasing the catalyst amount to 10% (reaction time 3 h) also increases the ratio of 1,3-di-*tert*-buxypropane-2-ol and the amount of oligoglycerols. When the reaction time was extended to 7 hours it was found that isobutene was produced and a reversible reaction takes place, which leads to a decreasing amount of monoalkylglycerol.

Reaction products were investigated using gas chromatography, NMR and IR spectrometry and 3-*tert*-butoxypropane-1,2-diol 1,3-di-*tert*-buxypropane-2-ol were purified by vacuum distillation, followed by column chromatography.

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Acknowledgment: The work is supported by the European Social Fund Project „Scientific Group Supporting Latvian Activities of the European Strategic Energy Technology Plan”, No. 1DP/1.1.1.2.0/09/APIA/ VIAA/027.

Catalytic Deoxygenation of Rapeseed Oil to *n*-paraffins

Raimonds Murnieks, Lauma Apseniece, Valdis Kampars and Zane Shustere (*Riga Technical University*)

Keywords **– deoxygenation, rapeseed oil, hydrotreating, supported metal catalysts, hydrocarbons.**

I. Introduction

The liquid biocrude conversion to hydrocarbon fuels is the primary step in refining liquid fuels produced from vegetable oils, animal fats, biodiesels and waste cooking oils. The removal of oxygen is needed for biofuels to enhance the fuel enthalpies, decrease viscosity, and improve stability [1].

In this process three parallel reactions occur: hydrogenation of the double bonds, hydrodeoxygenation and decarboxylation. In the hydrodeoxygenation reaction n-paraffins with an even number of carbon atoms corresponding to related fatty acids in the rapeseed oil, mainly n-C16 and n-C18, are formed along with water and propane. In the case of decarboxylation, the products comprise CO_2, propane and n-paraffins with an odd number of carbon atoms in molecules (mainly n-C15 and n-C17). The number of carbon atoms in these compounds is lower by one than that of the used fatty acid [2].

II. Experimental

Rapeseed oil, 2 g, was deoxygenated at a hydrogen pressure of 15-70 bar and 220-300 °C temperature in the presence of 0.1-0.6 g Raney Ni or 66%Ni/SiO_2-Al_2O_3 catalyst powder, using a V4A high grade steel 100 mL batch reactor. The batch reactor was stirred with a magnetic stirrer. The range of reaction durations was 1 – 6 h under the deoxygenating conditions.

The experiments were performed by varying only one experimental parameter at a time (pressure, temperature, catalyst amount or reaction duration) for each of the experimental series. Only fresh feedstock and catalyst (Raney Ni or 66%Ni/SiO_2-Al_2O_3) were used in the experimental work. Oxygen removal from the triglycerides of liquid rapeseed oil and the yield of obtained hydrocarbons was evaluated by using gas chromatography.

III. Results and Discussion

The main product of the resulting hydrocarbons is heptadecane (reduced from fatty acids containing 18 carbon atoms), consequently the decarboxylation process prevails over hydrodeoxygenation under the corresponding reaction conditions. In most cases the obtained product was a white solid with an odor similar to paraffin wax.

A. Reaction duration

In experiments with both catalysts – Raney Ni and 66%Ni/SiO_2-Al_2O_3 the degree of conversion increased with increasing reaction duration in the range of 1 to 6 h, while the pressure (70 bar), temperature (300 °C) and catalyst amount (5 wt%) remained constant. Using 66%Ni/SiO_2-Al_2O_3 as catalyst, reaction duration had a greater impact on rapeseed oil conversion than with the Raney Ni catalyst. Best results with Raney Ni were obtained in 6 h, yielding 13.4 wt% hydrocarbon content in reaction products, whereas with 66%Ni/SiO_2-Al_2O_3 the hydrocarbon content after 6 h was 55.5 wt% .

B. Temperature and pressure

In the experiments with both catalysts – Raney Ni and 66%Ni/SiO_2-Al_2O_3 the degree of conversion increased with increasing reaction temperature from 220 to 300 ºC. Significant increase of conversion was obtained with 66%Ni/SiO_2-Al_2O_3 catalyst at temperatures above 280 ºC. When Raney Ni catalyst was used, conversion dependence on temperature was close to linear over the corresponding temperature range. As for the influence of pressure, rapeseed oil conversion increased with increase in pressure in the range from 15 to 70 bar. The impact of pressure on conversion was higher using 66%Ni/SiO_2-Al_2O_3 catalyst, especially in the range of 50 to 70 bar. Best results (after 4 h under 70 bar, 300 ºC and 5 wt% catalyst amount) were 8.1 wt% hydrocarbon content with Raney Ni; 29.2 wt% hydrocarbon content with 66%Ni/SiO_2-Al_2O_3.

C. Catalyst amount

The conversion of rapeseed oil to *n*-paraffins was directly proportional to the amount of catalyst. Higher conversion was reached with Ni/SiO_2-Al_2O_3 catalyst, using identical catalyst amounts (by weight). Best results (after 4 h under 70 bar, 300 ºC and 20 wt% catalyst amount) were 40.0 wt% hydrocarbon content with Raney Ni and 72.1 wt% hydrocarbon content with 66%Ni/SiO_2-Al_2O_3.

IV. Conclusions

The best results in all cases were obtained with 66%Ni/SiO_2-Al_2O_3 catalyst. The degree of conversion of triglycerides to *n*-paraffins significantly increases with increasing amount of catalyst, reaction duration, temperature and pressure. Decarboxylation becomes significant when the pressure exceeds 50 bar and the temperature is 280 °C or higher, which was confirmed by the high heptadecane content in the resulting hydrocarbons. The optimal conditions for deoxygenation of rapeseed oil to get hydrocarbons (*n*-paraffins) are: 50-70 bar and 280-300 °C.

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Selective Inhibitor Studies of Carbonic Anhydrase Using NMR and Molecular Modelling

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Keywords **– Carbonic anhydrase, NMR, Molecular Modelling.**

Carbonic anhydrases (CA) are proteins that are well-suited to serve as models in many types of studies in biophysics, bioanalysis, the physical-organic chemistry of inhibitor design, and medical chemistry. In vivo, these enzymes catalyze the hydration of CO_2 and dehydration of bicarbonate. There are 16 different isoforms of CA, which are expressed in different cell types or compartments and a few of them are associated with disease development, e.g. CA IX is associated with cancer development and CA II is involved in glaucoma. These isoforms are promising drug targets, but it is important that the obtained inhibitors are very selective [1-2].

Recently in Latvian Insititute of Organic Synthesis new type of carbonic anhydrase inihibitors – coumarine bioisosters with overall formula **S** were synthesized [3] . We used NMR and molecular modeling methods to investigate the binding ofthese inhibitors to carbonic anhydrase.

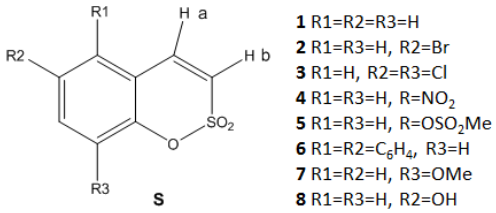

Fig.1. Coumarine bioisosters.

We expressed and purified from *E. coli* a ^{2}H, ^{13}C and ^{15}N labeled mutant of CA II, which incorporates the active site mutations A65S and N67Q and is designed to mimic CA IX. We were able to assign 243 amino acid residues out of 245 (not including 15 prolines). Recently at our institute a new class of potentially selective CA IX inhibitors – sulfocoumarines – was discovered. We used 1D (^{1}H, STD, WaterLOGSY) and 2D (^{15}N-^{1}H HSQC) NMR experiments to study the interactions of these compounds with CA. Based on protein backbone amide chemical shift perturbation data, we modeled the 3D structures of the protein-inhibitor complex using molecular docking (OPLS 2005 force field). Chemical shift changes of the inhibitor suggested that sulfocoumarines bind in an open form and the sulfate group interacts with the zinc ion. The ligand additionally forms a hydrogen bond between a hydroxyl group and a threonine located in the active site. We also observed that the backbone amide signals of some amino acid residues disappeared from the HSQC spectra during the titrations, indicating a possible conformational change upon ligand binding.

Also we did research on selective inhibitor (**9**) shown in figure 2 of CA I compare to CA II protein.

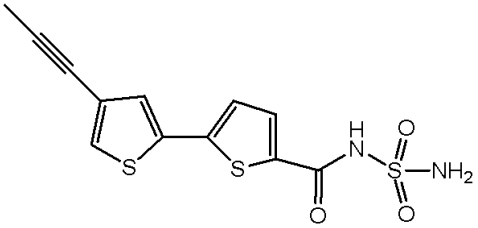

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Fig.2. Selective CA I inhibitor.

We used the same methods as previously described. For the inhibitor, which binds strongly to CA I (K_i=0.63 μM), we observed reduction of signal intensities for residues in the active site corresponding to strong affinity. The inhibitor selectivity against CA I versus CA II is explained by a different coordination of the carbonyl group of the inhibitor to the catalytic Zn^{2+} ion. In CA I the Zn^{2+} ion is coordinated with the carbonyl group of the inhibitor and zinc becomes five-coordinated, while in CA II the carbonyl group is unable to coordinate with the Zn^{2+} ion. This selective interaction explains the higher affinity of the inhibitor towards CA I compared to CA II. Quantum chemistry calculations of the active sites of both CA confirm that the five-coordinated model is energetically more favorable by ~6 kcal/mol than the four-coordinated model.

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Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
The 1st Congress of World Engineers and Riga Polytechnical Institute / RTU Alumni

New Methods of Biofuel Production

Valdis Kampars, Kristaps Malins, Janis Brinks, Tatjana Rusakova, Zane Shustere, Kristine Lazdovica, Karina Cirule, Raimonds Murnieks and Ruta Kampare (*Riga Technical University*)

Keywords **– biodiesel, hydrodeoxigenation, pyrolysis, mixed fuels**

I. Introduction

The conversion of biomass into liquid or/and gaseous fuels is a very promising way to reduce the existing geopolitical and environmental risks of the increasing oil and fossil fuel dependency. In the search process for fossil fuel replacements probably biofuels have attained the greatest results and it is important to admit that the biofuel production today is a global thriving industry. Thus the global production of ethanol and biodiesel accordingly to the "Global Biofuel Market Analysis" report, is expected to grow at a CAGR of around 8% and 11% respectively, and so will achieve together 6% of the world's estimated liquid fuel production in 2020. Unfortunately, the first-generation biofuels - ethanol made from corn, or sugar cane, or biodiesel made from vegetable oil, have restricted raw material basis, therefore their productions technology must be improved and in order to broaden the raw material basis such new technologies as hydrodeoxygenation, pyrolysis and gasification of biomass have to be developed.

II. Results and Discussion

Splitting of triglycerides into mono-alkyl esters in transesterification or interesterification reactions remarkably lowers the viscosity of vegetable oil or animal fat and thus gives a liquid fuel known as biodiesel [1]. The good quality vegetable oil commonly was used as the stock, because the high yield of the biodiesel in the presence of the most active homogeneous basic catalyst cannot be achieved if the stock contains more than 1-3% of free fatty acids. In order to broaden the raw material basis of vegetable oils we elaborate an acid catalyzed multi-step esterification and trans-esterification process for low quality stocks. The obtained results show that in presence of such acid catalyst as sulfuric acid the esterification reaction proceeds noticeably faster than transesterification reaction. However in real biodiesel production processes the transesterification reaction proceeds only after the esterification.

In the process of the transesterification reactions of rapeseed oil not only the methanol has been used as a chemical reagent. In order to elaborate new additives for improving the low temperature flow properties we have synthesized a group of new rapeseed oil esters by variation of the alcohol part. The obtained results show that the number of carbon atoms and structural features of alcohol moiety in rapeseed oil biodiesel influenced all characteristics of the biofuel. The density has decreased, but the viscosity increased with increasing carbon atom number in the alcohol moiety. Regardless of higher viscosity of alkyl esters with homologs of methanol the highest carbon residue was determined for FAME. The variation of the chemical structure of alcohol moiety in biodiesel synthesized from rapeseed oil gives the possibility to remarkably improve the cold flow properties without the observable changes of other properties. And the use of branched chain alcohols such as 2-buthanol, 2,2-dimethylpropanol and 4-methyl-2-pentanol instead of methanol gives the largest effect. The CFPP for the biodiesel fuel from these alcohols is -24 ^{o}C.

The by-product of the transesterification reactions is glycerol, which in such case is a low-purity product and must be processed, if use in further applications. The synthesis of biodiesel has been made also by interesterification with methyl or ethyl acetate [2]. In this process instead of glycerol a new - higher value by-product triacetin is obtained. Our investigation shows that in reaction of rapeseed oil with ethyl acetate in the presence of 30% MeONa in methanol the yield of triacetin increased with increasing of the ethyl acetate to oil molar ratio and reached 7.6 % at the ratio 36/1. The yield of triacetin in the presence of BuOK in the tert-butanol at the same conditions was 13.1%, because the transesterification reaction of rapeseed oil with solvent of catalyst does not proceed. The obtained mixtures of methyl esters and triacetin have all the diesel fuel characteristics and the interesterification may be a way for a complete use of rapeseed oil for further fuel production.

Another way for the complete use of vegetable oil for fuel production is the catalytic rapeseed oil hydrodecarboxylation. Investigation of this process shows that the most active catalysts are the Ni containing ones and the process proceeds well if the initial pressure of hydrogen exceeds 50 atm and the temperature is over 280 ^{o}C. In this process a mixture of several alkanes was obtained.

The use of the new biofuels as pure fuels practically is less perspective, than their use in a form of mixtures with fossil fuels. Therefore the systematic investigation of such mixed fuel properties is very important. Our investigation of biodiesel - winter diesel fuel mixtures shows that if the biodiesel content do not exceed 30% the mixed fuels meet the requirements of standard LVS EN 590. And the dependence of the Cold Filter Plug Point on the biodiesel content in the mixed fuel (Fig. 1) is very interesting from the scientific point of view. Many other characteristics show an additive behavior.

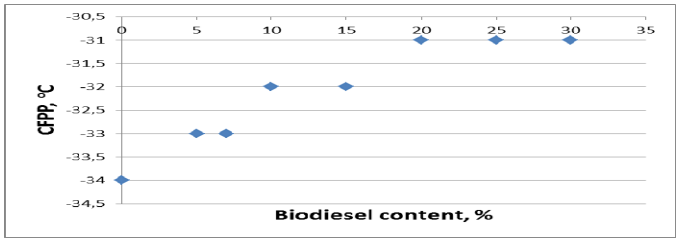

Fig.1. The CFPP dependence on biodiesel content.

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Acknowledgment: This research was granted by Latvian National Research Programme "LATENERGI".

Nonlinear Optical Chromophores with 1,3-Indanedione Moiety

Valdis Kampars, Pauls Pastors, Jana Kreicberga, Lauma Laipniece, Ilze Neibolte, Mara Plotniece, Kristine Teivena and Ruta Kampare (*Riga Technical University*)

***Keywords* – nonlinear chromophore, 1,3-indandione, synthesis.**

I. Introduction

The nonlinear organic optical chromophores possess strong second-order nonlinear capabilities, and can be used for frequency mixing to convert laser wavelengths to different regions of interest, or to be incorporated as thin-films into the electro-optical devices (electro-optical modulators, switches, OLEDs, photovoltaics). These compounds can also be used in materials meant for writing and processing of the optical information [1]. Organic molecules with intramolecular charge-transfer (D-T-A) are among the most important nonlinear chromophores and because of their chemical features have attracted the serious interest of the scientists. Numerous characteristic groups and structures have been used as the electron donor (D), electron acceptor (A) or bridge (T) parts for the synthesis of nonlinear organic chromophores. One of the most popular electron acceptor moiety is 1,3-indandione or its dicyanomethylene derivatives, used for synthesis of the new organic nonlinear chromophores during the last decades in Riga and abroad [2,3]. The derivatives of 2-(N-pyridinium)-1,3-indandione (IPB) are also a very interesting group of zwitterionic chromophores with 1,3-indanedione moiety.

II. Results and Discussion

The most popular nonlinear chromophore with 1,3-indandione acceptor moiety is 2-(4'-dimethylaminobenzylidene)-1,3-indandione (DMABI). Molecular zero frequency hyperpolarizability β_0 = 38 x 10^{-30} esu of the DMABI has been already reported. DMABI is photo and thermo stable and can be used for making a host – guest films with large optical nonlinearity and fast optical response. The expression for the NLO coefficient $d_{33} \approx N\beta F \langle\cos^3\theta\rangle$, where N - number density and F – local field factor and $\langle\cos^3\theta\rangle$ - average orientation factor, shows that the optical nonlinearity of material depends of the molecular hyperpolarizability of the chromophore and of the chemical structure features, setting limits for the other factors. In order to increase the optical nonlinearity of materials the molecular hyperpolarizability of chromophore shall increase keeping other characteristics contributing. However this is a very complicate problem and cannot be resolved without serious studies of the synthesis process and so the synthesis and investigation of many new chromophores has to be done. In our work we have tried to develop the structure modifications of DMABI and IPB in several directions:

1) Synthesis of DMABI analogues by modification of phtaloyl-, carbonyl- and phenyl part of DMABI;
2) Synthesis of IPB analogues;
2) Synthesis of di- and polychromophore;
3) Synthesis of dendronized chromophore;

As it is shown in Table 1 the first direction gives the possibility to synthesize and investigate a set of similar compounds, that allows solving several theoretical problems. As the slope of correlations (a) of the charge-transfer (CT) energy of the investigated chromophore X in different solvents with the CT energy of the DMABI in the same solvents is directly proportional to the $\Delta\mu(X)/\Delta\mu(DMABI)$ we can conclude, that the 2-(2,3,6,7-tetrahydro-1*H*,5*H*-pyrido[3,2,1-*ij*]quinolin-9-ylmethylene)-1*H*-4-azaindene-1,3(2*H*)-dione is the more prospective chromophore from this set.

TABLE I
DMABI ANALOGUES

Modifications of DMABI			**Solvatochromic behaviour**		
Phenyl	Carbonyl	Phthaloyl	r	a	$\Delta\nu$, cm^{-1}
no	no	no	1	1	0
Methoxy	no	no	0,847	0,407	4990
no	$=C(CN)_2$	no	0,984	0,748	-2913
no	$2 \times =C(CN)_2$	no	0,954	0,782	-4536
no	no	4,7-Dimethyl	0,997	0,944	364
no	no	4-Aza	0,999	0,969	-723
no	no	5-Aza	0,996	0,956	-690
Tetrafluoro	no	no	0,994	0,888	-666
Julolidyl	no	4-Aza	0,98	1,032	-1960

Synthesis of di- and polychromophores with 1,3-indandione acceptor moiety (Fig.1) allow to obtain a new class of chromophores with anticipated specific behaviour during the poling procedure.

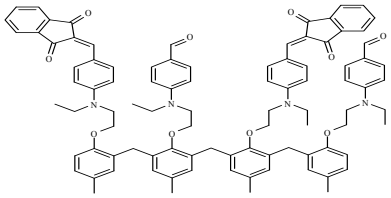

Fig.1. Tetraphenole polychromophore

The synthesis of dendronized chromophores gives the possibility to include different chromophores into one molecule and so obtain the products with interesting UV-Vis spectra and increased poled film stabilization.

III. References

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Acknowledgment: This research was granted by Latvian National Research Programme in Materials Science and by the Taiwan-Baltic Partnership Project.

Effect of the Heating Rate on the Wheat Straw Pyrolysis

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Keywords **– effect of heating rate, wheat straw, pyrolysis, TG-FTIR.**

I. Introduction

With the depletion of fossil fuels and increasing concern for the environment and climate changes, biomass resources become a very important potential renewable energy source. There are many conversion technologies for utilizing biomass, such as biochemical and thermochemical processes [1]. Pyrolysis plays a vital role in the biomass conversion as one of the promising thermal conversion routes. Solid, liquid and gaseous products are obtained from biomass pyrolysis. Temperature of pyrolysis and heating rate are the most important factors, which influenced the yield of pyrolysis products and its composition. High temperature favors gaseous products, high heating rate provides the high yield of liquid products, and low heating rate and low temperature tends to increase the high char yield [2-3]. In this work the influence of different experimental conditions on wheat straw pyrolysis was investigated using a thermogravimetric analyzer STA 6000 combined with a FTIR Spectrum 100.

II. Experimental Procedure

The pyrolysis experiments were performed by ramping the temperature- from 30 to 900^{O}C at heating rates of 30, 60, 80 and 100^{O}C/min with sample mass 32mg in a pure nitrogen flow of 20 ml/min. The transfer line and the gas cell were heated to an internal temperature of 280^{O}C to avoid condensation or adsorption of the semi - volatile products. Each FTIR spectrum was recorded every 9s in the spectral range between 4000 and 650 cm^{-1}.

III. Results

The thermal degradation of wheat straw occurred in three major weight loss steps. The first weight loss step between 30 – 150^{O}C with endothermic effect was due to moisture content. The second weight loss step, ascribed to the decomposition of hemicellulose and cellulose, was the largest. Decomposition of hemicellulose (220 – 315^{O}C) started before the decomposition of cellulose (315 – 400^{O}C). The third step with weight loss between 400 and 900^{O}C involved the decomposition of lignin. The main gas products of wheat straw pyrolysis identified and quantified by FTIR were CO_2, CO, CH_4. Other volatile organic compounds (acids, aldehydes, ketones, alcohols, phenols) and water condensed to give bio–oil. As it is shown in Fig.1. the carbon monoxide, carbon dioxide, methane and acetic acid yield increased with heating rate. Although the total weight loss during the pyrolysis was approximately constant (76,25-76,65%) the gas phase composition changed noticeably as the heating rate was varied. At the heating rate of 100^{O}C/min carbon monoxide and methane appear to have reached their maxima, but the yield of acetic acid and carbon dioxide showed a tendency to increase with further increasing of heating rates.

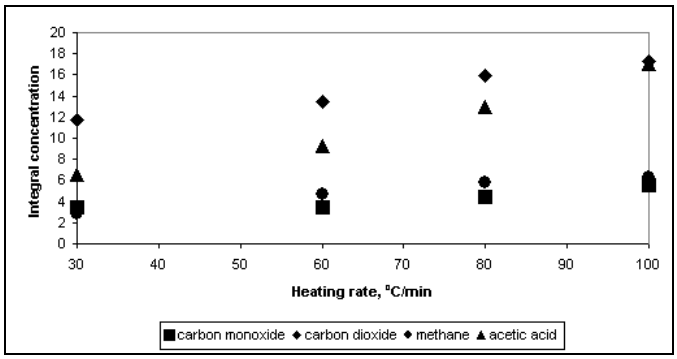

Fig.1. Carbon monoxide, carbon dioxide, methane and acetic acid

IV. Conclusions

The heating rate has a minimal effect on the total amount of volatile fraction, but influences the composition of the gas phase. By using heating rates in the range from 30 to 100^{O}C/min the total weight loss of wheat straw increases only slightly from 76.25 to 76.65%, while the yield of carbon monoxide, methane, acetic acid and carbon dioxide increases substantially.

V. References

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Azobenzene Core Dendrimers with Trityl Groups in the Periphery

Lauma Laipniece and Valdis Kampars (*Riga Technical University*)

Keywords **– dendrimer, azobenzene, trityl group.**

I. Introduction

Dendrimers are assembled step by step and can be easily customized at each level of their structure (core, branches, and surface), resulting in well defined and highly functionalized three-dimensional architectures. Azobenzene containing dendrimers can be used for drug delivery, molecular imprinting, pH indicator, or holographic experiments. [1]

II. Results and Discussion

All four generations of dendrimers **G0-G3** (Fig. 1) are synthesized from precursor dendrimers containing hydroxyl groups in the periphery adding trityl chloride and triethylamine in pyridine. Detailed synthesis of hydroxyl precursors is found elsewhere [2].

Solvatochromism of all four dendrimers has been investigated. Light absorption maxima correlated well with solvent polarity parameter π* [3] (Fig. 2). Absorption characteristics were different for compound **G0**, it had absorption maxima in about 20-30 nm longer wavelengths, very likely that reason is lack of branching structure comparing to dendrimers **G1-G3**. Dendrimers **G1-G3** had batochromic shift with increasing generation in all used solvents, this could be explained with effect of dendrimer generation – increasing isolation of core azobenzene in polar dendrimer branches, which partially acts similar to solvent.

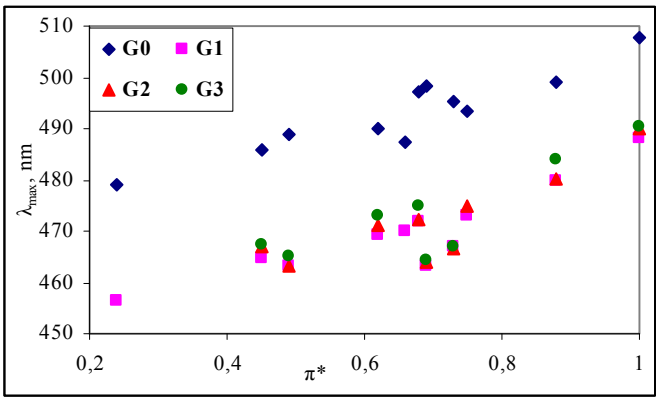

Fig.2. Absorption maxima of dendrimers **G0-G3** plotted against solvent polarity parameter π*. Solvents (along with their π* values) used were: Et_2O (0.24), EtOAc (0.45), toluene (0.49), acetone (0.62), MeCN (0.66), EtOBz (0.68), $CHCl_3$ (0.69), CH_2Cl_2 (0.73), $MeNO_2$ (0.75), DMF (0.88), DMSO (1).

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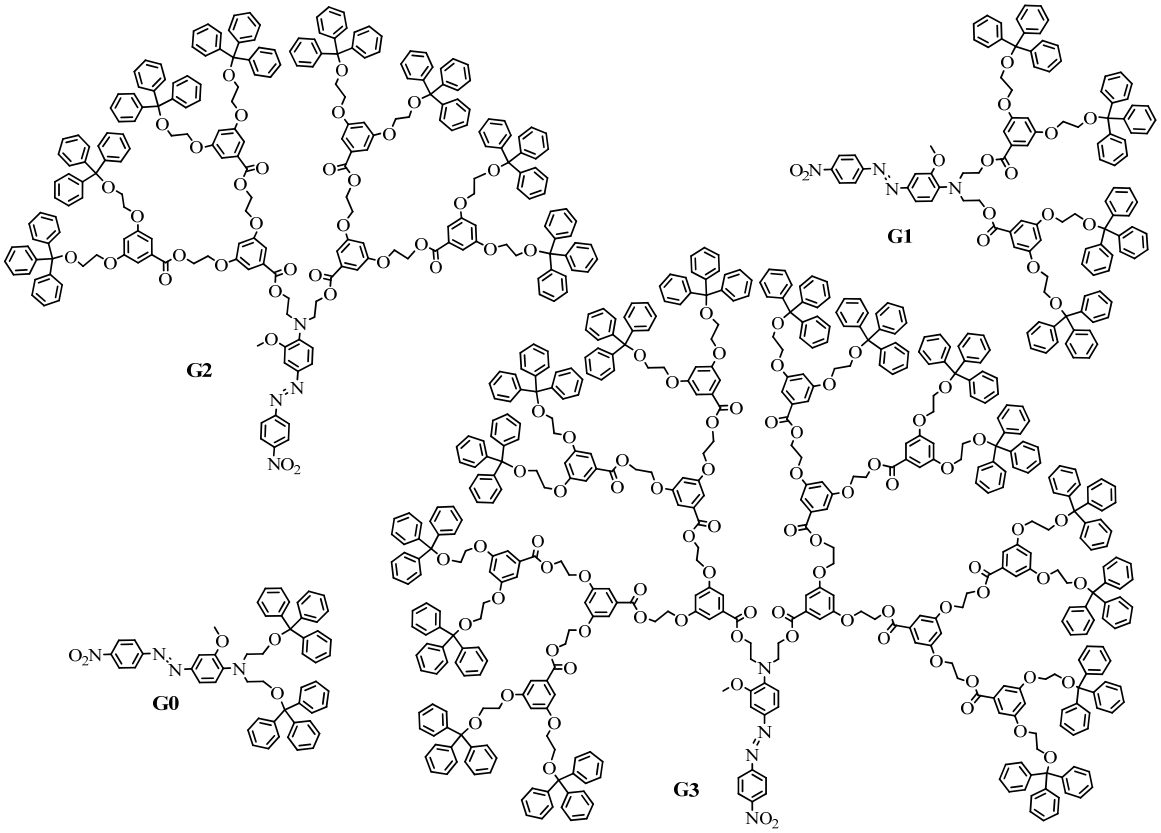

Synthesis of Dendronized Azochromophores with Benzyl and 2,3,4,5,6-Pentafluorobenzyl Fragments

Lauma Laipniece and Valdis Kampars (*Riga Technical University*)

***Keywords* – azochromophore, perfluoroaromatic substituents.**

I. Introduction

Usually molecules with large hyperpolarizabilities - dipolar push-pull chromophores - have large dipole moments and tend to align antiparallely decreasing the macroscopic EO response due to centrosymmetric ordering [1].

Fluoroaromatic and aromatic moieties of the same or two different molecules can self-assembly in stacks owing to arene-perfluoroarene (Ar-Ar^F) quadrupolar interaction between electron-rich and electron-deficient aromatic rings [2, 3]. Molecular glasses containing small dendrons with phenyl and pentafluorophenyl moieties have been synthesized to improve poling efficiency utilizing Ar-Ar^F interactions; they show increased EO coefficients and orientation stability [3].

II. Results and Discussion

Aniline **1** was esterified with both dendronizing acids ROH using *N,N'*-dicyclo-hexylcarbodiimide (DCC) and 4-(dimethylamino)pyridine (DMAP), thus esters **2** and **3** were obtained (Fig. 1), which in turn reacted in azo-coupling reaction with diazonium salt from aniline **4** to form monodendronized azochromophores **5** and **6**. Asymmetrical chromophores **7** and **8** were obtained from compounds **5**, **6** and both dendronizing acids R'OH in DCC ensured ester synthesis.

Synthesis of symmetrical azochromophores was more straightforward. At first azocompound **9** was synthesized in azocoupling reaction from compounds **1** and **4**. Then symmetrical azochromophores **10** and **11** were synthesized in one DCC ensured esterification step with both acids ROH.

Structures of all chromophores were approved by ^{1}H and ^{13}C NMR spectroscopy.

TABLE 1

THERMAL PROPERTIES AND UV-VIS SPECTRA OF COMPOUNDS **7**, **8**, **10**, **11**

Compound	λ_{max}, nm ($CHCl_3$)	T_g, °C	mp, °C	T_d, °C
7	478.9	54	147	250
8	480.2	58	70	260
10	479.1	47	130	264
11	476.3	62	103	264

Light absorption maxima of all compounds (Table 1) were similar because the same azochromophore is used in the core of the molecule. Glass transition temperatures (T_g) showed that four 2,3,4,5,6-pentafluorobenzyl fragments of compound **11** increase T_g, but four benzyl fragments of compound **10** decrease T_g.

III. Summary

We have synthesized four dendronized azochromophores varying ester bond formation reaction and azo-coupling reaction. We expect capability of these four azochromophores to form complexes with parallel aligned dipoles and enchanced nonlinear optical properties in thin films.

IV. References

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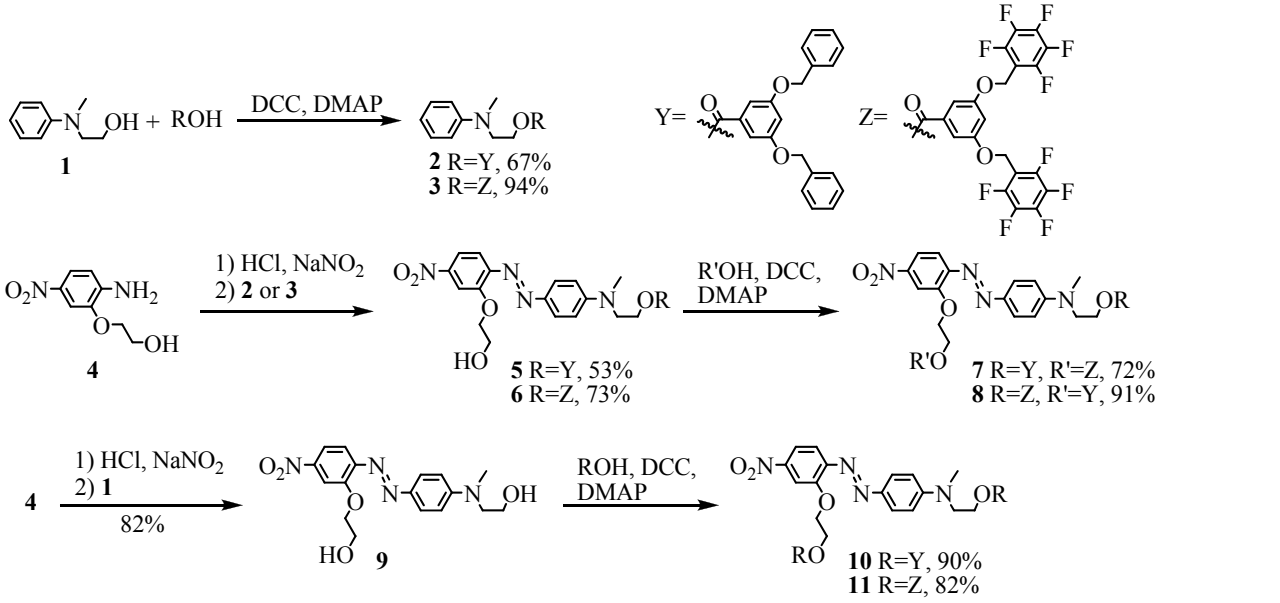

Fig.1. Synthesis of dendronized azochromophores.

Synthesis of Phthalocyanine, Containing Nitrogen Heterocycles

Tatjana Krivicha and Modris Roze (*Riga Technical University)*

Keywords **– phthalodinitrile, 4-nitrophthalodinitrile, phthalocyanine.**

Phthalocianines by their structures are similar to naturally occurring porphyrins with highly conjugated systems and 18π electron systems. The simplest molecule is unsubstituted phthalocyanine H_2Pc and phthalocyanines form coordinating complexes with most metals of periodic table, exception being silver and mercury. Unsubstituted phthalocyanines have poor solubility in organic solvents, so phthalocyanine molecule synthesize with peripheral substituents.

4-Nitrophthalodinitrile is a good starting material for the synthesis of substituted phthalocyanines. Nitro group can be easily displaced with some *N*- and *O*-nucleophiles. All reactions were carried out in aprotonic solvents *N*,*N*-dimethylformamide and *N*-methylpirolidone in the presence of K_2CO_3 at the temperature interval of 50 – 60 ºC under argon atmosphere. As *N*-nucleophiles isonipecotic acid ethyl ether and as *O*-nucleophiles 3-piridylmethanol and 3-piridylpropanol were used. The nucleophilic substitution reaction yields varied in range from 75 to 85 % (fig.1).

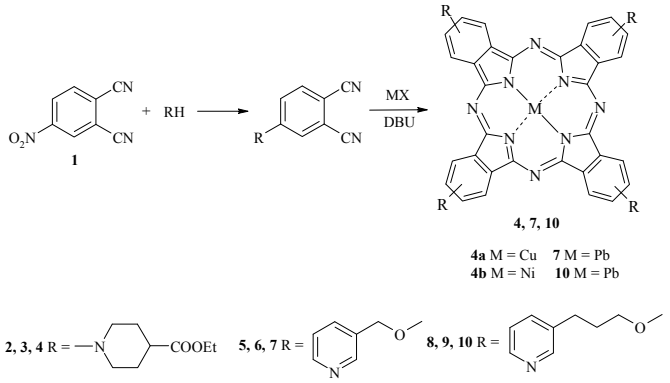

Fig.1. 4-Nitrophthalodinitrile nucloephilic substitution reactions and phthalocyanine synthesis

Substituted metal containing phthalocyanines were synthesized in mild conditions in presence of base DBU in absolute ethanol or 1-penthanol at boiling temperature. Metal salt or complex was added to substituted phthalodinitriles **3**, **6** and **8** and the synthesis was controlled with UV spectroscopic method.

The main target of investigating phthalocyanine reaction kinetics was determining the optimal synthesis time and calculation of the molar absorption coefficient (fig.2).

Synthesis reaction of copper 4-piperidylcarboxy-phthalocyanine was carried out in two stages. First stage production of copper [4-(ethylcarboxy)piperidyl]-phthalocyanine in absolute ethanol, with the presence of DBU which resulted in a yield of 21 % yield. Second stage was ethyl ether group hydrolysis in 9M hydrochloric water solution which yielded 80 % of the compound (fig.3).

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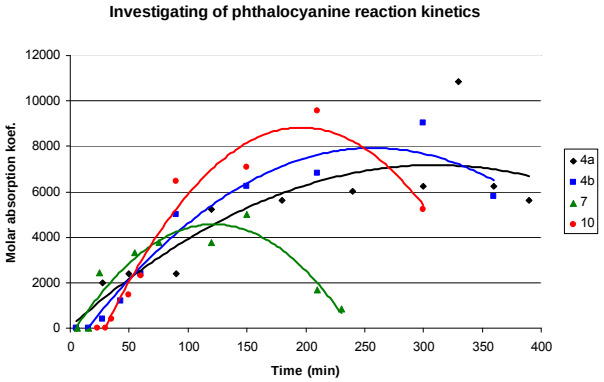

Fig.2. Investigation of phthalocyanine reaction kinetics, controlled with UV spectroscopic method

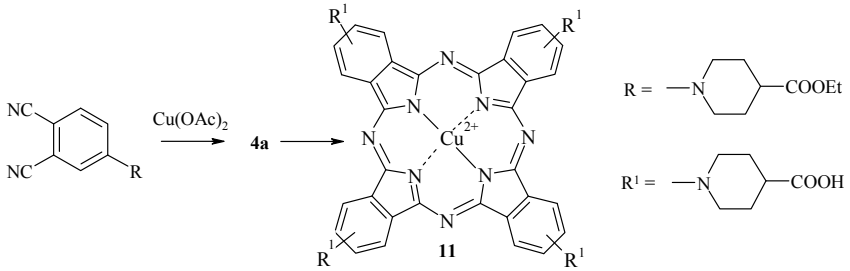

Fig.3. Periphery substituted 4-piperidylcarboxy phthalocyanine synthesis reaction

Crystal Structure of Diltiazem Base

Glebs Kiselovs and Anatoly Mishnev (*Latvian Institute of Organic Synthesis)*

Keywords **- Diltiazem, Calcium channel blocker, Crystal structure, X-ray single crystal analysis.**

Diltiazem is a pharmaceutical substance, belonging to the group of cardio-vascular drugs. At present there are two known crystal forms of diltiazem – hydrogenhloride and hydrogenchloride hydrate. In this work we present the X-ray crystal structure of diltiazem base. Comparison with the known crystal structures is also presented.

Diltiazem, [5-(dimethylaminomethyl)-2-(4-methoxyphenyl)-4-oxo-2,3-dihydro-1,5-benzothiazepin-3-yl] acetate, (fig. 1) is a member of a class of drugs known as calcium channel blockers.

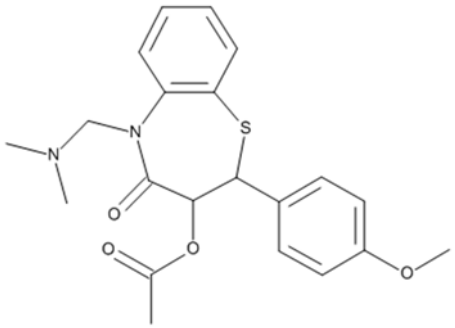

Fig.1. Molecular structure of diltiazem

Diltiazem is used in treatment of angina pectoris, hypertension and heart rhythm disorders. It is administrated in the form of hydrochloride salt and is known under trademarks *Cardizem, Dilacor XR, Diltzac*.

Solid phase of diltiazem was not properly studied, since only two crystal forms – diltiazem hydrogenchloride [1] and diltiazem hydrogenchloride hydrate [2] are deposited at the Cambridge structural database [3]. In both structures diltiazem is protonated at dimethylated nitrogen atom. The goal of this study was to obtain and determine diltiazem base crystal structure using x-ray diffraction.

Diltiazem base (fig. 1.) crystallizes from dichloromethane as colourless prisms. Crystallographic data of all known diltiazem forms are given in TABLE I. There are no other interactions except van der Vaals forces between molecules.

The 7-membered ring of diltiazem adopts distorted boat conformation. To characterize the conformation, we constructed a plane through atoms S1, N1 and C7, and calculated the deviation of the other atoms from the plane. Deviations of C1, C2, C8 and C9 from the average plane were 0.874 Å, 1.019 Å, 0.969 Å and 0.468 Å respectively. The dihedral angle of 4-methoxy-phenyl substituent average plane and the plane of 7-member ring was 81.60°. The acetoxy group was in the equatorial position and the dihedral angle of the substituent and 7-membered ring was 30.39°.

Solvent accessible voids and crystal packing index, which is a ratio of filled space and volume of the unit cell, was calculated for diltiazem base **I**, hidrogenchloride **II** and hidrogenchloride hydrate **III** using PLATON program suite. As a result it was found that diltiazem base and hydrogenchloride have four solvent accessible voids. Void volumes are given in table 1.

Voids in structure **I** are the largest and occupy about 4.3% of the single unit cell space. Small molecules, like water can be allocated in these voids. Due to comparably large amount of free space, crystal packing index of compound **I** is low.

Voids in compound **II** are smaller, and occupy 2.9% of the total single unit cell volume. Nevertheless, the packing index of crystal structure **II** is not higher than in crystal structure **I**, this may be explained that more space is needed for chloride anion to bond with protonated diltiazem cation.

Compound **III** has no voids and, therefore, has the highest crystal packing index.

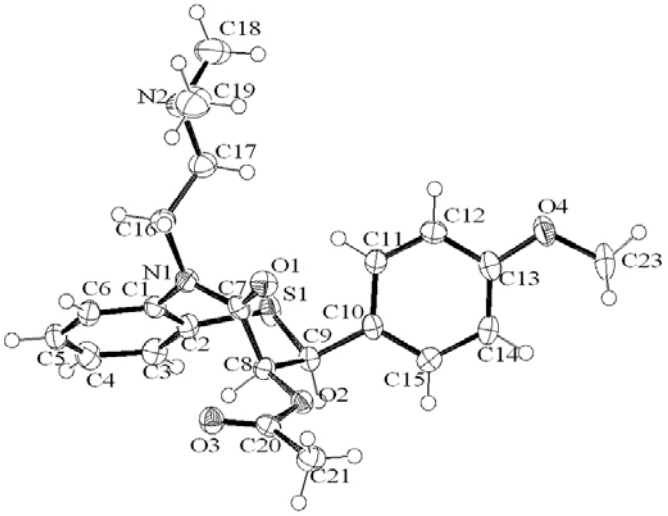

Fig.2. *Ortep-III* drawing of diltiazem base

TABLE I.

CRYSTALLOGRAPHIC DATA OF ALL KNOWN DILTIAZEM FORMS

	Compound **I**	Compound **II**	Compound **III**
crystal symmetry	orthorhombic	orthorhombic	orthorhombic
space group	P 2_1 2_1 2_1	P 2_1 2_1 2_1	P 2_1 2_1 2_1
a, Å	9.3420(2)	42.18(1)	34.621(2)
b, Å	13.9060(4)	9.079(1)	11.721(1)
c, Å	16.5640(6)	6.035(2)	6.071(1)
V, Å^3	2151.83	2311.22	2465.67
Z	4	4	4
D_x, Mg/m^3	1.279	1.218	1.301
Packing index	66.7	60.2	67.5
Void volume in unit cell	4x23.0(7)	4x17.0(1)	no voids

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Spectral and Thermal Properties of mono- and Disubstituted Benzanthrone Dyes

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Keywords **– Luminiscent dyes, benzanthrone derivatives, azomethines, amidines, amides.**

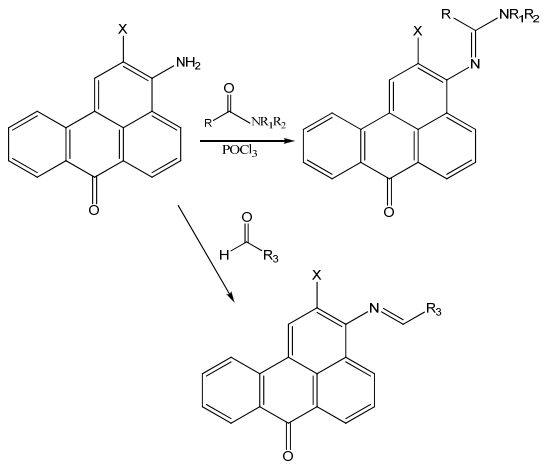
I. Introduction

The unique photophysical properties of benzanthrones have resulted in their extensive use as disperse dyes for textiles, polymers, daylight fluorescent pigments and laser dyes. These dyes emit in the spectral region from yellow–green to red-purple, depending on the structure[1].

Recently we reported the synthesis, molecular structures and spectral properties of a series of amino, amidino, and iminobenzanthrones, which appeared to be particularly interesting because they lead to perspective luminescent materials[2]. The aim of present investigation was to create a series of mono and disubstituted benzanthrone amidines and azomethines. Spectral, structural and thermal properties of prepared dyes were investigated.

II. Results and Discussion

Target mono and disubstituted benzanthrone derivatives are synthesized by condensation reaction of corresponding amino-benzanthrone with appropriate amides or aldehydes:



Compound		R	R_1	R_2	R_3
1	X=H	-	-	-	
2		-	-	-	
3		-	-	-	
4		-	-	-	
5	X=Br	Me	Me	Me	-
6		H	Me	Me	-
7		Me	Et	Et	-
8		H	Et	Et	-
9		Me	H	Me	-
10		-	-	-	
11		-	-	-	
12		-	-	-	
13		-	-	-	

Fig.1. The structure of investigated benzantrhrone derovatives

All obtained amidines have marked luminescent properties, but synthesized azomethines are not luminescent. In this work, the influence of solvents with various polarities upon absorption and emission spectra was investigated and the charge transfer phenomenon in these compounds was studied. It was found that introduction of bromine atom in benzanthrone moiety strongly influences the photophysical properties of corresponding amidines.

The mass spectra of synthesized dyes had a peak of the 1-phenylnaphthalene ion, which is usual for benzanthrone derivatives losing C=O and amidine or azomethine side chain. Besides, similarly to other N-containing derivatives of benzanthrone the following peaks were observed: a peak of molecular ion of unsubstituted benzanthrone (M=230), a peak of ion $[BA\text{-}N{=}CH_2]^+$ (M=258), and a peak of ion $[BA\text{-}N{=}CH\text{-}CH_2]^+$ (M=270).

The thermal stability studies were performed: above 380-420°C the thermogravimetric curves of obtained compounds show a major loss in weight. These results testify that prepared dyes are thermally stable compounds.

III. Conclusion

Novel dyes containing imino or amidino and benzanthrone groups were synthesized using corresponding amino derivatives. The constitution of compounds was confirmed by the elemental analyses, MS, and NMR spectra. The thermal properties of prepared dyes were investigated. A strong influence of the character of N-substituents, presence of bromine atom, and of the solvent polarity on fluorescence quantum yields has been found. Some relationships between structure and fluorescence properties were revealed.

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Synthesis of Thiazolylsubstituted Derivative of Quinoline- and Isoquinoline-5,8-Diones

Nelli Batenko, Olesya Popova and Raimonds Valters (*Riga Technical University)*

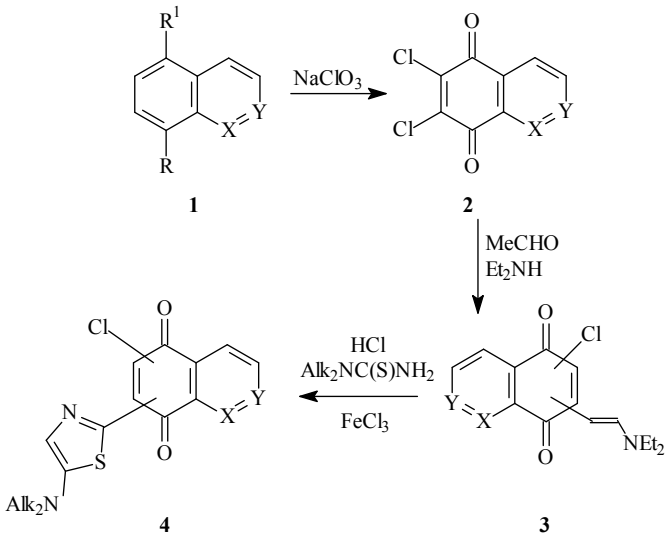
Keywords **– isoquinoline-5,8-dione, quinoline-5,8-dione, thiazole, nucleophilic substitution.**

The derivatives of quinones are the basic structure of many natural products and drugs. Heterocyclic quinones possess various biological and pharmacological properties including anticancer, antifungal, antiviral and antibacterial activities. Quinones, containing heterocycle nucleus fused to a quinone system have attracted considerable attention. Nitrogen containing heterocycles are important part of many drugs. Isoquinoline- and quinoline-5,8-diones are precursors for producing multiple type of bioactive products. Replacing an atom or a group of atoms by appropriate moieties can improve the biological activity.

We have previously shown that mono- and bis-heteroarylsubstituted 1,4-benzoquinones where heterocycle and quinone parts are linked by a C–C bond can be obtained by the method [1, 2]. This method can be applied for the preparation of quinones containing both fused and linked by C-C bond heterocycles.

Heterocyclic quinones **2** were obtained by oxidation and chlorination with $NaClO_3$ of readily available 8-hydroxyquinoline (**1**, X = N, Y = CH, R = OH, R^1 = H) or 5-hydroxyisoquinoline (**1**, X = CH, Y = N, R = H, R^1 = OH). On the next stage quinones **2** were reacted with C-nucleophile *N*-diethyl-*N*-vinylamine, which is formed *in situ* from dietylamine and acetaldehyde. As a result of nucleophilic substitution reaction the mixture of 6- and 7-substituted products **3** was received [3]. Quinoline-5,8-dione 6- and 7-diethylaminovinyl-substituted derivative mixture was separated by column chromatography method.

The next step was diethylamino group hydrolysis by conc. hydrochloric acid and reaction with bifunctional compounds. It is supposed that reaction proceeds *via* α-chloro-acetaldehyde derivative formation [2]. α-Chloroacetaldehyde derivative reacted with dialkylsubstituted thiourea with formation of thiazole ring. Subsequent oxidation with aqueous $FeCl_3$ led to the mixture of 6- and 7-thiazolylsubstituted isoquinoline-5,8-dione (**4**, X = CH, Y = N) and quinoline-5,8-dione (**4**, X = N, Y = CH) derivatives. The mixture of quinoline-5,8-dione isomers was separated by column chromatography method. 6- and 7-thiazolylsubstituted isoquinoline-5,8-dione derivative mixture was not separated.



R = OH, R^1 = H, X = N, Y = CH
R = H, R^1 = OH, X = CH, Y = N

Quinoline-5,8-diones **4** are deeply colored compounds and in their UV spectra long wave band (~600 nm, $CHCl_3$) can be associated with strong intramolecular charge transfer between electron donating thiazole fragment and electron accepting quinoline-5,8-dione part.

In summary, we have elaborated synthetic method for obtaining thiazolylsubstituted quinoline-5,8-dione and isoquinoline-5,8-dione .

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Propanephosphonic Acid Anhydride–Mediated Cyclodehydration of Maleic Acid Monoamides

Eduards Bakis (*University of Latvia*), Elina Petrova and Igors Klimenkovs

***Keywords* – Propanephosphonic acid anhydride; maleic acid monoamides; cyclodehydratation; maleic acid isoimides; green synthesis.**

I. Introduction

Propanephosphonic acid anhydride (T3P, Figure 1) has been recently used for a wide variety of dehydration reactions. Its use for large scale processes has been extensively promoted by scientists at several pharmaceutical companies, as it is considered a cost-efficient and environmentally benign reagent [1].

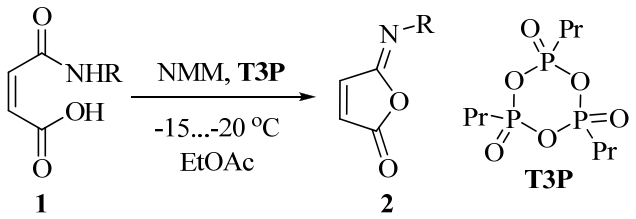
Our aim was to explore the possibilities of expanding the use of this versatile reagent, so as to include cyclodehydration of maleic acid monoamides (**1**). This reaction may proceed to yield either the thermodynamically preferred maleic acid imides or the somewhat labile isoimides. The high reactivity of maleic acid isoimides (**2**) makes them very appealing as reactive intermediates in many synthetic sequences. The reagents currently used for the synthesis of isoimides **2** are cyclohexylcarbodiimide and ethyl chloroformate [2]. They both are highly undesirable because of serious safety concerns.

T3P could in this case be an excellent alternative, as it is already widely employed in organic synthesis, it is user-friendly and in dehydration reactions produces only innocuous by-products. The reagent used to prepare isoimides **2** has to be able to effect dehydration of monoamides **1** at temperatures low enough to suppress thermal isomerization of isoimides to imides, and the reaction medium must be devoid of chemical species able to promote catalytic isomerization. We propose that T3P corresponds to these two requirements: it is an efficient and gentle dehydrating reagent.

II. Results and Discussion

As our aim was to determine the scope and applicability of T3P-mediated cyclodehydration of monoamides **1**, we decided to explore this reaction for structurally different monoamides **1**: substituted aromatic, simple aliphatic, as well as α- and β-branched aliphatic (Figure 1).

T3P is usually available as a solution in different solvents. Previously isoimides **2** have almost invariably been synthesized in dichloromethane solution, and even up to date it still remains the solvent of choice. As we wished to develop an environmentally benign synthetic method for the preparation of isoimides **2**, we replaced dichloromethane with ethyl acetate. Two equivalents of a tertiary amine have to be used in most reactions employing T3P to convert the carboxylic acid group in the substrates to the more nucleophilic carboxylate anion and to prevent the reaction medium from becoming acidic, as propanephosphonic acid is liberated in the course of reaction. *N*-Methylmorpholine (NMM) has been suggested as a good choice. Addition of NMM also often helped to achieve homogeneous reaction medium, as several monoamides **1** were poorly soluble in ethyl acetate. T3P was added at -15…-20 °C, and the reaction was left to proceed at +4 °C. The only by-products in these T3P-mediated reactions were propanephosphonic acid tertiary ammonium salts, which were easily removed by simple extraction with water. Purification of the obtained isoimides **2** was achieved by dissolution in dry diethyl ether and removal of the unreacted monoamides by filtration. Crystallization or chromatographic purification were not required, and indeed were better avoided to prevent isomerization of isoimides to imides.



1 **2**

R = *i*-Pr (80%); *n*-Bu (85%); *s*-Bu (88%); *t*-Bu (51%); *neo*-C_5H_{11} (81%); $C_{12}H_{25}$ (85%); *cyclo*-C_6H_{11} (85%); $CH_2C_6H_5$ (70%); *p*-ClC_6H_4 (85%); *p*-$MeOC_6H_4$ (96%); *p*-$EtO_2CC_6H_4$ (93%)

Fig. 1. Synthesis of isoimides **2**.

The yields of isoimides **2** were generally high and in the same range as obtained by the classical methods [2]. A lower yield was obtained for maleic acid *tert*-butyl isoimide, yet it can be readily accounted for by unfavorable sterical interaction during the reaction.

III. Conclusions

In summary, we have developed a novel method for the preparation of isoimides **2** that is similar to the published methods in terms of yield, but is clearly advantageous from the environmental point of view. We have also broadened the applicability of T3P – a newly introduced dehydrating reagent, and validated that this reagent combines efficiency and gentleness, necessary to convert monoamides **1** into isoimides **2**.

IV. References

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Spectroscopic Monitoring of Biodiesel Aging

Mikelis Svilans, Aivars Blums and Ruta Kampare (*Riga Technical University*)

***Keywords* – Fluorescence, biodiesel, degradation, aging, optical absorption.**

I. Introduction

The environmental and economical advantages of biodiesel (BD) are well documented [1]. Compared to its fossil counterpart, BD has a major disadvantage due to its lower chemical stability, reflected in higher degradation rates. For practical applications, a rapid and reliable method of monitoring BD quality is essential. Spectroscopy offers such a convenient monitoring technique. In this work fluorescence in the UV-VIS spectral region is shown to have the required sensitivity to detect the progress of BD aging.

II. Background

Earlier work [2] has demonstrated that accelerated aging of BD under severe conditions produces substantial changes in the fluorescence spectrum, which have not been studied in relation to standard parameters such as acid number (EN 14104), viscosity (EN IS0 3104) and induction period (EN 14112). In particular, acid number is one of the more sensitive parameters being among the first to exceed specifications as BD aging progresses.

Accelerated aging experiments were performed at elevated temperatures with BD from three different manufacturers while recording absorption spectra in the UV-VIS and IR spectral regions, as well as fluorescence in the UV-VIS region. The measured results were analyzed and correlated with the parameters prescribed in the above standards, namely induction period, acid number and viscosity.

III. Method

A. Accelerated aging

BD (500-600ml) was heated to 110°C in darkness with no forced air circulation in a 1000ml flask fitted with a magnetic stirrer, a vertical reflux condenser as vent and thermometer. A total of 7-9 samples (15-30ml) were removed at 60 minute intervals. Samples of untreated BD as well as BD containing anti-oxidizing agents were investigated.

B. Fluorescence

Total luminescence spectra of neat BD were recorded with a LS-45 fluorimeter producing an excitation-emission matrix (EEM). Samples were not diluted to avoid artifacts due to solvent interaction. Typically excitation wavelengths were used in the range from 250-800nm at 5nm intervals, with the emission spectra covering the wavelength range from 200-900nm in 0.5nm steps.

C. Absorption

UV-VIS spectra were captured with a Lambda 35 spectrometer in the range 250-1100nm. FTIR spectra were obtained with an ATR in the range 650-4000cm^{-1}.

IV. Results

As expected, the induction period decreased, while viscosity and acid number increased approximately linearly with the heating time.

UV-VIS absorption exhibited a marked decrease with heating time in four bands centered about 402, 424, 450 and 480nm, the latter being most affected. Little change was observed in a peak at 670nm, generally attributed to chlorophyll. For wavelengths above approximately 500nm the absorption stayed below 1.0 for all heating times.

The FTIR spectra had only a small and irregular dependence on heating time, mostly in the 870-930, 1184-1284, 1330-1400, 1680-1800, and 2880-3150cm^{-1} bands.

A more complex behavior with heating time was discovered for the fluorescence spectra, in which the trend was dependent on the excitation wavelength (Fig. 3). In the emission spectral region 520-640nm, the fluorescence intensity decreased with heating time for excitation wavelengths in the approximate range 300-370nm, while the trend was reversed for excitation wavelengths 390nm or greater. For every additional hour of heating the change in intensity was appreciable, indicating a sensitive dependence of luminescence on aging time.

For excitation wavelengths 340nm or less, the emission spectra had troughs corresponding to the four UV-VIS absorption bands referred to above.

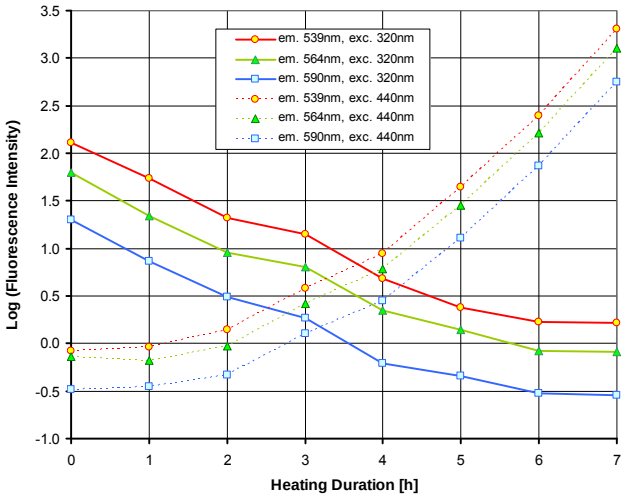

Fig.3. Fluorescence emission intensity trend with aging for excitation wavelengths 320nm and 440nm.

V. Conclusions

Fluorescence spectroscopy was found to provide an effective and sensitive indication of the progress of aging of biodiesel. The observed changes in fluorescence spectra are strongly tied to UV-VIS absorption, which can be explained by inner filter effects due to the high optical density of biodiesel at short wavelengths.

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Extraction and Identification of Pentacyclic Lupane-Type Triterpenoids From Alder Bark

Liga Roze, Oskars Bikovens and Galina Telysheva (*Latvian State Institute of Wood Chemistry)*

Keywords **– Alder, bark, pentacyclic lupine- type triterpenoids, gas chromatography, gas chromatography – masspectometry.**

I. Introduction

Worldwide demand for bioactive molecules of natural origin has progressed sharply in recent years. Secondary metabolites are natural products that often have an ecological role in regulating the interactions between plants and their environment. An important group of natural products are the terpenes. They exhibit low polarity and a higher lipophilic character. Several studies have demonstrated the strong potential of triterpenes as preventative agents in human health attributed to antimicrobial, fungicidal, anti-inflammatory, cytotoxic and anticancer properties [1]. Gas chromatography (GC) has been traditional technique for the analyses and identification of different lipophilic plant extractives. Derivatization of extractives for GC analysis is usually carried out to improve compound resolution, and can be achieved by methylation, acetylation or silylation [2]. The aim of the present work was extraction and identification pentacyclic lupane-type triterpenoids from bark of grey alder grown in Latvia.

II. Materials and Methods

The bark of grey alder (*Alnus incana)* was collected in Ogre, Latvia in October 2010. Triterpene were extracted with *n*-hexane using three extraction methods. Terpenes were analyzed by Perkin Elmer gas chromatography (GC-FID) on a 25 m x 0.20 mm i.d. column coated with cross-linked methyl polysiloxane (HP-1) with a film thickness of 0.11 μm, after evaporation of the extract solution and silylation of the extractives. No FID correction factors were used. Cholesterol was used as internal standard. Identification of individual components was performed using GC with mass spectrometric detector (HP 6890-5973 GC-MSD instrument) and the similar 25 m HP-1 GC column as above for analysis of the silylated components. For identification of terpenes were used both their retention time and mass spectra comparison with the GC-MS spectral library. All results, given in mg/g, are calculated on an oven dried matter (o.d.m.) basis.

III. Results and Discussion

Three extraction methods (Soxhlet, fluidized bed extraction (FBE), accelerated solvent extraction (ASE)) showed similar extraction efficiencies. The chemical composition profile of grey alder bark lipophilic extract was similar to that previously reported for common alder (*Alnus glutinosa*) [2], however, the yield of lipophilic extractives (~ 4.5%) found for *A. incana* bark was higher than reported for *A. glutinosa* (~ 2.3% and 3.5%) [2-3]. The dominant compound group identified in the lipophilic extractives from bark were triterpenoids (lupen-3-ons, lupeol, betulone, betulinol and betulinic acid).

Analysis of triterpenoids in the bark of the grey alder tree shows, that bark could present a prospective source for valuable pentacyclic lupane-type triterpenoides, known as high potential biological active substances.

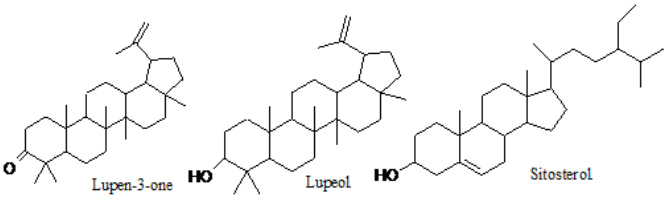

Fig.1. Structures of the main triterpenes

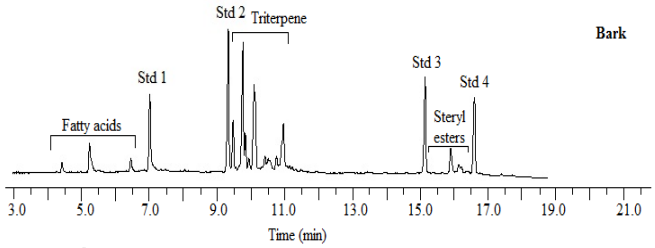

Fig.2. Short column (6m) GC chromatogram of lipophilic extractives of bark

TABLE I

TRITERPENES IN GREY ALDER BARK (MG/G OF O.D.M.).

Triterpene	w/w
Lupen-3-one	0.75
Lupeol	0.34
Betulone	0.04
Betulinol	0.16
Betul_Acid	0.24
Sum triterpene	1.53
Total eluated compound sum	4.6

Triterpenoids were the most abundant group of compounds and accounting for about one-third part of all identified lipophilic compound.

IV. References

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Acknowledgment: The research was financially supported by Latvian National Programme Nr. 2010.10-4/VPP5 subproject "High value added functional products and chemicals from bark" and the ESF within the project "Support for Magister Studies at University of Latvia". The authors are grateful to Prof Dr Andrey Pranovich and Markku Reunanen from Åbo Akademi, Wood and Paper Chemistry laboratory (Finland) for their help with ASE and MS analysis.

Esterification and Transesterification of Rapeseed Oil/Fatty Acids Mixture in Presence of Sulfuric Acid

Kristaps Malins, Valdis Kampars and Janis Brinks *(Riga Technical University)*

Keywords **– rapeseed oil, biodiesel, esterification, transesterification, sulfuric acid.**

I. Introduction

Currently biodiesel is one of the most promising first generation biofuel. It is possible to produce biodiesel from any raw material containing either vegetable or animal fatty acids or their mono-, di- and triglycerides. In the case of fatty acid glycerides, the most common method for producing the biodiesel is using transesterification reaction with methanol in the presence of homogeneous alkaline catalysts [1]. Inexpensive, but valuable biodiesel feedstock, such as the by-products of vegetable oil refining, used cooking oils, animal fat, fats contained in crude glycerol, etc. contain high levels of free fatty acids which completely eliminate the use of alkaline catalysts, but increase the possibilities of acid catalyst application [2]. Due to the high activity and low cost sulfuric acid has become the most widespread acidic catalyst used in the biodiesel production [3]. Considerable amounts of energy and raw materials could be saved and thus reduction in overall product costs could be attained as a result of optimization of various fatty acids containing mixtures esterification and transesterification in the presence of sulfuric acid.

II. Results and Discussion

To study how different concentrations of RFA (fatty acids of rapeseed oil) affect transesterification and esterification reactions (see Fig.1) various mixtures of fatty acid and rapeseed oil were used (free fatty acid concentrations 100, 90, 50, 30, and 0%). Experiments were conducted at 70 ^{o}C with a reaction time of 0 - 360 min using 5.0 moles of methanol per one mole of fatty acids. In the case of 100 and 90% fatty acid mixtures esterification 1.0% (from the weight of the mixture) of sulfuric acid was used, otherwise the 0.5% of sulfuric acid was applied. In experiments refined rapeseed oil was used, while the fatty acids used were derived from the same oil hydrolysis reaction in presence of sulfuric acid (acid number ~185.0-187.0 mgKOH/g). After the separation of reaction by-products and other impurities the control parameter for esterification and transesterification reaction processes was set to be the acid number (using standard method LVS EN ISO 14104:2005) and ester content (using gas chromatography standard method LVS EN ISO 14103:2003).

It was established that only esterification reaction occurs when acid catalysis reactions where performed using mixtures with free fatty acid concentration of ≥30%. Both esterification and transesterification reactions occured if lower concentrations of fatty acids were used. In the prescribed conditions reaction equilibrium was reached in 240-270 min when esterificating 100% fatty acids and thus obtaining 97.6% RME content. The experimental results show that oil transesterification is slower than free acid esterification. Transesterification of pure rapeseed oil did not reach the reaction equilibrium within 360 min and the maximum RME content obtained was only 15%.

III. Summary

In this research various mixtures containing fatty acids and rapeseed oil were prepared to examine how different concentrations of RFA affect transesterification and esterification reactions.

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Acknowledgment: This work was financially supported by state programm: Innovative Technologies of Acquisition and Use of Power Resources and Provision of Low Carbon Emissions Through Renewable Energy Resources, Supporting Measures for Restriction of Environmental and Climate Degradation.

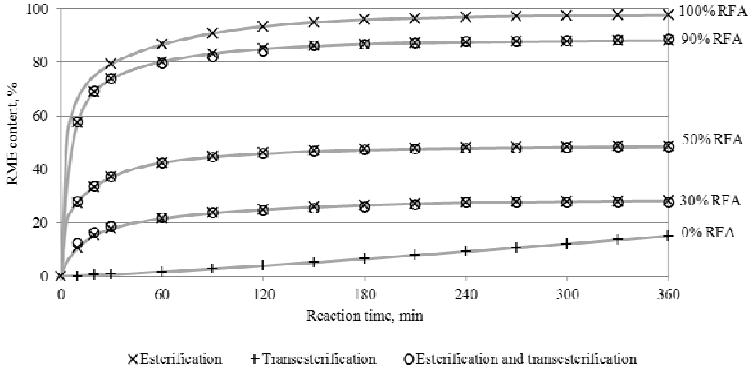

Fig.1. Influence of RFA on esterefication and transesterification reactions

Influence of Branched Rapeseed Oil Fatty Acid Alkyl Esters on Biodiesel Cold Filter Plugging Point

Kristaps Malins and Valdis Kampars *(Riga Technical University)*

Keywords **- branched chain alcohol, biodiesel, cold filter plugging point, flash point, carbon residue.**

I. Introduction

In Latvia rapeseed oil is the most important raw material for RME (rapeseed oil methyl esters) synthesis. It is mainly due to the Latvia's favorable climate conditions for seed growing and the fact that the quality measurements of produced biodiesel are similar to those of diesel fuel. Even though RME production is ever increasing as it serves as a valuable substitute for the traditional fossil fuel its use can be problematic during winter conditions [1-3]. The cold filter plugging point of RME is at approximately -10 ^{o}C, this is almost 20 ^{o}C higher than that of the regular winter diesel fuel.

II. Results and discussion

In this research five different RAE (rapeseed oil alkyl esters) (R.O. 2-butyl esters, R.O. 4-methyl-2-pentyl esters, R.O. neopentyl esters, R.O. isobutyl esters, R.O. 2-methylbutyl esters) were synthesized in order to discover the possibilities of using these esters in blends with RME to improve the properties of biodiesel at low temperatures (see Fig. 1). The RAE synthesis was done using three-step synthesis in reaction with different alcohols in the presence of concentrated sulfuric acid. After the crude biodiesel purification RAE were distilled using fractional vacuum distillation at a 0.1 mm Hg pressure in order to get rid of unwanted impurities and to obtain RAE with the ester content > 96.5%.

RME with CFPP ~-11 ^{o}C was synthesized at the same conditions. Flash point (EN ISO 3679) 173 – 185 ^{o}C and Carbon residue (EN ISO 10370) 0.010 - 0.036% of prepared RAE correspond to standard (LVS EN 14124). This compliance with the standards confirms the chemical purity of the produced RAE and the reliability of results. The resulting R.O. 2-butyl esters, R.O. 4-methyl-2-pentyl esters, R.O. neopentyl esters, R.O. isobutyl esters and R.O. 2-methylbutyl esters of high purity have CFPP -24, -24, -24, -22 un -22^{o}C respectively. It is established that in order to reduce RME CFPP by 4-5 ^{o}C an approximate ~30% content of RAE is necessary; ~70% RAE content reduces the RME CFPP by 8-9^{o}C.

III. Summary

In this research five different RAE (R.O. 2-butyl esters, R.O. 4-methyl-2-pentyl esters, R.O. neopentyl esters, R.O. isobutyl esters, R.O. 2-methylbutyl esters) were synthesized with the purpose to estimate the possibilities of using these esters in blends with RME to improve the properties of biodiesel at low temperatures.

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Acknowledgment: This work was financially supported by state programm: Innovative Technologies of Acquisition and Use of Power Resources and Provision of Low Carbon Emissions Through Renewable Energy Resources, Supporting Measures for Restriction of Environmental and Climate Degradation.

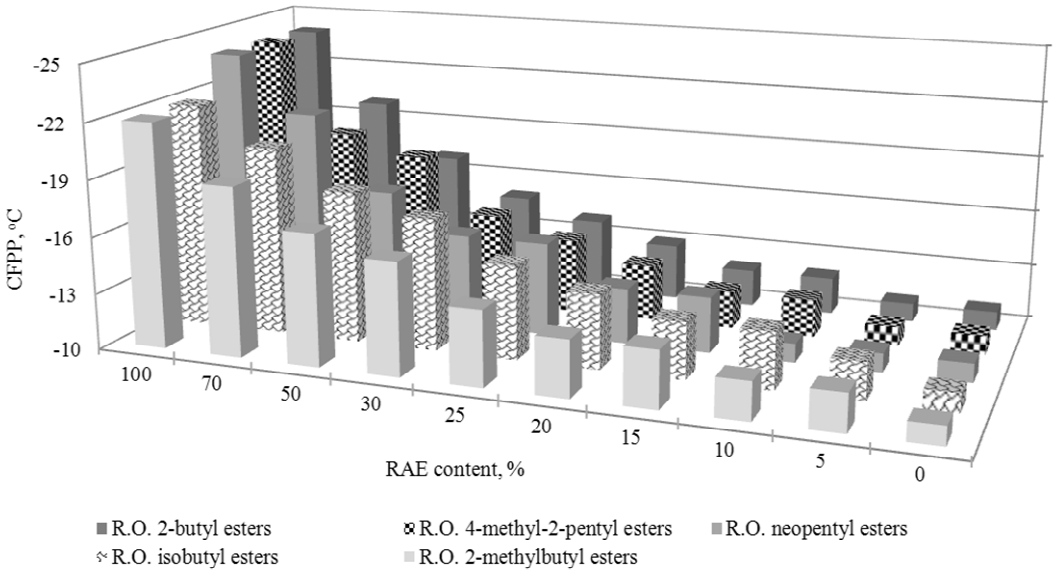

Fig.1. Influence of RAE concentration on RME CFPP

Biodiesel Preparation Using CaO as Catalyst

Kristaps Malins, Valdis Kampars and Tatjana Rusakova, *(Riga Technical University)*

***Keywords* – rapeseed oil, heterogeneous alkaline catalysts, biodiesel, CaO, transesterification, optimization.**

I. Introduction

Studies of the transesterification reaction of vegetable oils are of key importance in the development of a country's national economy. By optimizing the conditions of the biodiesel preparation process it is possible to achieve significant savings of energy resources and raw materials, thus reducing the end product cost. The decrease in the price of biodiesel will encourage consumer interest and demand, ensuring further development of domestic resources and production to meet transportation requirements. In the biodiesel industry, homogeneous alkaline catalysts such as NaOH, KOH and $NaOCH_3$ are used most widely. These catalysts provide high transesterification reaction yield and ester content with a minimal reaction time. Usually after the biodiesel production process homogeneous alkaline catalysts that are in high concentration in the crude biodiesel and glycerol, are neutralized by using mineral acids and isolated in the form of salts. These additional operations and consumption of raw materials significantly increase the cost of biodiesel production. Use of effective heterogeneous catalysts for the transesterification reaction in biodiesel production would enable the development of a no-waste technology [1] and hence result in an economic benefit. CaO is a common local ingredient in Latvia that is derived from the limestone and can be used as heterogeneous alkaline catalyst in a transesterification reaction of vegetable oils or animal fats [1-3].

II. Results and Discussion

CaO of purity >98% (purchased from Sigma – Aldrich Chemie Gmbh) was used in the experiment to determine the CaO influence on the process of obtaining RME (rapeseed oil fatty acid methyl esters). In this abstract the effect of CaO concentration (1-7% of rapeseed oil mass) on RME preparation process was examined while using a 6 : 1 molar ratio of methanol to rapeseed oil (see Fig. 1). The temperature for the experiment was sustained at 70 °C and reaction time from 10 to 180 min was used. The obtained results were compared to NaOH (0.5%) catalyzed RME production process that was conducted under similar conditions.

The results show that using 1% CaO as catalyst a content of ~82% RME was attained, although the reaction equilibrium was not reached. However, using CaO in a higher concentration (3 - 7%) led to reaching reaction equilibrium within approximately 180 min with a RME content of 94.2 - 95.3%. Meanwhile NaOH catalyzed transesterification reaction necessitated ~30 min long reaction time to reach the RME of similar content. Using NaOH as catalyst a maximum RME conversion (~97%) was achieved in ≥60 min that is by ~1.7% higher compared to CaO catalyzed reaction.

III. Summary

In the experiment CaO was used as a catalyst in order to determine its influence on the process of obtaining RME. Eventually CaO concentration on RME obtaining process was examined and the results were compared to NaOH catalyzed RME production process that was performed under similar conditions.

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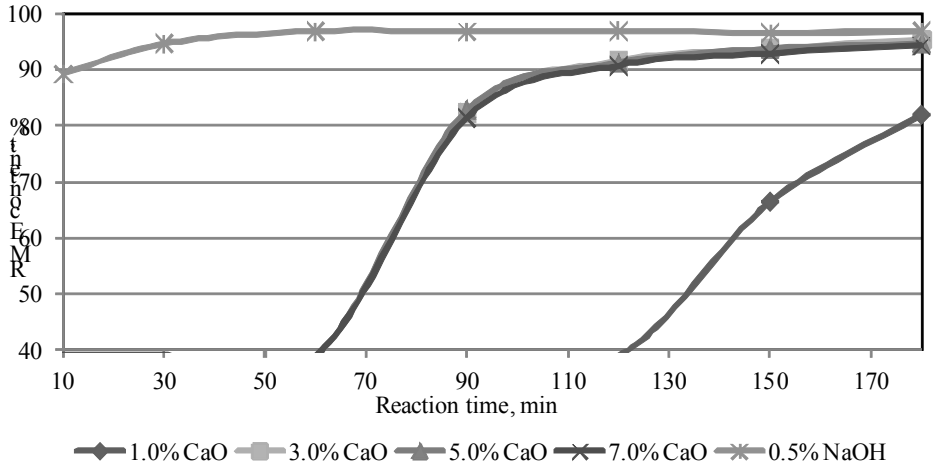


Fig.1. Influence of catalyst concentration on RME preparation process

Synthesis of Novel 4-Amino-tetrahydro-pyrrolo[1,2-*a*]quinazoline Derivatives

Daina Zicane, Zenta Tetere, Irisa Ravina and Maris Turks (*Riga Technical University)*

Keywords **– Pyrrolo[1,2-*a*]quinazolines, hydrazides of cyclohexene carboxylic acids, 2-oxo-glutaric acid, stereospecific decarboxylation, amide linker.**

Fused quinazolines such as pyrrolo[1,2-*a*]quinazolines are an important class of polyheterocyclic compounds found in natural alkaloids and are known to possess a variety of biological activities.

Our group is interested in the synthesis of new classes of pyrrolo[1,2-*a*] quinazoline derivatives from anthranylhydrazides of *N'*-cyclohexene dicarboxylic acids [1]. We present here the synthesis of amide-linked-conjugates between 1,5-dioxo-2,3,4,5-tetrahydro-1*H*-pyrrolo[1,2-*a*]quinazoline-3a-carboxylic acid and 4-methyl-6-aryl-cyclohex-3-ene (**3**).

Decarboxylation of substituted monohydrazides of 6-aryl-cyclohex-3-ene 1,1-dicarboxylic acids proceeds stereospecifically and leads to 1,6-*cis*-disubstituted-cyclohex-3-enes **1**. It was found that pyridine was a far better solvent for this process than acetic acid or DMF that were described earlier.

Due to the presence of anthranilic acid moiety these decarboxylated hydrazides **1** undergo formation of pyrrolo[1,2-*a*]quinazolines **3**, when treated with 2-oxo-glutaric acid (**2**).

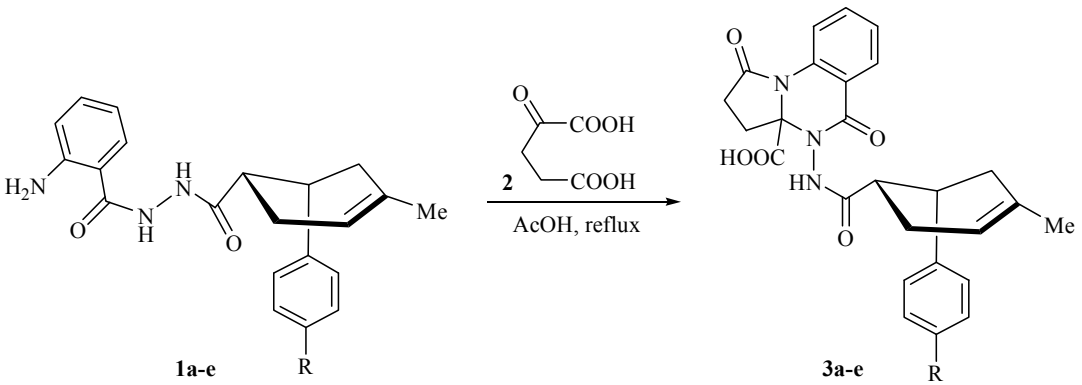
Differently substituted cyclohexene carboxylic acids, are interesting molecular platforms in terms of medicinal chemistry.

The target compounds **3** were obtained in good to excellent yields. Thus, for the first time *N*-substituted-4-amino-1,5-dioxo-2,3,4,5-tetrahydro-1*H*-pyrrolo[1,2-*a*]quinazoline ring system was generated in a chemoselective process without a concurrent formation of phthalazino[1,2-*b*]quinazoline derivatives. Products **3** are obtained and characterized as a mixture of C(3a)-diastereoisomers, except for **3a** which gave separable 2.5:1 mixture of isomers. In the latter case it was possible to prove that the 1,6-*cis*-arrangement of cyclohexene unit is retained as coupling constant analysis and 2D NOESY cross peaks in product **3a** showed a pattern similar to that of **1a**.

TABLE 1
SYNTHESIS OF HYDRAZIDES **1a-e** AND AMIDE-LINKED PYRROLO[1,2-*a*]QUINAZOLINE – CYCLOHEXENE CONJUGATES **3a-e**

Entry	R	Yield of **1**, %[a]	m.p., °C of **1**	Yield of **3**, %[b] (mix. of diastereoisomers)	d.r.
1	NO_2	**1a**, 95	223-224	**3a**, 83	2.5:1
2	F	**1b**, 80	102-104	**3b**, 88	1:1
3	Cl	**1c**, 89	232	**3c**, 89	1:1
4	Br	**1d**, 84	205-207	**3d**, 87	1:1
5	H	**1e**, 68	108-110	**3e**, 78	1.5:1

[a] – pyridine, 2h
[b] – AcOH, 2h



1a, 3a: R= NO_2; **1b, 3b**: R=F; **1c, 3c** : R=Cl; **1d, 3d**: R= Br; **1e, 3e**: R=H

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Isolation and Characterization of Biologically Active Components from *Streptomyces milbemycinius*

Maris Turks (*Riga Technical University*), Sergey Belyakov, Erika Bizdena, Viktors Kumpins, Mara Jure and Inguna Grinsteine

***Keywords* – *Streptomyces milbemycinius* NRRL 5739, Dianemycin, Milbemycins A4 and A3, X-ray diffraction analysis.**

I. Introduction

Among the natural products, polypropionates represent an important class which can be found as common products of metabolism in plants, bacteria, insects, fungi and marine organisms. The group includes plant flavonoids, fungal aflatoxins, as well as many compounds that can inhibit the growth of bacteria, viruses, fungi, parasites or human tumor cells [1]. Indeed, at least hundred compounds from approximately 10000 known polypropionate natural products possess drug activity [2].

II. Results and Discussion

A strain of *Streptomyces milbemycinius* NRRL 5739 is known for production of several antibacterial and antiparasitic substances or their precursors. We have isolated from the aforementioned strain milbemycins A4 and A3. The latter are active substances of well known miticide *Milbeknock* and the key starting materials for the semi-synthesis of milbemycin oxime, a prominent antihelminthic drug. For the first time these important natural products are fully characterized by X-ray diffraction analysis.

In accordance of X-ray crystallographic data the crystals represent a solid solution of milbemycins A3 and A4. In the crystal structure the occupation *g*-factor of molecule A3 is 0.28, all other positions are occupied by molecules A4. Figure 1 shows a perspective view of the molecular structure. In spite of the two hydroxy groups intermolecular hydrogen bonds are not observed in the structure. These groups form intramolecular hydrogen bonds (1 and 2 in Fig. 1) with lengths of 2.630(4) and 2.746(4) Å. By means of these bonds the additional five- and six-membered cycles are formed in the molecules.

The structure of pure milbemycin A4 is isomorphous to the solid solution. The parameters of the trigonal lattice of milbemycin A4 are only on 3% greater than these in the solid solution.

On the other hand, we have unexpectedly isolated natural product dianemycin from the strain of *Streptomyces milbemycinius* NRRL 5739. It is known since 1970-ties; however, its previous X-ray studies were not based on crystals with excellent quality. In our case the X-ray quality crystals of the product were isolated in the form of methanol solvate (methanolsodium dianemycin — methanol (1:2)) with the final *R*-factor 0.058 (Fig. 2) [3].

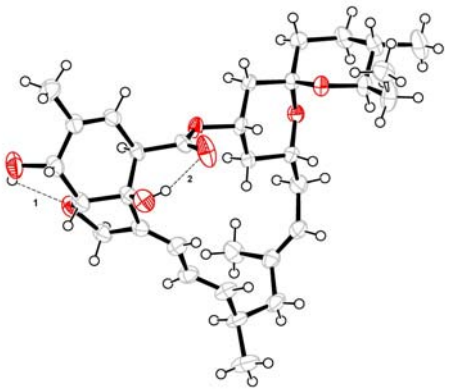

Fig.1. ORTEP molecular structure of the solid solution of milbemycins A3 and A4 showing formation of hydrogen bonds.

Dianemycin belongs to the class of carboxyl ionophores that complex the first row metal cations and therefore affect the transport of these latter in mitochondria. This property results in outstanding activity against chloroquine-resistant forms of malaria.

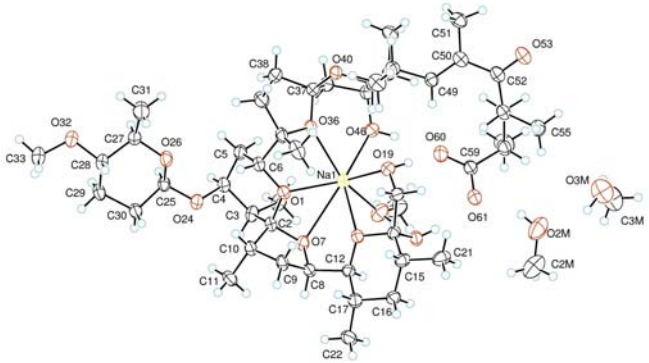

Fig.2. ORTEP molecular structure of methanolsodium dianemycin — methanol (1:2) [3].

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Acknowledgment: This work was supported by ERS Fund project 2010/0278/2DP/2.1.1.1.0/10/APIA/VIAA/045.

Synthesis of Enantiomerically Pure 4-Amino-tetrahydroindazoles

Inta Strakova Natalja Strelnikova, Maris Turks (*Riga Technical University*), and
Sergey Belyakov(*Latvian Institute of Organic Synthesis*)

Keywords **– Tetrahydroindazoles, Chiral resolution, Tartaric acid, Camphoric acid.**

I. Introduction

Tetrahydroindazoles play important role in medicinal chemistry. There has been considerable interest in the development of various molecular scaffolds for this field of chemistry. The term Fsp^3 has been suggested which stands for the ratio of sp^3 hybridized carbon atoms to the total carbon count.[1] It was demonstrated that for a successful drug candidate Fsp^3 approaches 0.5 and that the structure probably contains at least one chiral center. In this context tetrahydroindazoles (THIs) have proved to be particularly attractive due to the presence of both the planar pyrazole moiety and a C_4-tether which points the substituents in distinct spatial directions. This concept in the tetrahydroindazole series has resulted in many distinct biological activities [1]. In the light of these facts, many groups, including ours [2], have worked on functionalization of the tetrahydroindazole core.

II. Results and Discussion

Here we report a straightforward method for synthesis of racemic 4-aminotetrahydroindazoles and their resolution into enantiomerically pure forms (+)-**1** and (-)-**1**, (+)-**2** and (-)-**2**, (+)-**3** and (-)-**3** (Fig. 1).

The synthesis starts from well known tetrahydroindazolones **4-6** [3], which are transformed into corresponding oximes. The following reduction provides racemic amines **1-3**. In the case of amine **3** better results in its synthesis are achieved *via* the Ritter reaction [2c] (Fig. 2).

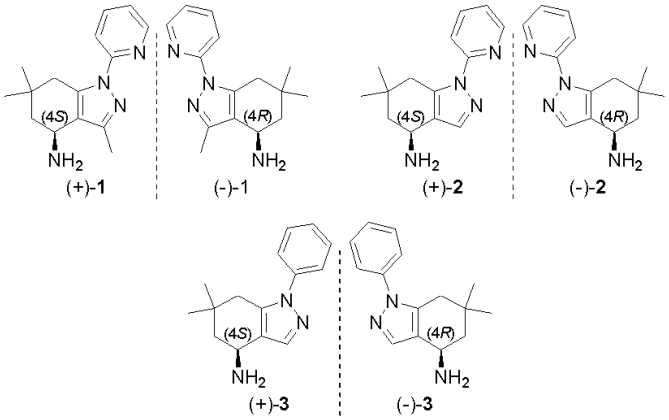

Fig.1. Obtained chiral 4-amino-tetrahydroindazoles

Chiral resolution of racemic amines **1-3** can be performed by following enantiomerically pure acids: tartaric acid, di-*O*,*O*'-benzoyl-tartaric acid, camphoric acid. It is interesting to note that in the case of *N*(1)-substituted 4-amino-tetrahydroindazoles **1** and **2** (+)-(1*R*,3*S*)-camphoric acid and (-)-(2*R*,3*R*)-*O*,*O*'-dibenzoyl tartaric acid (L-form) produce the precipitate with the same amine enantiomer. Thus, they are exchangeable. This allows to exchange also (-)-(1*S*,3*R*)-camphoric acid with (+)-(2*S*,3*S*)-*O*,*O*'-dibenzoyl tartaric acid (D-form). The latter observation is important form economical viewpoint as (-)-camporic acid is much more expensive then (+)-dibenzoyl tartaric acid. The absolute configuration of obtained amines was unambiguously established by single crystal X-ray analysis in one case (Fig. 3).

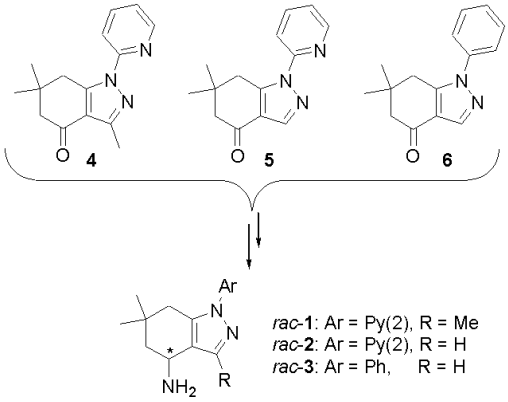

Fig.2. Synthesis of racemic amines **4-6**.

With the developed experimental conditions amines **1-3** can be obtained with good isolated yields and excellent ee's (up to 98%).

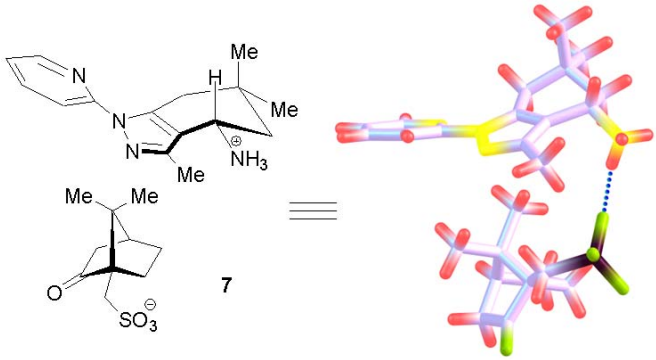

Fig.3 Molecular structure of salt **7** between (4*S*)-4-amino-3,6,6-trimethyl-1-(pyrid-2-yl)-4,5,6,7-tetrahydro-1*H*-indazole and (-)-(*R*)-camphor-10-sulfonic acid.

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Condensation of Malonanilic Acids with Aromatic Aldehydes

Inese Mierina, Agnese Stikute and Mara Jure (*Riga Technical University*)

Keywords **– malonanilic acids, aldol condensation, cinnamanilides, 4-hydroxy-1*H*-quinolin-2-ones.**

I. Introduction

Cinnamic acid derivatives – amides and esters – demonstrate wide range of biological activity, among them antioxidant and antiradical activities deserve attention. Most often these compounds are synthesized by acylation of the aniline with activated derivatives of cinnamic acid; the disadvantage of such strategy is necessity of protecting groups when the aniline or cinnamic acid contains free hydroxyl or amino group. Less common, but more attractive appears condensation of malonanilic acid and aromatic aldehyde [1, 2]. The aim of our work was to find appropriate conditions for the synthesis of cinnamanilides **1** from malonanilic acids **2** and aromatic aldehydes **3** by Knoevenagel-Doebner condensation.

II. Results and discussion

According to the literature [1] the condensation of malonanilic acids **2** and aromatic aldehydes **3** proceeds in pyridine in the presence of β-alanine under reflux providing exclusively cinnamanilides **1**. Unfortunately, we observed fast decarboxylation of monoamides **2** forming acylated anilines **4** under these conditions; due to this the yield of Knoevenagel condensation in some cases was even only 30%.

In order to optimize synthesis of cinnamanilides **1**, we studied reaction of 2-[(4-methoxyphenyl)carbamoyl]acetic acid (**2A**) with vanillin (**3A**) at different conditions. When the reaction was carried out in pyridine, the change of base (β-alanine, guanidine and piperidine) did not affect its course – decarboxylation product **4A** was the main compound in the crude mixture of products; the condensation was little preferred in the presence of guanidine and piperidine in comparison with β-alanine.

We varied solvents using those with high boiling point - over 100°C. When mixture of reagents was refluxed in acetic acid, duration of reaction was the same as in pyridine: decarboxylation of malonanilic acid **2A** occurred and the crude product contained only 13% of cinnamanilide **1A**. The reaction was more successful when it was carried out at 75°C – the decarboxylation of raw material **2A** did not happen and we obtained product of aldol condensation **5A**. In water decarboxylation of compound **2A** did not take place, but the Knoevenagel condensation proceeded slowly; when the reaction was carried out in pyridine or water at temperature ~75°C, the reaction did not take place at all.

When the reaction of vanillin (**3A**) and malonanilic acid **2A** was carried out in trifluoroacetic acid, we were able to synthesize 4-hydroxy-1*H*-quinolin-2-one **6A** just in one step; when reagents were allowed to react in different solvents at room temperature (~20°C), condensation did not proceed at all.

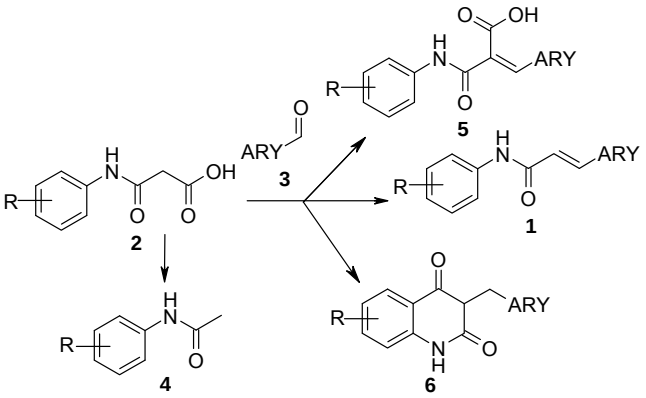

TABLE I
CONDENSATION OF COMPOUNDS **2A** WITH **3A**

No	Conditions of reaction[a]			Products[b]			
	Solvent	Duration	Temp., °C	Comp. **1A**, %	Comp. **4A**, %	Comp. **5A**, %	Comp. **6A**, %
1.	Acetic acid	2 h 25 min	118	13	68	0	0
2.	Acetic acid	> 9 h	75	0	0	97	0
3.	Pyridine	3 h 15 min	116	6	47	0	0
4.	Water	4 h 5 min	100	6	0	0	0
5.	Trifluoroacetic acid	10 h 40 min	72	0	0	0	96
6.	Ethanol	9 h 5 min	78	27	59	0	0

[a]condensation was carried out in the presence of 10 mol-% of guanidine; [b]amount of compounds **1**, **4-6** in the crude product was detected with HPLC.

III. Conclusions

Above described examples demonstrate, that the condensation of malonanilic acids **2** and aldehydes **3** strongly depends on the conditions of reaction: their variation opens way to the synthesis of different products. Undesirable decarboxylation of both starting malonanilic acids and products of aldol condensation can be prevented if reaction is carried out at lower temperature (~75°C) in polar solvents.

To the best of our knowledge for the first time derivative of 4-hydroxy-1*H*-quinolin-2-one was obtained by condensation of malonanilic acid and aromatic aldehyde in trifluoroacetic acid under reflux.

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Saccharopeptides and their Triazole Isosteres

Vitalijs Rjabovs, Maris Turks (*Riga Technical University*),
Diana Zelencova and Edvards Liepins (*Latvian Institute of Organic Synthesis*)

Keywords **– Saccharopeptides; amides; triazoles; Click chemistry.**

I. Introduction

Oligopeptides arising from synthetic sugar amino acids exhibit interesting self-assembling structures in solution, and were intensively studied as peptidomimetics.[1] After the discovery of click synthesis of 1,2,3-triazoles,[2] the latter were studied as amide bond isosteres as they exhibit similar spatial arrangement and geometry.[3]

Herein, we present synthesis of hybrid building blocks and their synthetic application for the synthesis of saccharopeptides.

II. Discussion

Our synthesized hybrid building blocks contain several structural rigidity elements and several functionalization sites. Structural hybrid **1** (Fig. 1) contains two carbohydrate-based bicyclic rings with defined molecular scaffold, and amide functionality that can participate in intramolecular hydrogen bond formation. It also contains C-terminal alkyne along with masked N-terminal azide for differentiated copper-catalyzed azide alkyne cycloadditions.

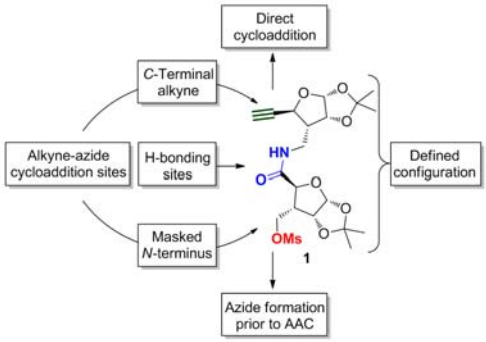

Fig.1. Dimeric structural hybrid **1**

Iterative cycloaddition reaction azidation sequence using this hybrid allows the synthesis of oligomeric saccharopeptides of type **I** (Fig. 2) which has both the amide and triazole linkers between carbohydrate cores.

Substitution of the amide linker in dimeric hybrid with 1,2,3-triazole moiety brings another degree of rigidity and opens the opportunity for the synthesis of type **II** saccharopeptide with all-triazole linkages. 1,2,3-Triazole is considered as weaker both the H-bond donor and H-bond acceptor than amide, thus it is expected that weaker or no intramolecular hydrogen bonds would form.

To find out whether saccharopeptides of types **I** and **II** can acquire certain conformations that are stabilized by intramolecular hydrogen bonds, Nuclear Magnetic Resonance (NMR) studies as well as molecular mechanics (MM) calculations were performed.

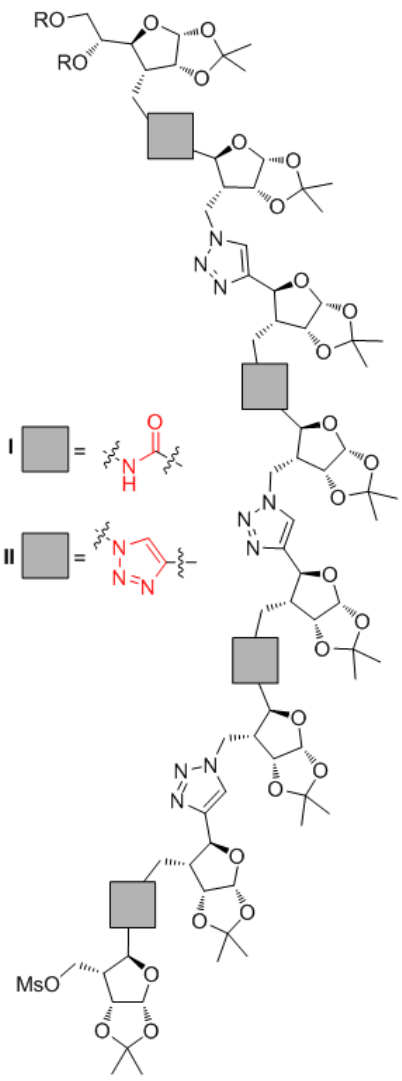

Fig.2. Oligosaccharopeptides of types **I** and **II**

Dimeric structural hybrid studies by NMR allow establishing distances between functional group protons that can help to compare amide and 1,2,3-triazole linkers. This information can be valuable in the analysis of oligomeric structure NMR spectra whereas oligomeric saccharopeptide investigation by NMR establishes intramolecular interactions between protons. Distance comparison of the dimers and oligomers can indicate the formation of secondary structure.

On the other hand, MM calculations give valuable thermodynamic data for the molecules, and can foresee interactions in different solvents.

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Synthesis of 4-Aminobutyric Acid Derivatives: a Sugar-Based Chiral Auxiliary Approach

Viktors Poznaks and Maris Turks (*Riga Technical University*)

Keywords **– Chiral auxiliaries, diacetone-α-D-glucose, diastereoselective Michael addition, 4-aminobutyric acid.**

I. Introduction

Carbohydrates and their derivatives are compounds of great versatility in terms of stereoselective synthesis. Although a large variety of synthetic methods employing sugars as chiral scaffolds has been described, there is a vast selection of compounds which could benefit from novel chiral pool synthesis strategies. Our work is directed towards applications of commercially available and inexpensive diacetone-α-D-glucose (**1**, DAG) as a chiral auxiliary.

II. Results and Discussions

Here we report our approach towards synthesis of enantiomerically enriched 3-aryl- or 3-alkyl-4-aminobutyric acids. This class of compounds includes well known CNS drugs baclofen, phenibut and pregabalin.

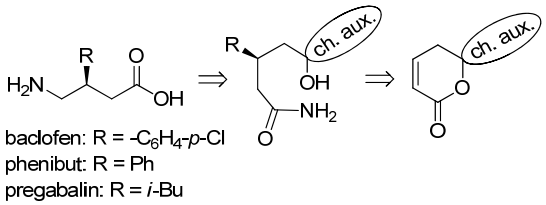

Fig.1. Retrosynthetic analysis of 3-aryl- or 3-alkyl-4-aminobutyric acids.

The proposed key reaction is diastereoselective Michael addition[1] on α,β-unsaturated lactone **4** which contains sugar moiety as chiral auxiliary[2]. The latter is obtained in a three-step synthesis. In the first step, DAG is oxidized[3] using sodium hypochlorite and TEMPO as a catalyst to afford ketone **2**, which is then subjected to addition of allylmagnesium chloride followed by acylation with *trans*-crotonyl chloride. The obtained diene **3** is converted into the desired lactone **4** by ring-closing metathesis reaction. Cuprate addition to lactone **4** affords products **5a** and **5b**.

To the date, we have observed a partially diastereoselective conjugate addition of nucleophilic reagents on α,β-unsaturated lactone moiety of **4**. Product **5a** is obtained in slight excess over **5b**. A screening of catalytic systems which could modify the product ratio is currently in progress.

At this stage, the addition products **5a** and **5b** can be separated by chromatography or recrystallization. Compounds are readily distinguished by ^{1}H-NOESY NMR spectra: both molecules show characteristic NOE interactions.

Further, treatment of pure diastereomer **5a** with ammonia in methanol affords amide **6** which, upon removal of protecting groups and subsequent oxidative cleavage of sugar moiety with sodium periodate, is converted into 3-substituted glutaric acid monoamide **7**. After Hofmann rearrangement of the latter, the target molecule **8** is obtained in enantiomerically pure form.

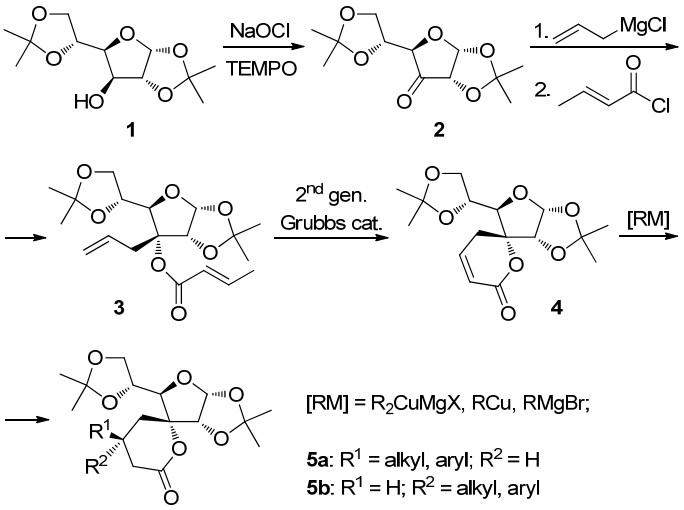

Fig.2. Synthesis of sugar-functionalized lactone **4** followed by diastereoselective Michael addition reaction.

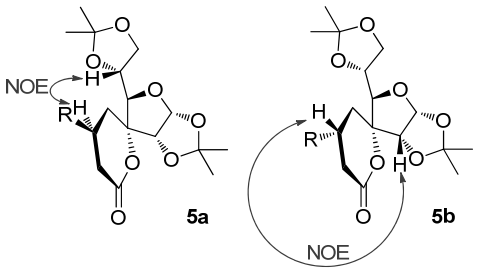

Fig.3. NOE interactions characteristic for **5a** and **5b**.

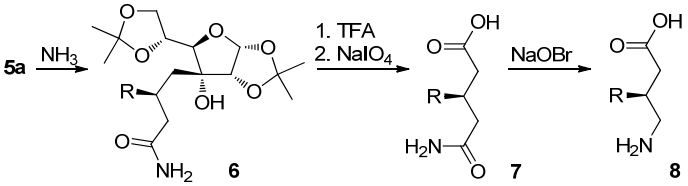

Fig.4. Synthesis of 3-substituted 4-aminobutyric acid derivatives.

The potential application of current results is not limited to the particular 4-aminobytyric acid derivatives and can be used as a general method.

Diastereoselectivity of the process **4** → **5a** + **5b** and its optimization will be discussed.

III. References

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Properties and Structure Studies of New 2,6-Bis-(1,2,3-Triazolyl) Substituted Purine Arabinonucleosides

Irina Novosjolova, Armands Kovaļovs, Erika Bizdena and Maris Turks *(Riga Technical University)*

Keywords **– Purine arabinonucleosides, 2,6-bistriazolyl derivatives, 1,3-dipolar cycloaddition, fluorescence.**

I. Introduction

Modified nucleosides are prominent anticancer and anti-viral agents. Antimetabolic purine nucleosides used in anti-cancer therapy among others include fludarabine, clofarabine and cladribine [1]. Additionally, purine derivatives have found significant applications as agonists and antagonists of adenosine receptors [2]. Thus, the agonists of A1 receptor have provided clinical candidates for atrial arrythmias, type 2 diabetes and insulin-sensitizing agents, pain management, and angina [3].

II. Results and Discussions

The aim of this study was to develop synthetic methodologies towards different types of novel (1,2,3-triazolyl)purine nucleosides, including those substituted with two triazolyl moieties (**1**) and to study chemical reactivity, fluorescence properties and biological activity of the title products (Fig. 1).

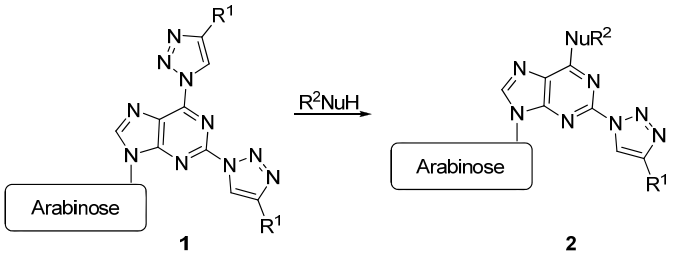

Fig.1. General synthesis of nucleophile substituted nucleoside triazole derivatives with main formula **2**.

2,6-Bis-(1,2,3-triazolyl)purine nucleosides (R^1 = phenyl, butyl, pentyl, hexyl, hydroxymethyl, acetoxymethyl, 1-hydroxycyclohexyl, 2-hydroxypropan-2-yl) **1** were obtained from diazido derivatives **3** via copper catalyzed azide-alkyne 1,3-dipolar cycloaddition reaction.

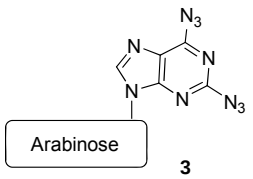

Fig.2. The main structure of diazido derivatives **3**.

The diazido derivatives **3** can be obtained by linear or convergent synthesis methods. The first method consists from the reaction between protected monosaccharide and 2,6-dichloropurine in the presence of *N,O*-bis(trimethylsilyl)acetamide (BSA) and trimethylsilyltriflate (TMSOTf) and the following reaction with sodium diazide in ethanol. While the other method showed the reaction between sodium azide and 2,6-dichloropurine and later exposure with protected sugar by silylation conditions with BSA and TMSOTf.

We used D-arabinose as sugar in nucleosides synthesis both in pyranose and furanose form.

Then, nuclophile substituted nucleoside triazole derivatives **2** were synthesized exploring reactions with different *N*- and *S*-nucleophiles (R^2Nu = methylamine, dimethylamine, pirrolidine, piperidine, 1,1-dimethylhydrazine, undecane-1-thiol). The fluorescence properties of the nucleophilic substitution products were studied in THF, MeCN, DMSO and water. One example is given in Fig. 3.

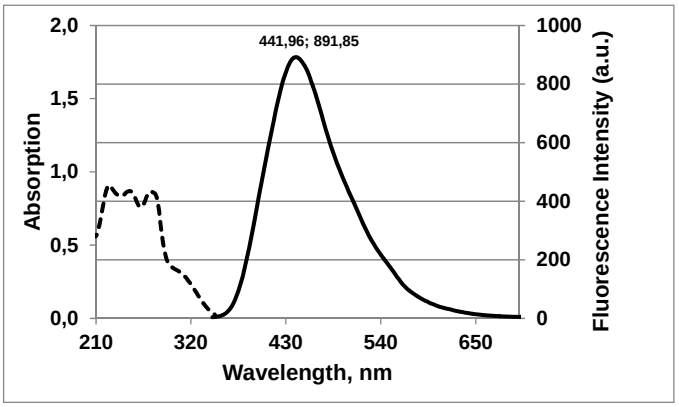

Fig.3. Absorption (dashed line) and emission (solid line) spectrum of 9-(α-D-arabinopyranosyl)-2-(4-(2-hydroxypropan-2-yl)-1*H*-1,2,3-triazol-1-yl)-6-(pyrrolidin-1-yl)-9*H*-purine ($7.7 \cdot 10^{-7}$ M) in water.

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Derivatives of 5-benzyl Meldrum`s acid – novel antioxidants

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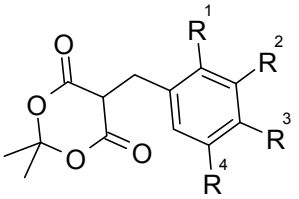
Keywords **– 5-benzyl Meldrum`s acid, DPPH test, antioxidant.**

I. Introduction

Known antioxidants can be divided into two groups: phenolic type antioxidants and 1,3-dicarbonyl compounds. Recently 5-arylidene derivatives of Meldrum`s acid have been disclosed as a new class of antioxidants [1]; earlier it was found that 5-bisaminomethylene-1,3-dioxane-4,6-diones possess excellent antioxidant properties [2]. For this reason we synthesized and tested for antiradical activity a range of 5-arylmethyl derivatives of Meldrum`s acid **1**, which can be assumed as cyclic 1,3-diketones, containing phenolic type substituent.



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II. Results and Discussion

Derivatives of 5-benzyl Meldrum`s acid were easily prepared by condensation of Meldrum`s acid and corresponding aromatic aldehyde, followed by reduction of the obtained 5-arylidene Meldrum`s acid with $NaBH_4$, according known method [3]. All synthesized compounds **1** were tested for their antiradical activity against 2,2-diphenyl-1-picrylhydrazyl (DPPH) and similarly to other cyclic 2-benzyl-1,3-diketone Warfarin demonstrated strong antiradical activity – at least 65% of DPPH were inhibited when the molar ratio of DPPH and compound **1** was 1:1 (fig. 1). We observed that the antiradical activity did not strongly depend on the substituents in the aromatic ring – it was similar both for compounds containing electron donor (OH, OMe or NMe_2) and electron acceptor (NO_2 or F) group in the *p*-position of the benzene ring. It seems that compounds **1** act as free radical scavengers due to the α hydrogen in the 1,3-dicarbonyl moiety. This assumption can be supported by the fact that these compounds demonstrate antiradical activity even when the aromatic ring does not contain substituents or none of substituents can act as hydrogen atom donor. Meldrum`s acid by itself, as well as its' 5-methyl and 5-phenyl derivatives exhibit medium antiradical activity; on the contrary, 5,5-disubstituted Meldrum`s acid did not show any significant antiradical activity. The highest antiradical activities we observed in case of compounds which contained substituents in aromatic ring similar to that of vanillin and syringaldehyde (concentrations that inhibited 50% of DPPH in case of **1L** and **1M** were 14.48 μM and 20.73 μM, respectively; for other compounds it was 30 μM or more). The higher antiradical activity of **1L** and **1M** can be explained by synergy between two types of antioxidants: phenolics and 1,3-dicarbonyl compounds.

III. Conclusions

Our studies revealed a novel group of strong free radical scavengers: derivatives of 5-benzyl Meldrum`s acid.

IV. References

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Acknowledgment: *This work has been supported by the European Social Fund within the project «Support for the implementation of doctoral studies at Riga Technical University».*

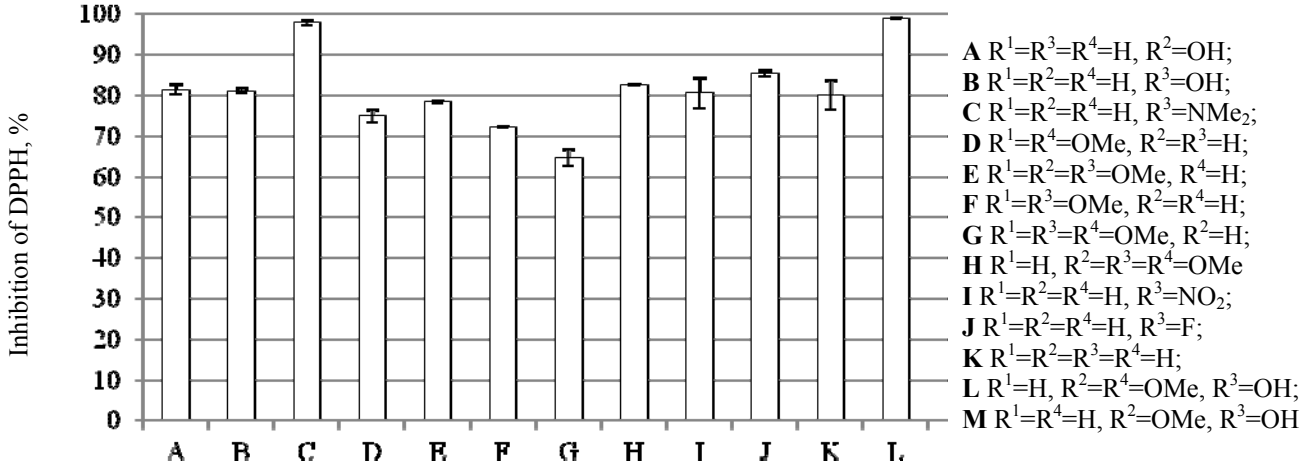

Fig.1. Antiradical activity of derivatives of 5-benzyl Meldrum`s acid (ratio DPPH:comp. **1** = 1:1)

Phenolic Antioxidants of Barley Grains and Oil

Elga Ivdre, Inese Mierina and Mara Jure (*Riga Technical University*)

***Keywords* – barley, barley grain oil, antioxidant extracts, total phenolic content.**

I. Introduction

The main antioxidants of barley are vitamin E and different phenolic acids (gallic acid, vanillic acid), cinnamic acids (caffeic acid, ferulic acid) and flavanols (prodelphinidin B3, catechin) [1]. The major proportion of phenolic compounds present in barley kernels exist in the insoluble-bound form, which contributes most to the total phenolic content (TPC) of barley [2]. Consumption of barley grain can lower LDL cholesterol level in blood and prevent from cardiovascular diseases and cancer [3].

II. Results and Discussion

Our aim was to determine phenolic antioxidants and to compare their quantity in diverse barley varieties developed in Latvia. We used two hulled (varieties 'Jumara' and 'Rubiola') and four hulless (variety 'Irbe' and breeding lines PR-4651, PR-3808.2.1, PR-5099) barley varieties and breeding lines developed at Priekuli Plant Breeding Institute. The barley was grown both in organic and conventional farming; in the last case samples differ with rations (kg/ha) of used fertilizer: N1 (N90 P35 K70), N2 (N140 P50 K98) and N3 (N140 P50 K98+leaf fertilizer).

For TPC analysis we prepared barley grain extracts using 80% ethanol (mixing barley flour with solvent at room temperature for 24 h) and grain oils (obtained by reflux of barley flour in petroleum ether for 1.5 h). We determined TPC spectrophotometrically by Folin-Denis method and expressed TPC as gallic acid equivalents (GAE) per 100 g of grain. Results are summarized in tables I and II.

Table I

Total phenolic content in barley grain oils, mg GAE/100 g grain

Variety or breeding line	Farming type			
	Organic	Conventional		
		N1	N2	N3
'Jumara'	3.67	3.02	5.20	2.81
'Rubiola'	2.66	2.49	6.22	1.40
'Irbe'	1.57	2.32	4.17	2.18
PR-4651	2.28	3.91	8.52	5.98
PR-3808.2.1	2.41	6.80	6.94	2.00
PR-5099	2.20	2.53	4.56	2.47

TPC in barley grain oils varies from 1.40 to 8.52 mg GAE/100 g grain, but in 80% ethanol extracts it varies from 98.70 to 140.13 mg GAE/100 g grain.

It shows that alcohol extracts contain more phenolic compounds than oils. In case of barley grain oils the greatest TPC was achieved when fertilizer composition N2 was used for conventional farming. Oil obtained from hulled barley grown by organic farming was richer in phenolics than oils from hulless barley grown at the same conditions. In the case of 80% ethanol extracts there are differences in total phenolic content depending on genotype of barley, for example, hulled barley varieties contain more phenolic compounds in conventionally grown samples, while hulless – in grains obtained by organic farming.

Table II

Total phenolic content in barley grain 80% ethanol extracts, mg GAE/100 g grain

Variety or breeding line	Farming type			
	Organic	Conventional		
		N1	N2	N3
'Jumara'	118.21	140.13	118.01	120.57
'Rubiola'	98.78	108.84	110.97	111.76
'Irbe'	122.64	115.33	112.64	109.51
PR-4651	135.95	111.38	108.17	119.21
PR-3808.2.1	128.65	104.67	105.64	105.34
PR-5099	135.22	116.00	114.58	111.30

For identification of individual phenolic compounds in barley we used reverse phase HPLC method and three types of extracts:

1) 80% ethanol extract;
2) alkali hydrolyzed barley extract (barley meal obtained after extraction with 80% ethanol was further treated with NaOH solution);
3) acid hydrolyzed barley extract (barley meal obtained from extraction with 80% ethanol first was hydrolyzed with alkali and after treated with HCl).

We found out that 80% ethanol extracts contain gallic acid, but barley extracts obtained by alkali and acid hydrolysis did not. Barley extract prepared by alkali hydrolysis mainly comprises quercetin, but extract obtained with acid hydrolysis – caffeic acid.

III. Conclusions

Our investigations improve that TPC depends on barley genotype, variety, farming type and solvent used for extraction of phenolic compounds. Barley grains of studied varieties and breeding lines contain gallic acid mainly as free acid which can be extracted without hydrolysis, while quercetin and caffeic acid are bound phenolics.

IV. References

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Acknowledgment: This work has been supported by the European Social Fund within the project «Support for the implementation of doctoral studies at Riga Technical University».

Stabilization of Hempseed Oil with Natural Antioxidants

Rasma Serzane, Maija Strele, Inese Mierina and Mara Jure *(Riga Technical University)*

Keywords **– hempseed oil, stabilization, antioxidants, sea buckthorn pomace, peppermint leaves, hop cones.**

I. Introduction

Hempseed (*Canabis sativa*) oil is most perfectly balanced oil for its high content and perfect ratio (1:3) of the two essential acids – linolenic acid and linoleic acid. Hempseed oil is widely used for food as well as in medicine and cosmetics. The oil improves skin condition and is used for antiaging and quick wound healing. Unfortunately, due to the high amount of polyunsaturated fatty acids, the hempseed oil easily undergoes to undesired autooxidation processes. This shortage can be prevented by addition of antioxidants - most often synthetic compounds are used for this purpose, but more valuable would be stabilization of hempseed oil with extracts of natural antioxidants.

II. Results and Discussion

In this work we investigated influence of extracts of plant antioxidants obtained from sea buckthorn (Hippophae rhamnoides) pomace (SBP), peppermint (*Mentha × piperita*) leaves (PL) and hop (*Humulus lupulus*) cones (HC) on the oxidative stability of hempseed oil (HO).

The sea buckthorn pomace is press residue of juice production – pomace consists from peels and seeds, which contain ~8-12% oil. The main natural antioxidants in lipophilic extracts of sea buckthorn pomace are tocopherols and carotenoids [1], of peppermint leaves - flavonoids, phenols and terpenoids [2], of hop cones – xanthohumol, humulones and lupulones [3]. Beside antioxidants these plant materials rise interest due to other compounds, which they comprise: e.g., peppermint leaves contain menthol, menthone, menthyl acetate, 1,8-cineole, limonene, β-pinene, β-caryophyllene, but extracts of hop cones can be used as natural UV filters.

We used in our experiments cold-pressed hempseed oil and 4 hempseed oil extracts (see table 1), which were prepared by cold-pressing of hempseeds together with grounded plant materials.

TABLE I
HEMPSEED OIL EXTRACTS OF PLANT MATERIALS

Extract	Plant material			
	No 1	%	No 2	%
1	sea buckthorn pomace	5	-	-
2	sea buckthorn pomace	5	peppermint leaves	2.5
3	sea buckthorn pomace	5	hop cones	1.5
4	sea buckthorn pomace	5	hop cones	2.5

Total phenolic content (TPC) of hempseed oil and plant extracts was determined by Folin-Denis method: in comparison with pure hempseed oil TPC of SBP extract (No 1) increased more than 2 times. Extracts which beside lipophilic compounds of SBP contained components of the second plant material (PL or HC) had considerably higher TPC: even 5-10 times higher than pure hempseed oil; the most effective were extracts of hop cones. It is well known, that blends of different type antioxidants often has enormously increased activity - synergy is observed.

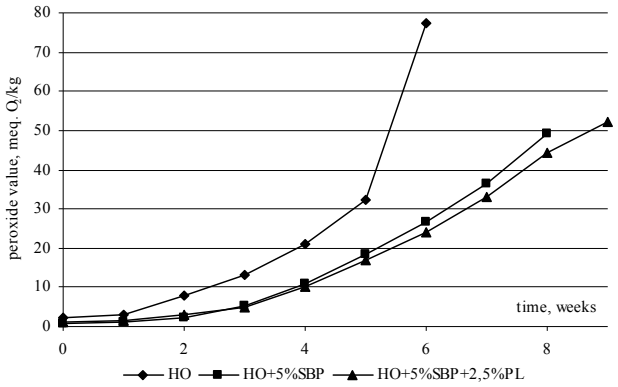

Fig.1. The impact of antioxidants of sea buckthorn pomace (SBP) and peppermint leaves (PL) on the oxidative stability of hempseed oil (HO)

We investigated influence of extracts of plant antioxidants on oxidative stability of hempseed oil by monitoring of peroxide values of samples which were kept under accelerated oxidation conditions (40°C, air); the acid and peroxide values were monitored once per week. Plant material additives improve oxidative stability of hempseed oil. The oxidative stability increased about 1.5 times when sea buckthorn pomace was added to hempseed oil, and for 1.6 times when hempseed oil was enriched both with antioxidants of sea buckthorn pomace and peppermint leaves (see fig. 1).

III. Conclusions

The extracts of sea buckthorn pomace, peppermint leaves and hop cones which contain different type lipophilic antioxidants can be successfully used to improve oxidative stability of hempseed oil; such stabilized oil can be used for production of cosmetics.

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Acknowledgment: This work has been supported by the European Social Fund within the project «Support for the implementation of doctoral studies at Riga Technical University».

Novel 1,2,3-Triazolyl-Glycoconjugates in *Allo*-, *Galacto*- and *Gulo*-Series

Jevgenija Mackevica and Māris Turks (*Riga Technical University*)

Keywords **– Click chemistry, azide-alkyne 1,3-dipolar cycloaddition, 1,2,3-triazoles, carbohydrates.**

I. Introduction

Since discovery of synthetic nucleoside tiazofurin and its analogs ribavirin, eicar and bredin that show antiviral and antitumour activities sugar-heterocycle adducts have drawn substantial synthetic interest in medical chemistry. Among other azoles, 1,2,3-triazole moiety has gained an undivided interest in recent years.

Our studies were focused on glycohybrids with triazole heterocycle at C(3) in hexapyranoses, what is not so broadly described in the literature. There are only few examples dealing with C-3-triazolylglycoconjugates.[1]

II. Results and Discussions

We would like to report here the synthesis of novel 1,2,3-triazole-linked glycohibrids **2**, **4** and **6**, using a well-known copper(I) catalyzed azide – alkyne cycloaddition (CuAAC) (Fig. 1, Fig. 2, Fig. 3) Starting materials were diacetone-D-allose, diacetone-D-galactose and diacetone-D-gulose derived azides **1**, **3** and **5**, that were synthesized from 1,2:5,6-di-*O*-isopropylidene-α-D-glucofuranose. Commercially available 1,n-diynes or 2,2-dipropargyl dimedone, 5,5-dipropargyl Meldrum's acid, 3,3-dipropargyl barbituric acid and ether of ethylene glycol were used as precursors for extended linkers.

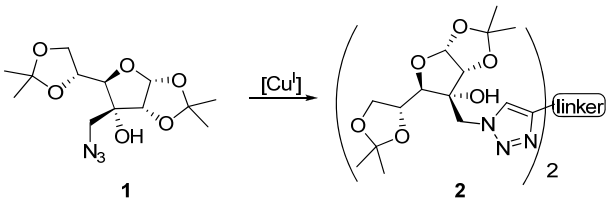

Fig.1. Synthesis of triazolyl-glycohybrids with *allo*-configuration

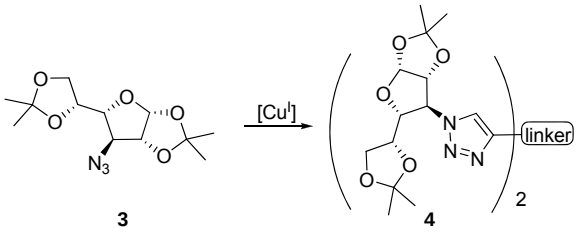

Fig.2. Synthesis of triazolyl-glycohybrids with *galacto*-configuration

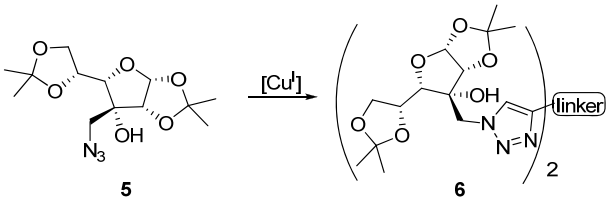

Fig.3. Synthesis of triazolyl-glycohybrids with *gulo*-configuration

Protecting groups are easily removed by aqueous trifluoroacetic acid (Fig. 4).

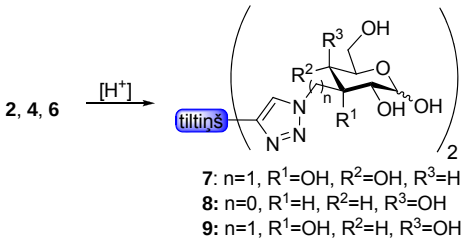

Fig.4. Deprotected triazolyl-glycohybrids

Biological properties of deprotected derivatives will be discussed.

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Sequential Michael Addition and 1,3-Dipolar Cycloaddition Reactions as a Simple Method for Combining of Carbohydrates

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Sergey Belyakov (*Latvian Institute of Organic Synthesis*)

Keywords – Isoxazole, carbohydrates, 1,3-dipolar reaction, Michael addition, diacetone-α-D-glucose.

I. Introduction

Isoxazoles are recognized as versatile structural elements in biologically active substances [1]. They are often used as linkers between different pharmacophores. Isoxazoles have found their way in carbohydrate chemistry together with triazoles which are other prominent azole congeners of the former [2].

II. Discussions

Herein we report a novel approach for isoxazole- or/and thioether-amine-linked glycoconjugates which is based on sequential Michael addition – 1,3-dipolar cycloaddition reactions.

As a starting material to prepare the different products of nuclephilic addition we used inexpensive and commercialy available diacetone-α-D-glucose **1**. Its oxydation followed by Henry reaction with nitromethane provided diastereomeric mixture of nitroalcohols that were dehydrated into **2** by Moffatt procedure.

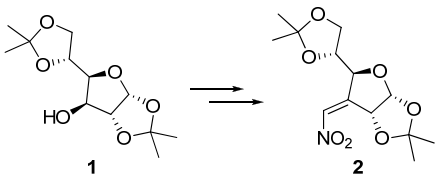

Fig.1. General route for the preparation of Michael acceptors.

We have identified glucose-derived nitroalkene **2** as a suitable structural motif which is capable to link a molecule possessing nucleophilic center and a molecule possessing terminal alkyne.

Michael addition of nucleophiles to corresponding acceptor **2** allows the formation of novel sugar derivatives. Various *O-, S-, N*-adducts are possible, including addition of natural amino acid esters. Futher, the Michael adducts can be converted either to spirocyclic sugar-piperazinones or they can serve as precursors for isoxazole synthesis.

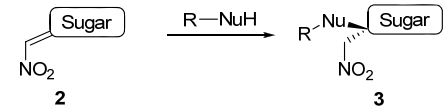

Fig.2. Stereospecific Michael addition to nitromethylene derivative.

Similarly to diacetone-α-*D*-glucose derived ketone **4**, key-product **2** accepts nucleophiles selectively from its *si*-face[3].

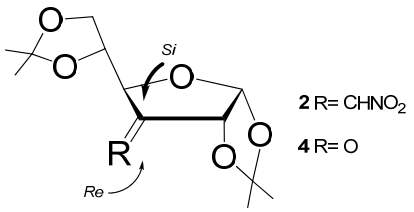

Fig.3. Diastereospecific addition of nucleophiles carbohydrates **2** and **4**.

The resulting nitromethylgroup can be transformed into nitrile oxides and then coupled with suitable terminal alkynes. Both the Michael addition and the cycloaddition occur with excellent isolated yields.

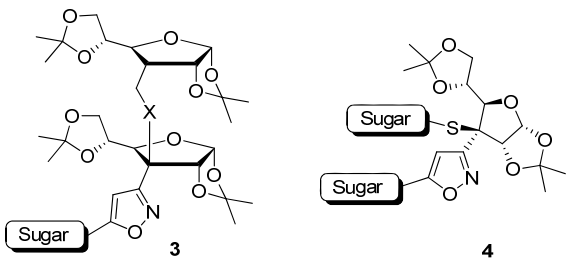

Fig.4. Trisaccharides illustration.

The overall process yields either disaccharides (only nucleophilic component is a carbohydrate) or trisacharides of type **3** and **4**.

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Coumarin Derivatives as Potential Antiradical Agents

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***Keywords* – coumarin-3-carboxylic acid, 4-hydroxycoumarins, 4-hydroxy-2(1*H*)-quinolinones, cinnamanilides, antioxidants.**

I. Introduction

Coumarin derivatives are well known anticoagulants, often demonstrate antiproliferative and anti-HIV effects, but 4-hydroxycoumarins [1, 2] and derivatives of coumarin-3-carboxylic acid [3] are known as antioxidants.

II. Results and Discussion

In order to evaluate structure–antiradical activity relationships we synthesized a range of coumarin-3-carboxylic acids **1** and their *N*-arylamides, 4-hydroxycoumarins **2** (Y=O) and 4-hydroxy-2(1*H*)-quinolinones **2** (Y=NH).

Compounds **1** were obtained by Knoevenagel condensation of Meldrum`s acid (**3**) with corresponding *o*-hydroxybenzaldehydes **4**. Derivatives of coumarin-3-carboxylic acid **1** were converted to acylchlorides and treated with anilines **5 –** this provided amides **6**. Due to the fact that hydroxycinnamoylanilines are well known antioxidants, we were interested in synthesis of 2-hydroxycinnamanilides **7**, which could be obtained by hydrolysis of lactone ring of *N*-(3-coumarinoyl)-anilines **6**. While hydrolysis of carboxylic acid **1** (R=H) in the presence of piperidine proceeded with decarboxylation providing coumarin and ring opening product – *o*-coumaric acid, anilide **6** (R=H) at such conditions gave amide hydrolysis product - compound **1**.

Synthesis of 4-hydroxycoumarins **2** (Y=O) and 4-hydroxy-2(1*H*)-quinolinones **2** (Y=NH) we realized by intramolecular acylation of malonic acid monoarylesters **8** (Y=O) and *N*-aryl-malonamic acids **8** (Y=NH) in the presence of Eaton`s reagent; the derivatives of malonic acid **8** were obtained from Meldrum`s acid (**3**) in reactions with corresponding phenols **9** (Y=O) or anilines **9** (Y=NH).

4-Hydroxy-*bis*-coumarins are strong radical scavangers and chain-breaking antioxidants [2] – this stimulated us to synthesize a few new *bis*-coumarins **10** by reaction of 4-hydroxycoumarins **2** (Y=O) with aromatic aldehydes **11**.

III. Conclusions

All synthesized compounds were tested for their antiradical activity against DPPH (diphenyl picryl hidrazyl). A few compounds demonstrated good antiradical activity, even 5 times higher than widely used antioxidant butylated hydroxytoluene.

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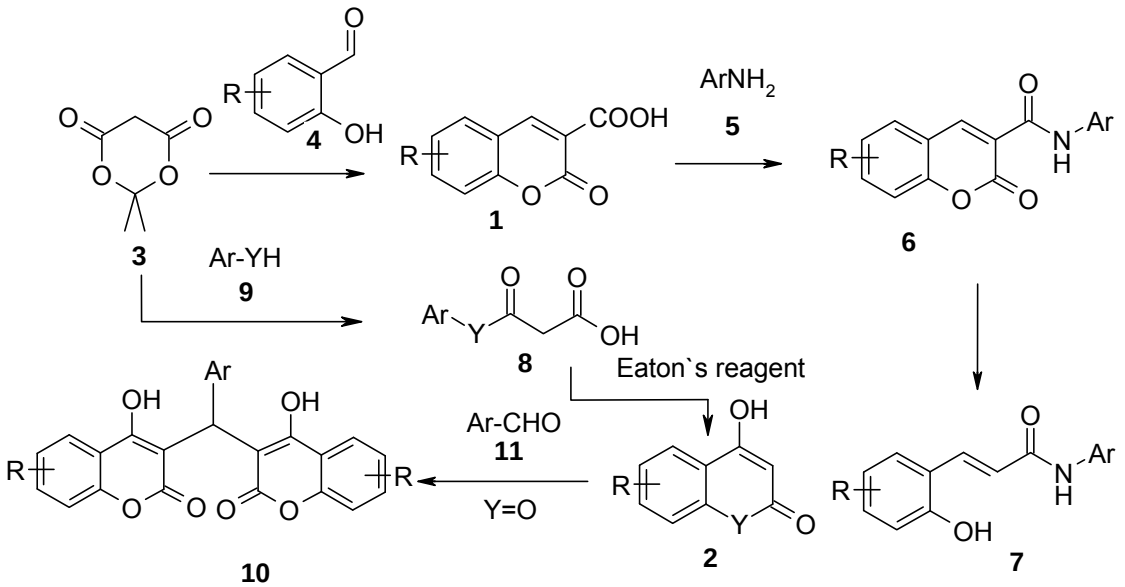
Acknowledgment: This work has been supported by the European Social Fund within the project «Support for the implementation of doctoral studies at Riga Technical University».



Studies of Novel 2,6-Bis-(1,2,3-Triazolyl) Substituted Purine Ribonucleosides

Erika Bizdena, Irina Novosjolova, Inga Bizane and Maris Turks *(Riga Technical University)*

Keywords – Purine nucleosides, ribonucleosides, 1,3-dipolar cycloaddition, fluorescence, ditriazolyl derivatives.

I. Introduction

The synthesis of purine nucleoside analogs has seen a renaissance during the last decade [1]. The modifications of purine nucleoside analogs are very important for antiviral and antitumor therapy [2].

II. Results and Discussions

The synthesis of 2,6-bis-(1,2,3-triazolyl)purine nucleosides **2** and nucleophile substituted nucleoside triazole derivatives **3** was started from diazido derivatives **1**. "Click" reaction with terminal alkynes in the presence of a copper sulfate catalyst with sodium ascorbate as a reducing agent produced 2,6-bistriazolyl derivatives **2**, which with different nucleophiles yielded the target products **3** (Fig. 1).

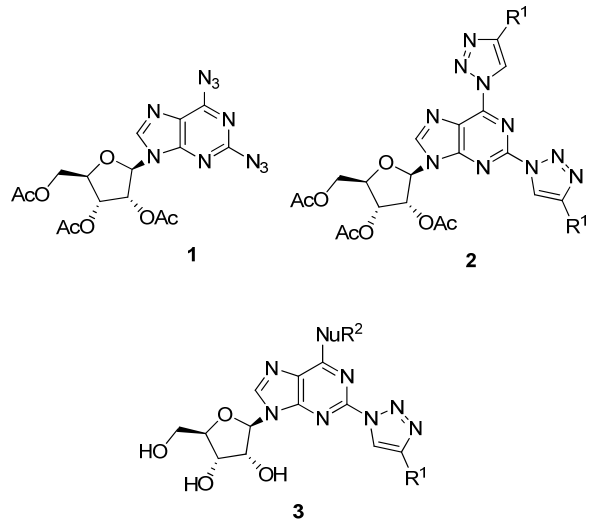


Fig.1. Structures of diazido nucleoside **1**, 2,6-bisitriazolylpurine nucleosides **2** and *C(6)* substituted purine nucleoside **3**.

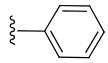
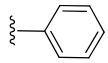
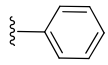
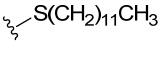
Starting material **1** was prepared by two different approaches. The first approach combines diazidopurine with peracetylated ribofuranose under Vorbrüggen conditions [3]. The alternative way includes ribosylation of 2,6-dichloropurine followed by reaction with NaN_3.

Product **1** underwent 1,3-dipolar cycloaddition reaction with various terminal alkynes and leads to 2,6-bistriazolylnucleosides **2**.

With the latter compounds in hand we studied their reactivity. Aromatic nucleophilic substitution at *C(6)* produced products with general structures **3**.

Amines, alcohols, thiols, substituted hydrazines and hydroxylamines can be used as nucleophiles. The examples of *C(6)* substituted triazolyl purine nucleosides are given in Table 1.

TABLE I
Examples of *C(6)* Substituted Purine Nucleosides **3**

Product A	R^1	NuR^2	Yields, %
3a			90
3b			86
3c			91
3d			88
3f			62

Additionally, the nucleophilic substitution products with general structures **3** possessing donor and acceptor groups perfectly fit in the group of "push-pull" systems. This allows us to study their florescence properties.

III. References

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Glyceric, Lactic and Mesoxalic Acids Production by Oxidation of Glycerol in Presence of Supported Gold Catalysts

Svetlana Cornaja, Olga Stepanova, Svetlana Zizkuna, Konstantins Dubencovs, Valdis Kampars, Dzidra Jankovica and Elina Sproge (*Riga Technical University*)

***Keywords* – Glycerol, oxidation, supported gold catalysts.**

I. Introduction

Glycerol is the main by-product of biodiesel fuel manufacturing, its yield makes up about 10-14% of overall mass of the products. Glycerol catalytic oxidation by molecular oxygen is one of the feasible methods of glycerol utilization. A number of important and valuable products, which are used as a feedstock in various processes of organic synthesis, can be obtained in the process of glycerol oxidation. Currently the supply of these chemicals is limited due to high costs. Glycerol catalytic oxidation by molecular oxygen can substantially decrease the cost of oxidation products.

The utilization of gold based heterogeneous catalysts in the process of glycerol oxidation is attracting the great attention during the last years [1, 2]. Advantage of the gold based catalyst is associated with the fact that the molecular oxygen does not deactivate the surface of the catalyst in the process of oxidation. The catalyst can be utilized repeatedly without the need for regeneration.

II. General Information

Kinetics of glycerol oxidation in presence of various supported gold catalysts wass studied in this research. There were some novel synthesized (2,0-5,0%Au/TiO_2 [3]; 1,0-2,7%Au/CeO_2) and commercial WGC gold containing catalysts (1,5% Au/TiO_2; 5,0%Au/Fe_2O_3; 0,8%Au/C) utilized.

The aim of this work was to identify the regularities of glycerol catalytic oxidation in alkaline water solutions and in basic methanol solutions to form one of the oxidation products selectively.

We found that the novel catalyst activity and selectivity are dependent on the catalyst synthesis methods (extractive – pyrolitic or impregnation methods). The activity of Au/TiO_2 catalyst (impregnation method) is dependent on the metal catalyst reduction agent that was used in the synthesis process. Depending on the gold particle carrier (CeO_2 or TiO_2) different glycerol oxidation main products (glyceric or lactic acids) can be produced. The novel gold catalysts are considerably more selective by glyceric and lactic acids than the commercial WGC gold containing catalysts.

The conditions, which allow selectively produce glyceric or lactic acid in alkaline water solutions or mesoxalic acid in methanol solutions under mild conditions ($P(O_2)$ = 1 atm; T = 333 K) were found.

Examples of glycerol catalytic oxidation results are presented in a table.

Table

Glycerol Catalytic Oxidation with Molecular Oxygen in Presence of Novel Supported Au Catalysts

Catalyst	Glycerol conversion rate %	Selectivity		
		Mesoxalic acid	Glyceric acid	Lactic acid
Glycerol oxidation in a weak alkali solution of methanol				
2,7%Au/CeO_2	27	85	7	0
Glycerol oxidation in alkaline water solution				
2,0%Au/TiO_2	97	0	89	9
2,7%Au/CeO_2	89	0	34	42

Optimal parameters for the production of glyceric acid: catalyst 2%Au/TiO_2 (d_{Au} = 10-15 nm;), c_0(glycerol) = 0.3M, n(glycerol)/n(Au) = 400 mol/mol, $P(O_2)$ = 1 atm, c_0(NaOH) =1.5 M, T =333K. The yield of glyceric acid was 84 % with 87% selectivity, oxidation time equaling 6 hours.

Optimal parameters of production of lactic acid: catalyst 1%Au/CeO_2 (d_{Au}= 20–23 nm), c_0(glycerol) = 0.3 M, n(glycerol)/n(Au) = 400 mol/mol, $P(O_2)$ = 1 atm, c_0(NaOH) = 1.5 M, T = 333 K. The yield of lactic acid was 49% with 51% selectivity, oxidation time equaling 9 hours.

Optimal parameters for the production of mesoxalic acid: catalyst 2.7%Au/CeO_2 (d_{Au}= 20–25 nm), c_0(glycerol) = 0.3M, n(glycerol)/n(Au) = 400 mol/mol, $P(O_2)$ = 1 atm, c_0($NaOCH_3$) = 0.06 M, T =333K. The yield of mesoxalic acid was 16% with 87% selectivity, oxidation time equaling 9 hours.

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Acknowledgment: This work was supported by the ERAF project Nr. 2010/0304/2DP/2.1.1.1.0/10/APIA/VIAA/087.

The Impact of Individual Technological Parameters on the Water Electrolysis Process

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***Keywords* – electrolysis, titanium oxide ceramic, chloride ion, flow regime.**

I. Introduction

One of the most important water quality parameters is the microbiological status.

Among the numerous methods of disinfection water electrolysis takes an important part, during which strong oxidants from chloride ions in water are formed [1], which reduce the water of organic substances, including micro-organisms. Electrolytic production of chlorine in the process is affected by various technological factors, such as chloride ion concentration, current intensity, flow regime, the number of electrodes, the presence of other ions in water.

II. Materials and Methods

Electrolysis process was implemented in special electrolysis cell using titanium oxide ceramic electrodes. The model solution containing chloride ions was treated by electrolysis. The total amount of chlorine released by the electrolysis of water was determined by iodometric titration method [2].

The number of working electrods in the cell through which current flows ranged from 2 to 24. Using peristalsis pump with variable capacity (LongerPump®, YZ1515x), the electrolyzed solution flow regime impact on the amount of released chlorine was studied.

In order to determine the presence of other ions influence of process of electrolysis, the model solution which together with chloride ions contains sulfate ions commonly found in natural waters was used.

III. Results

It was found that increase in chloride ion concentration in processed solution, the released amount of chlorine increased. In addition, more pronounced increase is observed by increasing the chloride ion concentration of the solution from 0.5 to 4 mmol/L, but also at a minimum chloride ion concentration (0.5 mmol/L) in the treatment of water for 30 min at 0.1 A strong current released chlorine more than 1 mg/L.

Other ions can affect the rapid decrease of chlorine released in water electrolysis process. The treatment of the solution with sulfate ion at the maximum permitted concentrations in drinking water (250 mg/L) by electrolysis at 0.1 A high-intensity 15 minutes released only about 0.7 mg/L chlorine, which is 2 times less than in the same conditions without sulphate ions.

Literature studies have shown that for energy-efficient treatment of water by electrolysis it is important that the electrolysis cell resistance should be as small as possible without causing additional loss of energy to overcome the resistance of electrolysis equipment.

Experimentally it was found that increasing the number of electrodes, electrolysis cell resistance decreases, at a constant current. This is due to the increase in electrode area, and reduction in the current density per unit area, thereby reducing the resistance. Increasing the number of electrodes 12 times in electrolysis cell, the cell resistance decreased approximately 3-times and specific electrical work for 1 mg Cl_2 distribution decreased to about 3.5 times, but released chlorine outcome remained almost constant (1. Fig.).

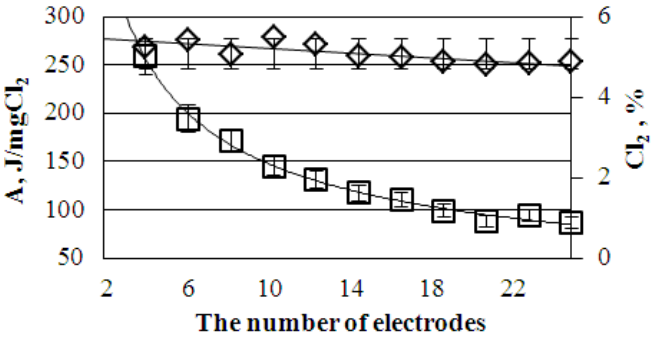

Fig.1. Specific electrolysis process work (A) and the released chlorine (Cl_2) outcome from the theoretical (calculated from the electrical power) depending on the number of electrodes: □ - specific work ◊ - chlorine outcome. Current intensity I = 0.1 A, Cl^- ion concentration 1 mmol / L.

It was found that treated solution flow rate affects the amount of chlorine released at low input current intensity, which may be associated with the intensification of mass exchange. The released amount of chlorine produced by electrolysis is limited by added the current intensity and flow rate shows no significant influence on the outcome of the released chlorine.

IV. Conclusions

It is possible to change the output amounts of chlorine in water electrolysis process by changing some of the technological parameters.

The presence of other ions in water, including sulfate ions, significantly reduces the amount of released chlorine, related to possible side reactions on the anode surface. It was found that changing nature of the flow rate, increasing chloride ion concentration and the applied current intensity can significantly increase the output of chlorine in electrolysis of water.

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Acknowledgment: This work has been supported by the European Regional Development Fund within the project "Development of innovative water procession technology using nanostructured ceramic", No.2010/0257/2DP/2.1.1.1.0/10/APIA/VIAA/012.

Bioaugmentation of Acid whey Anaerobic Digestion

Kristine Rugele and Simona Larsson (*Riga Technical University*)

***Keywords* – anaerobic digestion, biogas, bioaugmentation, acid whey.**

I. Introduction

Anaerobic digestion is a series of processes in which microorganisms break down biodegradable material in the absence of oxygen. Anaerobic system advantages also include the recovery of energy in the form of methane from the degradation of organic substrates. Improving bioprocesses by implementation of microbial populations (bioaugmentation) with improved degradation abilities has been known for years. Bioaugmentation has been investigated as a method to decrease the recovery period of anaerobic digesters exposed to transient toxic event [1].

II. Bioaugmentation

In wastewater treatment, bioaugmentation has most frequently been applied to aerobic systems to increase the population of nitrifying bacteria after upsets from uncontrolled biomass loss, fluctuations in pH, toxic events, or temperature decrease. Bioaugmentation has also been used for other aerobic applications, including improved flocculation and degradation of specific substrates, and for soil and groundwater bioremediation. However, only few studies have been done on bioaugmentation of anaerobic digestion and the results are inconsistent. To obtain a clear picture of the potential to use specific microbes for improvement of the process, it is necessary to follow the fate of the microbes added to the reactor system over time. Dairy waste water contains complex organics, such as polysaccharides, proteins and lipids, which after after hydrolysis form sugars, amino acids, and fatty acids [2,3]. In subsequent acidogenic reaction, these intermediate products are converted to volatile fatty acids (VFA), which are further degraded by acetogens, forming acetate, CO_2, and H_2. Lastly, both acetate and H_2/CO_2, are converted by methanogens to CH_4.

The acid accumulation is due to the slower methabolism of the microbes that utilize the acetic and propionic acids than the rest of the microbial population in the reactor; therefore if the microbes produce acids faster than the capacity of acid utilization, there will be an accumulation of acids, and consequently a drop in pH, unless the system is well buffered.

Another problem is hydrogen accumulation, which can lead to the inactivation of the reaction that produces acetate from propionate [4].

The addition of alkalinity is the most common remedy when a reactor is going “sour”. Another possible solution is the introduction of hydrogen-consuming methanogens to help reduce the concentration of hydrogen in the reactor.

There have been different methods reported for bioaugmenting anaerobic reactors:

a) *Adding exogenous microorganisms*. This is the most commonly used method. External microbial cultures capable of degrading of the target compound are added to the reactor to enhance degradation. Typically the microorganisms are cultured in an environment containing the pollutant target compound before adding them into the reactor.

b) *Utilizing indigenous microorganisms*. Microorganisms from the reactor are isolated, grown and then inoculated back to the reactor.

c) *Using enriched reactors*, which are connected to the reactor and supply enriched biomass, enhancing the degradation process. These enricher reactors can be inoculated with exogenous biomass, commercial strains or indigenous biomass from the same reactor to be bioaugmented. This method has been used to reduce start-up time of anaerobic and other reactors [5].

The most popular species for bioaugmentation are H_2 and propionate utilizing cultures. *Methanosarcina* are the only known anaerobic methanogens to produce methane using all three known metabolic pathways for methanogenesis. *Methanosarcina* sp. are, compared to other methanogens, quite robust towards different impairments as it is reported [6] to be tolerant to total ammonium concentrations up to 7000 mg L^{-1}, salt concentrations up to 18,000 mg Na^+ L^{-1}, a pH shock of 0.8–1.0 units and acetate concentrations up to 15,000 mg COD L^{-1}.

III. Conclusions

Indigenous culture adaptation, and both *Methanosarcina* sp. and *Methanococcus* sp. were tried for acid whey bioaugmentation in this study and it was concluded that both adaptation and addition of methanosarcina favored methane formation..

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Investigations of Electrical Properties of Titania Ceramic

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Janis Kleperis *(University of Latvia)*

Keywords **– titania ceramic, electrical conductivity, thermogravimetry, impedance spectroscopy.**

I. Introduction

Titanium dioxide (TiO_2) is one of the most widely used metal oxides because of it's excellent chemical stability in hazardous environments, hardness, high refractive index, and many other remarkable features [1].

Electrical properties of ceramics are affected by their microstructural features and defect structures (such as oxygen vacancies and titanium interstitials). The electrical conductivity increases strongly with increasing oxygen deficit. The defect structure and releated properties of TiO_2 are usually deduced from electrical conductivity measurements, assuming that the studied material is an electronic semiconductor [2].

II. Materials and Methods

Titanium oxide ceramics were prepared using extrusion process and subsequent thermal treatment in two stages – treatment in the air atmosphere, followed by treatment in vacuum. Samples were obtained using ceramic mass extruder DOR*ST V 10 SpHV*. Extrusion mass consisted of anatase 69,7 wt%, lubricant 1.4wt%, binder 0.3 wt%, glycerol 0,7 wt% and distilled water 27,9 wt%. Water and additives was kept to provide appropriate adhesion of particles and mass plasticity. Samples were sintered in air atmosphere at 1100°C, 1250°C, 1350°C or 1450°C for 6 h with a heating and cooling rate of 5 °C/min to burn out the additives and obtain rutile crystallographic modification. Further, samples were treated in vacuum ($2 \cdot 10^{-3}$ Pa) at 1250°C with 5°C/min heating rate and 3 h dwell time.

The influence of different thermal treatment conditions on phase composition, density, microstructure, and electrical conductivity of obtained TiO_2 ceramic was evaluated by the following analytical techniques: water displacement (Archimedes) method, X-ray diffraction (XRD), thermogravimetry (TG), scanning electron microscopy (SEM), atomic force microscopy (AFM), impedance spectroscopy (IS), and DC four-probe measurements.

III. Results

After thermal treatment obtained XRD analysis of samples shows only TiO_2 rutile phase. Whereas the rutile structure is more densely packed than anatase, change from anatase to rutile crystallographic modification causes ceramic densification.Relative density of the sintered TiO_2 samples obtained by extrusion was from ~68 to 93% and grain size in the range from ~2 to 22 µm depending from thermal treatment temperature in air (from 1100 to 1450°C).

Investigations have shown that vacuum heat treatment of TiO_2 causes the formation of nonstoichiometric TiO_{2-x} ceramics. Thermogravimetric analysis was carried out in air from room temperature up to 1300°C. During heating process, nonstoichiometric TiO_{2-x} oxidizes and sample mass changes. Calculated Ti:O ratio of the material is about 1:1,95.

DC four probe measurements shows that vacuum heat treatment of TiO_2 causes a significant decrease in resistance of the material, which is influenced by the heat treatment temperature in air. Electrical resistance value is about 1-2 Ω depending of thermal treatment temperature (Fig.1). Comparing the resistance value of the samples parallel and perpendicular to the extrusion direction no significant change was observed, although it was expected that after extrusion different oriented particles will affect the electrical conductivity.

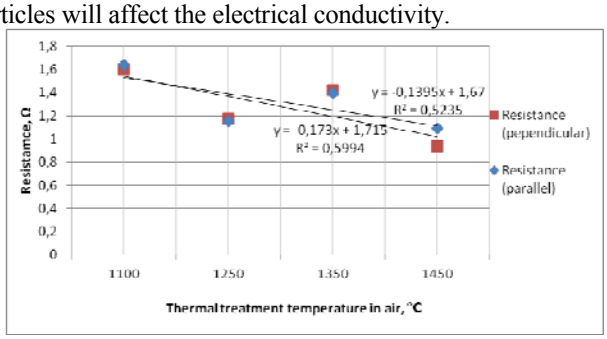

Fig.1. Resistance dependence on thermal treatment temperature in air with subsequent thermal treatment in vacuum

Electrical charge transfer mechanism in nonstoichiometric TiO_{2-x} ceramic was studied using AFM and IS. Comparison of the AFM topographic and current images reveals distinct correlation between the topography and local conductivity of the sample. It is evident that current flows mainly through grain boundaries Typical complex impedance diagram measured at room temperature shows semicircles assigned to the grain boundary response.

IV. Conclusions

Titanium oxide ceramics were prepared using extrusion process and subsequent thermal treatment in air at different temperatures and than in vacuum. Treatment of TiO_2 ceramics in air and vacuum significantly changes the properties of obtained ceramics. The present work determinate electrical resistance of vacuum treated titania ceramics and deviation from stoichiometry. Ti:O ratio in obtained ceramic is about 1:1,95.

It has been found from AFM and impedance spectroscopy that the current mainly flows through grain boundaries.

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Acknowledgment: This work has been supported by the European Regional Development Fund within the project "Development of innovative water procession technology using nanostructured ceramic", No.2010/0257/2DP/2.1.1.1.0/10/APIA/VIAA/012.

Lysozyme Immobilization onto Synthesized Terpolymeric Cationite and Subsequent Release from Conjugates

Valentina Krilova and Renate Steika (*Riga Technical University*)

***Keywards* – Lysozyme, immobilization, release, lytic activity.**

I. Introduction

An enzyme immobilization allows to improve its stability and to enhance duration of usage in technological processes. The main problem is to find appropriate support and immobilization protocol. Sorptive immobilization can be attributed to less traumatic for enzyme and easier in comparison with covalent immobilization. The usage of immobilized enzyme in technology provides for its controllable release in exploitation condition or functioning in conjugated form. This signifies that sorptive immobilization must be rather strong, and multipoint coupling to ion-exchanger having high content of functional groups might be the most advantageous. Immobilized enzymes may exhibit much better functional properties than the corresponding soluble enzymes [2].

II. Results

For lysozyme immobilization synthesized carboxylic ion-exchanger was used which contained methacrylic and acrylic acid units and long-chained cross-linking agent triethyleneglycol dimethacrylate. The structure and composition of carboxylic cationite was designed for effective sorption of proteins. Microglobular porous structure of cationite beads inside and surface do them permeable for large molecules. High content of functional groups and optimal level of their ionization ensure multipoint and reversible immobilization.

High sorption capacity towards lysozyme (330-350 mg/g) and selectivity of synthesized carboxylic ion-exchanger K-120 has been approved.

Reversibly conjugated lysozyme release was ascertained to depend from contacted medium composition. This was found both for lysozyme immobilized from model solution and from diluted hen egg white (Fig. 4). Enzymatic activity of lysozyme in contacting solutions was evaluated by *Micrococcus lysodeiktikus* cells lysis.

The lytic activity of conjugates was stable during all time of experiment. When conjugates were in close contact with cells dispersion lytic reaction was fast and unchangeable during at least 14 days.

To compare the lytic activity of non immobilized and immobilized lysozyme, cells lysis was noticed in constant volume containing dissolved lysozyme or immobilized one. The results were similar.

To evaluate the conjugate stability for a long time, samples were stored at ambient temperature during 72 days. Lytic activity of desorbates practically was not changed as compared with initial activity (24095 U/mg and 23976 U/mg, accordingly). *Micrococcus lysodeikticus* cells amount decrease in close contact with conjugate have the similar character as in the case of freshly developed conjugate.

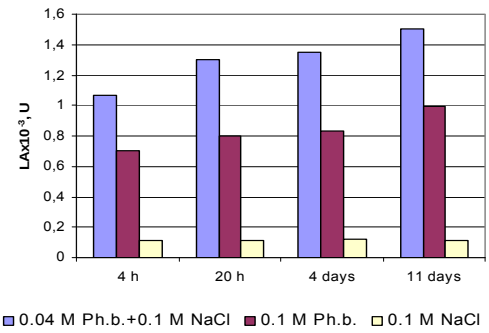

Fig.4. Immobilized lysozyme release from conjugates; lysozyme sorption was conducted from hen egg white; Ph.b.-phosphate buffer solution; lytic activity (LA) was calculated as units` quantum at identical condition

Immobilized lysozyme can be desorbed using solution having enhanced salt concentration or increased pH value. As experiments showed, the most suitable composition of desorbing solution is 0.2 M potassium phosphate with 0.3 M NaCl and having pH 9. In condition of experiment desorbates have pH value about 7.3 and preserved lytic activity. The resulting pH decrease till neutral level was due to high buffer capacity of ion-exchanger which, in its turn, was the result of large content of carboxylic groups in it.

III. Conclucions

Synthesized porous carboxylic ion-exchanger containing methacrylic and acrylic acid units and cross-linking agent triethyleneglycol dimethacrylate might be considered as appropriate support for basic enzyme lysozyme reversible immobilization.

Conjugates obtained by one-step sorption from diluted hen egg white demonstrate lysozyme release which defines stable and long-term lytic activity. Lysozyme release from conjugates depends on medium composition.

The re-use possibility, high buffer capacity of ion-exchanger and controllable level of lysozyme one-stage sorption from hen egg white allowed predicting of perspective and economical usage of formed conjugates in technological processes.

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Principles and Application of pO_2 Cascade Control in Fermentation Processes

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***Keywords* – biotechnology, fermentation, pO_2 cascade control.**

I. Introduction

Many of industrially used fermentation processes require reliable and precise control of system's aeration level by means of pO_2 (dissolved oxygen partial pressure) control. Most of currently available fermentation systems use pO_2 control in so-called cascade control way, e.g., control of pO_2 by aeration flow, stirrer speed, oxygen enrichment, and feeding rate under substrate limitation conditions [1, 2].

II. Principle of pO_2 Cascade Control

Controllers with pO_2 cascade control previse possibility to keep pO_2 level desirable for the process. This is achieved by selecting appropriate pO_2 setpoint and upper / lower boundary (dead band) within which pO_2 level will satisfy exact process performance. Then cascade control loops (*PID* controllers with configurable tuning parameters [3]) are selected which will sequentially react on increasing or decreasing oxygen demand. Example of pO_2 cascade control loops, their usual sequence and working principle are listed below:

1) *stirrer rotation speed* – the rotation speed *decreases* when $pO_2 > \{pO_2$ (set point) + pO_2 (dead band)$\}$, and it *increases* when $pO_2 < \{pO_2$ (set point) – pO_2 (dead band)$\}$;
2) *oxygen enrichment* or *aeration flow* – the oxygen impulse length or air flow rate *decreases* when $pO_2 > \{pO_2$ (set point) + pO_2 (dead band)$\}$, and it *increases* when $pO_2 < \{pO_2$ (set point) – pO_2 (dead band)$\}$;
3) *substrate feeding* – the feeding rate *increases* when $pO_2 > \{pO_2$ (set point) + pO_2 (dead band)$\}$, and it *decreases* when $pO_2 < \{pO_2$ (set point) – pO_2 (dead band)$\}$[1].

III. Materials and Methods

The above described principles were developed and implemented into laboratory bioreactor (6.2 l, working volume 2 – 4 l) system EDF-5.3_1 (BTC, Latvia). Bioreactor consisted of controller BIO-3 with following configuration:

(i) The available control loops were: temperature, *pH, pO_2,* foam, and level.
(ii) The possibility to carry out time-dependent feeding profiles (entering before the process, with the possibility to correct them during the process).
(iii) Cascade control of pO_2. The following cascades were used:
  (a) stirrer rotational speed, n,
  (b) oxygen enrichment, Q_{O2},
  (c) substrate feeding, Q_{Feed}.

Data exchange with the PC visualization program (SCADA) using an industrial standard MODBUS protocol.

The cascades realized in this study have the controlled parameters as well as the starting and transition limited values as listed in Table 1.

TABLE I
LOWER/UPPER LIMITS USED FOR pO_2 CASCADE CONTROL

Stirrer		O_2 enrichment		Automatic fed-batch	
n_{min}	350 rpm	$Q_{O2\ min}$	0 %	$Q_{Feedmin}$	0.00 ml/min
n_{max}	800 rpm	$Q_{O2\ max}$	10 %	$Q_{Feedmax}$	6.00 ml/min

The organism used in this study was recombinant *Escherichia coli* BL21 (American Tupe Culture Collection, ATCC). pO_2 was selected 40 (set point) % ± 5 (dead band) %. Also constant temperature 37.0 ± 0.2 ˚C, pH 7.0 ± 0.2 and air supply 1.7 slpm were maintained during the entire process. Batch media consisted of glucose (5 g/l), yeast extract (5 g/l), salts, and trace elements. Fed-batch solution consisted of glucose (100 g/l) and salts.

IV. Results

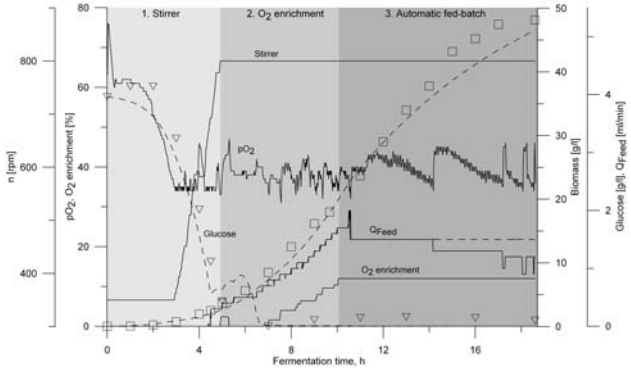

Fig.1. *Escherichia coli* fermentation results. Experimental data: triangles, squares and solid lines; modeled data: dashed lines.

Examined pO_2 control strategy allows to conclude that:

1. investigated approach was successfully implemented into bioprocess controller BIO-3;
2. adequate pO_2 control was achieved experimentally;
3. fermentation process can be divided into two phases, where in the first phase cells grow according to predefined growth rate, and in the second phase - by automatic fed-batch with a smaller cell segregation rate.

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Influence of Complete Dissolution of Carbonates on the Aggregation of Clay Particles

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***Keywords* – clays, aggregation, organic acids, carbonates, suspension stability.**

I. Introduction

Most naturally occurring clays typically are mixtures of clay minerals, non-clay minerals, such as quartz, feldspar, carbonates, metal oxides and hydroxides, muscovite and organic matter. The presence of carbonates, metal (iron, aluminum, manganese) hydroxides and oxides and organic matter prevents optimal dispersion and successful fractionation of clay minerals. Calcium and magnesium ions released from carbonates behave as cementing agents and cause aggregation of clay particles. Similarly, metal hydroxides and oxides (mostly iron) cause strong coagulation. Because of these clay aggregates the purification of raw clay samples from non-clay minerals is hindered. The removal of carbonates can be performed by dissolution with organic and inorganic acids. At the same time the oxides and hydroxides are also being dissolved [1].

Clay minerals are widely used as excipients and active ingredients in cosmetic products and pharmaceutical preparations. An important factor for this application is the purity of clay minerals [2]. In Latvia, the mineralogical composition and amount of clay minerals in raw clay samples depends on the place and depth of deposit. Illite is the most abundant clay mineral. The content of carbonates is 5-15 %. Latvia has large clay reserves, but they are traditionally used in building materials and pottery [3]. Effective clay mineral isolation would expand the application opportunities.

The aim of this study was to evaluate the changes in the aggregation of clay particles after complete removal of carbonates with different organic acids and hydrochloric acid. The dissolution of iron containing compounds and stability of clay-water suspensions is also investigated.

II. Materials and methods

The clay samples were taken from deposits in Latvia, containing 13-15% carbonates and illite as the main clay mineral. Sample fraction < 63 μm was used. The carbonates and iron containing compounds were dissolved in citric, oxalic, maleic and hydrochloric acids.

To evaluate the changes in aggregation process, the clay samples were fractionated with sedimentation process. The identification of clay minerals was performed by using X-ray diffractometer (XRD). Particle size distribution was measured for fractionated and non-fractionated clay samples with laser particle size analyzer. The amount of Fe(II) and Fe(III) ions in the filtrate after the dissolution were determinated with 1,10-phenantroline using spectophotometric method.

III. Results

The influence on the aggregation and size distribution of clay particles depends on the type the acids. Comparing with untreated clay, the overall stability of clay water suspensions has increased. Although in the dissolution process of the carbonates soluble and insoluble calcium and magnesium salts are formed as by-products, the XRD analysis shows only calcium oxalate. Dissolution of iron compounds increases with increasing the concentration of acids.

IV. Conclusions

The removal of carbonates decreases the aggregation process of clay particles. Therefore it is possible to improve the isolation of clay minerals from raw clay samples.

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Controlled Release of Dexamethasone from Fibrin Mixed with Biphasic Calcium Phosphate Bioceramics

Arita Dubnika, Ilze Salma, Dagnija Loca and Liga Berzina-Cimdina (*Riga Technical University*)

Keywords **– Hydroxyapatite, Plasma, Fibrin, Dexamethasone, Drug delivery.**

I. Introduction

Targeted drug delivery systems are used to minimize the adverse effects of the pharmaceutical agents while maintaining the high local drug concentrations. Dexamethasone is glucocorticoid that exerts various inhibitory effects on the inflammatory processes. For bone tissue engineering calcium phosphate (CaP) ceramics are suitable implant material due to their biocompatibility and osteoconductive properties. Composite material containing CaP and drugs would provide bone regeneration and site specific drug delivery. The association of bioceramics and fibrin sealants may develop the clinical applications of bone substitutes. Physical, chemical and biological properties of both CaP and fibrin sealants may be cumulated for preparing advanced bone substitutes. In our study human plasma was used as a raw material for fibrin sealant fabrication. Plasma has all the essential characteristics to be an excellent support biomaterial – to interface with biological systems for the purpose of treating or replacing any type of tissue or organ. Plasma is well tolerated by patients and is replaced by tissue after integration. The aim of experimental study was to prepare controlled dexamethasone delivery system which is based on synthetic biphasic hydroxyapatite/β-tricalcium phosphate bioceramic (BCP) granules mixed with fibrin.

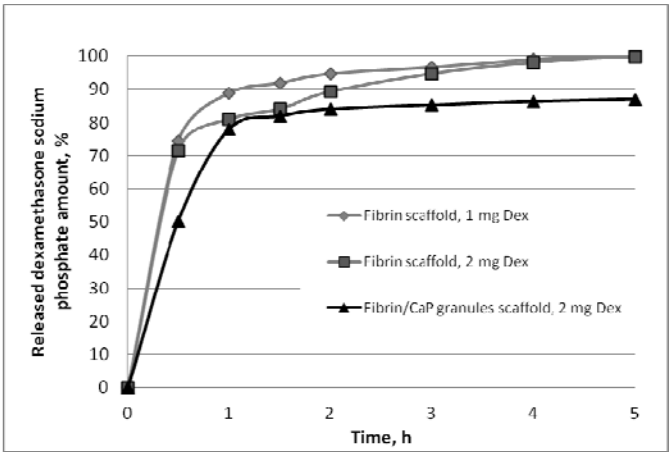
II. Experimental Methods

To obtain the plasma, blood was centrifuged for 10 minutes at 3000 rpm (Compact Star CS 4). For preparation of the bioceramic and fibrin sealant composites antifibrinolytic agent tranexamic acid (Amchafibrin 500mg/5ml; Rottapharm) was dissolved in the human plasma, calcium gluconate (Calcium Sopharma 8,94mg/ml; Sopharma) and BCP ceramic granules were added afterwards [1].

The obtained suspension was stored in an incubator at 37^0 C for 20 minutes. Several tests have been made to obtain the best possible scaffold. The quantities of its components have been changed: plasma (0.5 ml and 0.8 ml); tranexamic acid (0.1ml and 0.2 ml); calcium gluconate (0.25ml and 0.5 ml). The following quantities yield the best results: plasma 0.5 ml, tranexamic acid 0.2 ml and calcium gluconate 0.25ml. Dexamethasone sodium phosphate was added to suspension as a last component in various amounts. Prepared drug/fibrin/biphasic calcium phosphate granules composites were placed in 150 ml of simulated body fluid pH = 7.4 (SBF) incubated at 37°C and 50rpm. Dexamethasone release rate from composites was determined by taking samples of SBF in previously defined time. Release of dexamethasone was determined using high performance liquid chromatography method (Waters 2695 Alliance Separations Module). Scanning electron microscopy (SEM) was used to evaluate the surface morphology and inner structure of the scaffolds.

III. Results

Released amount of dexamethasone from composite materials was plotted against the incubation time (see Fig. 1).



In the first hour the initial burst release up to 80% was observed for fibrin scaffolds containing dexamethasone. In incubation period the slowest dexamethasone release was obtained for fibrin/CaP granules scaffolds. Dexamethasone release was sustained up to 20 h.

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Effect of Ozonation of the Pre-coagulated Model Wastewater on Removal of Wood Pollutants

Julija Brovkina, Galia Shulga (*Latvian State Institute of Wood Chemistry*), Jurijs Ozolins, Romans Neilands, Kristina Tihomirova *(Riga Technical University) and* Antons Podjava *(University of Latvia)*

***Keywords* – ozonation, coagulation, aluminium salts, composite coagulants, wastewater of plywood industry.**

I. Introduction

The plywood effluent is one of the high polluting effluent amongst the effluents obtained from wood industries. The wastewater after birch wood hydrothermal treatment contain hemicelluloses and lignin substances (HLES).

The coagulation is one of the cheapest process for treatment of various organic effluents. It is necessary to combine the method of coagulation with the method of post-treatment for providing the technology reliability and possibility of return of the purified water in a main technological cycle. It is set that the process of ozonation got the widest use as the second stage of purification. Thus, the removal of HLES, lignin, chemical oxygen demand (COD) and colour of wastwater was studied using coagulation and ozonation process.

II. Materials and Methods

For the development of technological scheme of hydrothermal pool wastewater treatment the model wastewater (MW) was used. The chemical composition of MW was related to the characteristic of wastewater from hydrothermal basin of plywood industry [1].

The coagulation process was performed using polyaluminium chloride (PAC) and composite coagulant on PAC basis (COMPAC). Aluminium coagulants have been described by traditional Ferron method [2] and by electrospray ionization (ESI) mass spectrometry [3]. The efficiency of HLES coagulation was defined after 2 hours of the system settling and filtration. The HLES and lignin removal were determined by UV/Vis spectrometry. COD, color, BOD_5, TOC and residual aluminium of the samples were determined according to the Standard Methods. Ozonizer (KH-AW-5A-2) with a flow rate of 0.6 mg L^{-1} was used as the ozone generator. The ozone/oxygen mixture, with the gas flow of 20 L min^{-1}, was continuously introduced to 1000 mL of the sample as bubbles through the porous ceramic at the bottom of the cilinder.

III. Results and Discussions

The proposed outcome of this study was the technology including the optimal model and reason that it might be realized in production facilities. The technology was implemented in four stages.

The first stage is based on water circulation through the grille nested in a hydrothermal basin in order to detain floating pollutants of considerable dimensions. The second stage is performed with a wastewater treatment by coagulation method. It was established that the optimal pH value for coagulation with PAC is 6.0 [1]. The most effective coagulant is COMPAC (Table 1). Using Ferron method and ESI-MS was indicated that COMPAC contains more polymeric aluminum species and the large polymer species. The optimal dosage was 100 mg/l.

TABLE I
THE EFFICIENCY OF MODEL WASTEWATER TREATMENT FROM HLES

	Removal, %						Al, mg/l	Cl^-, mg/l
	HLES	Lignin	COD	Color	BOD_5	TOC		
PAC	80	54	43	72	56	55	0.06	67
COMPAC	95	66	46	88	69	66	0.06	37

After sedimentation, the purified wastewater is delivered to the third treatment - filtration. In the given technological scheme, the filtration procedure prevents the non-sediment coagulates into the reactor, where the ozonation takes place. The filtrate is delivered to the contact chamber for ozonation. Ozone produced in generator is bubbling through the water layer in bubble reactor. The initial coagulation improved the oxidation potential of the effluent. Reduction percentage of HLES was 99%. Reduction of lignin compounds by coagulation followed by ozonation was 94%, out of which coagulation accounts for 66% and 28% was due to ozonation. Significant TOC (92%) and BOD_5 (94%) reduction was observed after ozonation. Purified water is supplied to the hydrothermal pools.

IV. Conclusion

It was established that the composite coagulant exhibited better HLES removal by coagulation compared to the known PAC. Ozonation of the pre-coagulated model wastewater demonstrated the beneficial effects on the removal of HLES. A combination of coagulation and ozonation stages can provide possibilities to return purified wastewater in a main technological cycle.

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Isolation and Characterization of Proanhocyanidins from Alder Bark by FTIR, GPC/SEC, ^{13}C-NMR and MALDI-TOF Mass Spectrometry

Sarmite Janceva, Tatiana Dizbite, Galina Telysheva (*Latvian State Institute of Wood Chemistry*) and
Marcis Dzenis (*Riga Technical University*)

Keywords **– Hardwood, bark, extract, condensed tannins, proanhocyanidins, polyphenol compounds, sequentially extractions, FTIR, GPS/SEC, ^{13}C nuclear magnetic resonance spectroscopy and time-off light mass spectrometry (MALDI-TOF MS) analyses.**

I. Introduction

Recently much attention of researchers is being paid to the usage of hardwood biomass for production of new products due to small increase in the growth dynamic of the deciduous trees in last years. At present the hardwood bark, as the waste of logging and woodworking (40% of wood), is burnt, although it might be a perspective raw stuff for production of polyphenol compounds, including condensed tannins (proanthocyanidins). Condensed tannin (CT) extracts are mostly composed of flavan-3-ols repeating unit, such as procyanidin, prodelphinidin, smaller fractions of simple sugars and other polysaccharides. In alder species CT are abundant components (as high as 30 – 50 % dry weight). More promising spheres of an industrial application both of the extract and of tannin are considered to be the environment-friendly adhesives (mainly the wood). Another important sphere for application of condensed tannins is the use of their biologically active and antioxidant properties in cosmetics, manufacture of veterinary medicines etc.

II. Materials and Methods

The bark of deciduous trees samples *alnus incana*, *alnus glutinosa)* were collected from the forest in the September of 2010 in the forest of Ogre. Proanthocyanidins (PAC) were extracted from alder bark using sequentially extractions with solvents of increasing polarity: hexane, ethyl acetate, ethanol/water 1/1, v/v and fractionated by a Sephadex LH-20 column. PAC content was measured by buthanol–HCl method using procyanidin dimer B2 as a reference compound. The structures of condensed tannins isolated from bark of two alder species were characterized by GPC/SEC, FTIR, ^{13}C nuclear magnetic resonance (NMR) spectroscopy and time-off light mass spectrometry (MALDI-TOF MS) analyses.

III. Results and Discussion

Results of the three-degree extraction show that the yields of hydrophilic extract substances of hardwood bark vary in the range 30 – 50%. Interesting results were demonstrated by the content of polyphenol compounds and of condensed tannins in the extract substance. The highest content of condensed tannins is in the bark of the grey alder. The MALDI-TOF and GPC/SEC spectrums illustrated a series of peaks corresponding to oligomers of condensed tannins of up to 7 flavonoid units (2100 Da). The structural diversity of the linkage (A and B type) and stereoisomer of catechin and epicatechin units is apparent from the ^{13}C-NMR spectrum.

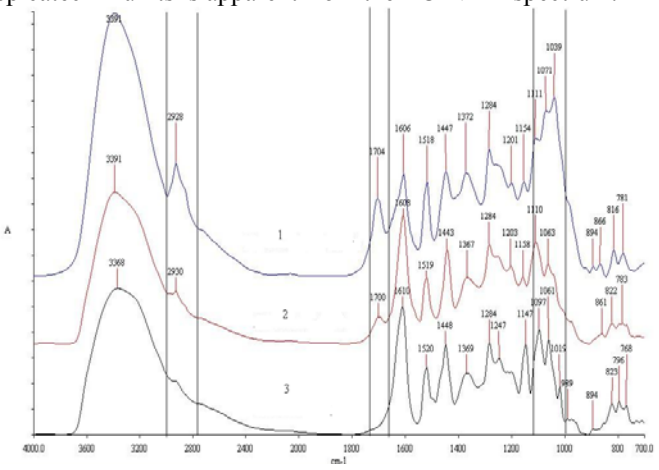

Fig.1. FTIR spectrum of proanthocyanidins from alder bark. (1 - hydrophilic extracts, 2 - PAC from alder bark, 3 - procyanidin dimmer B2).

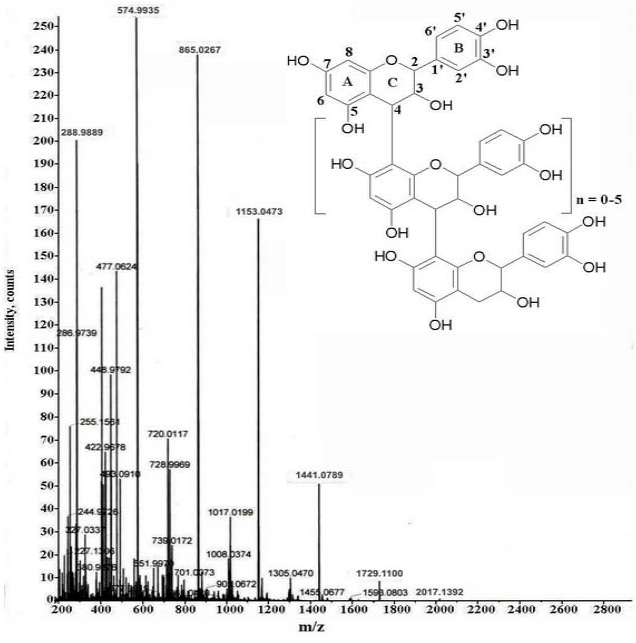

Fig.2. MS spectrum of proanthocyanidins from alder bark.

Acknowledgment: The financial supports from the EU Development Funding 2.1.1.1 "Support to Science Research" (Project Nr.2010/0241/2DP/2.1.1.1.0/10/APIA/VIAA/006), Latvian National Programme Nr.2010.10-4/VPP-5 and Latvian Research Grant 1547 are gratefully acknowledged.

Coagulation of Biomass from the Model Wastewater by Polyethyleneimine

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Skaidrite Reihmane, (*Riga Technical University)*

***Keywords* – coagulation, wastewater, biomass, polyethyleneimine.**

I. Introduction

The first stage of the veneer production is wood hydrothermal treatment in special basins. As a result the wastewater of the basins of the wood hydrothermal treatment is dramatically polluted with low molecular lignin fragments, hemicellulose fragments and wood extractives (WB) [1]. These organic substances are responsible for the high chemical oxygen demand and the colour of wastewater of the wood hydrothermal treatment and have a considerable negative effect on the environment.

The aim of this work was to study the coagulation process of model wastewater biomass in the presence of polyethyleneimine.

II. Materials and Methods

Treatment of birch wood sawdust was performed in a weak alkaline water solution with the hydromodulus 1/50 at temperature of 90ºC for 4 h. The characteristic of model hydrolyzate imitating wastewater of wood processing is given in Table 1.

TABLE I
CHARACTERISTIC OF THE MODEL HYDROLYZATE

pH	9.02
content of dry solids	1400 mg/l
colority	746 mg/lPt
chemical oxygen demand (COD)	1285 mg/l

For coagulation polyethyleneimine (PEI) with molecular weight $7.5 \cdot 10^4$ was used that was obtained from Sigma-Aldrich. Optimal conditions of biomass coagulation from the model hydrolyzate were searched in a PEI dosage range 7 – 140 mg/l and in a pH interval of 3-10.

The selected polyethyleneimine dosage was added to model hydrolyzate. After the addition of the coagulant, the pH value of the mixture was adjusted, and it was stirred for a period of 1 min at 200 rpm, followed by slow mixing at 40 rpm for 2 min. The effectiveness of coagulation was defined after system settling time of 120 min and filtration.

The efficiency of biomass and lignin isolation from the model hydrolyzate was evaluated in the terms of removal of biomass, lignin, colority and permanganate index. The residual concentration of the biomass and lignin was defined, using the preliminary received correlation curves for the biomass and lignin.

COD and the colority of the filtrate were determined by ISO 15705 and LVS EN ISO 7887.

III. Results and Discussion

PEI coagulation efficiency highly depends on pH and dosage [2]. The percentage of total suspended biomass removal at various PEI dosages and pH are shown in Fig. 1. It can be observed that with increasing a PEI dose the optimal value of the coagulation pH increases. For example, at a dose 7mg/l the maximal precipitation occurs at pH 3.0, however, at a dose 70 mg/l, the maximal yield of the biomass takes place at pH 9.0.

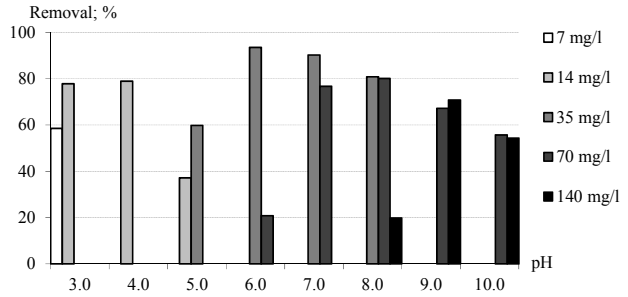

Fig.1. Total precipitated biomass from model hydrolyzate depending on PEI dosage and pH value

It was found that the maximal degree of purification is reached using PEI dosage 35 mg/l at pH 6 (Fig.2). Up to 93% of total biomass, 64% of lignin, 86% of colority and 41% of COD was reduced. In this medium the charge neutralisation mechanism between PEI and the biomass components with formation of polyelectrolyte complexes in the form of insoluble and colloid particles occurs.

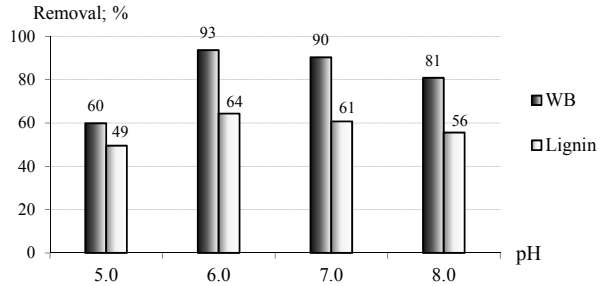

Fig.2. Biomass and lignin removal from model hydrolyzate at optimal dosage of PEI (35 mg/l)

Higher efficiency of the PEI as a coagulant may be governed by realising the hybrid mechanism of the biomass components precipitation, which includes their coagulation, following the pattern of charge neutralisation, and its flocculation, following the pattern of bridge formation, taking into account its high molecular mass.

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Composition of Birch Bark Extracts Depending on the Solvent Type

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***Keywords* – Outer birch bark, solvent extraction, triterpenes.**

I. Introduction

Birch is a very widespread tree genus, which is extensively used in the furniture, pulp and plywood manufacture where, as a by-product, it accumulates birch bark (BB) in the process, which does not find industrial application, and is often burned as fuel. BB comprises about 12.5 wt.% of the tree mass. Outer BB actually consists of a mixture of pentacyclic triterpenes (35–40 wt.%) and biopolyester suberin (45 wt.%) [1]. Betulin, betulinic acid and lupeol (Fig. 1), representatives of triterpenes, are biologically active substances, whose efficiency can be enhanced by synthetic modification. Betulin in the outer BB powder form is used in folk-medicine as an anti-inflammatory agent. Its derivative, betulinic acid, features properties, regulating the development of live cells, which transform the metabolism process in malignant tumour cells in the self-annihilation direction. Betulinic acid selectively kills human melanoma cells while leaving healthy cells intact and is found to delay the progression of the HIV 1 infection, which eventually leads to AIDS, by preventing the formation of syncytia [2, 3].

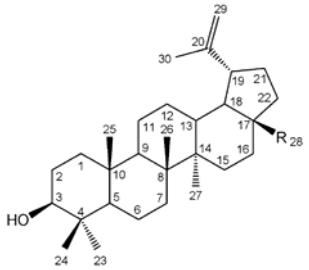

Fig.1. Chemical structure of lupeol, betulin and betulinic acid.

II. Materials and Methods

Freshly isolated BB, left over at a plywood factory, was chosen as a representative of industrial waste.

Milled (≤ 2 mm) and dried (moisture content of 2–4 wt. %) BB extraction was carried out in Soxhlet apparatuses by the selected solvents (ethanol - water mixtures in the range of 75 to 95 vol%, acetone, cyclohexane, heptane, chloroform and dichloromethane) up to 11 h. The components were identified with gas chromatography/mass spectroscopy by comparison of the spectra with those of the standards.

III. Results and Discussion

The properties and composition of BB were evaluated to gain information for selecting a technology, convenient for obtaining triterpenes. Laboratory experiments by making use of Soxhlet apparatuses demonstrated good and almost equal solvent properties of ethanol-water mixtures in the range of 75 to 95 vol%. However, the more diluted ethanol demonstrated a lower intensity of the extraction process (Fig. 2), but the yield of the extractives levelled off after 8 h. After 11 h, 85% ethanol gave the highest yield of the dry extract (Table 1).

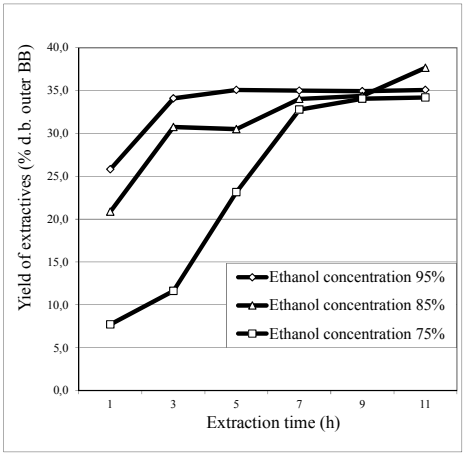

Fig.2. Effect of the extraction time and concentration of ethanol on the yield of extractives.

The yield of cyclohexane and heptane extractives was considerably lower than that in the case of acetone and ethanol, but the betulin content was the highest.

TABLE I

YIELD AND COMPOSITION OF OUTER BB EXTRACTIVES DEPENDING ON THE SOLVENT TYPE (SOXHLET APPARATUS, 11 H)

Solvent	Content of total extractives (% d.b.)	Betulin content (% d.b. extractives	Lupeol content (% d.b. extractives)
95% ethanol	35.1	61.7	6.0
85% ethanol	37.7	59.6	4.0
75% ethanol	34.2	60.7	3.8
Acetone	39.5	73.6	6.0
Cyclohexane	25.0	86.3	8.5
Heptane	11.5	86.8	4.8
Chloroform	33.3	73.0	7.5
Dichloromethane	33.0	64.5	6.7

However, the more selective solubility eliminated the amount of undesirable substances, e.g., polyphenols, tannins, etc. from the total extract.

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Assessment of Antioxidant Activity of Oligomeric Phenolic Compounds Isolated from Wood Bark Using Different Testing Methods

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Keywords **– Alder, bark, extract, oligomeric polyphenolic compounds, proanthocyanidins, antioxidant activity, ABTS$^{\bullet+}$, DPPH$^{\bullet}$, ORAC.**

I. Introduction

The usage of renewable natural resources for obtaining of new products, becomes increasingly urgent. Recently much attention is being paid to the usage of hardwood biomass for production of new products due to small increase in the growth dynamic of the soft broad-leaved trees in last years. The hardwood bark has a big potential as a source for obtaining of oligomeric poliphenolic compounds (proanthocyanidins-PAC). The schematic stucture of PAC is shown in Figure 1. Oligomeric poliphenolic compounds (OPC) are a class of secondary metabolites with pronounced biological activities found in many plants.

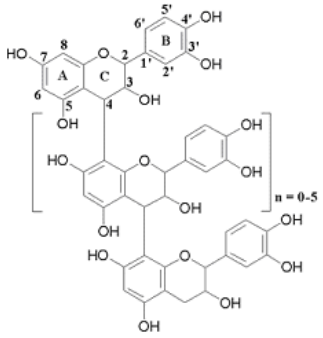

Fig.1. Structures of the proanthocyanidins

As a component in dietary fibers, OPC can inhibit activity of enzymes related to generation of superoxide anion radicals and even obstruct the growth of cancer cells. Comparing with low-molecular antioxidants, efficiency of OPC as a stabilizer of various materials/products can be higher, due to lower volatile ability and lesser toxicity. The aim of the present work was assessment of antioxidant activity of oligomeric phenolic compounds isolated from bark of grey alder (*A, incana*), black alder (*A. glutinosa*) and pine (*P. sylvestris*) trees grown in Latvia. For this purpose two free radical scavenging assays and the antioxidant capasity assay (ORAC) were used.

II. Materials and Methods

The barks samples were collected from a forest in the East-South part of Latvia. Samples were sequentially extracted with an solid-liquid fluidized bed extractor (IKA) using solvents of increasing polarity: hexane, ethyl acetate and, finally, aqueous ethanol (1:1, v/v). Ethanol was removed under vacuum and the remaining aqueous solutions were freeze-dried. The total amount of extractives was determined gravimetrically. PAC content was measured by buthanol–HCl method using procyanidin dimer B2 (Extrasynthese) as a reference compound. PAC were purified from non-tannin phenolics using Sephadex LH-20. The radical scavenging activity was evaluated, using ABTS$^{\bullet+}$, DPPH$^{\bullet}$ and peroxyl radical absorbance capacity (ORAC) assays. Water soluble E vitamin analog - Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) was used as a reference standard. The radicals' inhibition values were plotted as a function of the antioxidant concentration. From the graphs the antioxidant concentration needed to obtain 50% inhibition was determined and defined as IC_{50}. According to the definition, higher antioxidant activity results in lower value of IC_{50}.

III. Results and Discussion

The yields of hydrophilic extractives in the bark varied between 12-18 % on bark dry mass. The total content of polyphenol compounds (PC) in the ethanol-water extracts of grey alder, black alder and pine were 39.4%, 45.5% and 42.7%, respectively. The content of PAC in the studied barks varied between 24 – 40% of extracts. The PC also revealed considerably high antioxidant activity (table 1).

TABLE I
RESULTS OF PAC ANTIOXIDANT ACTIVITY ASSESSMENT USING THE DPPH$^{\bullet}$ AND ABTS$^{\bullet+}$ AND ORAC TESTING METHODS

Samples	IC_{50}/ ABTS●+ mg/l	IC_{50}/ DPPH● mg/l	ORAC µmol TE/g of PAC
PAC from black alder	1.4	3.0	4853
PAC from grey alder	3.3	6.9	5310
PAC from pine	n.d.	n.d.	5987
Trolox	4.0	4.7	3985

The radical scavenging activities of all proanthocyanidins samples were high in the three test methods used and close/higher to that for the reference compound Trolox.

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Acknowledgment: The research was financially supported by Latvian National Program Nr. 2010.10-4/VPP5 subproject "High value added functional products and chemicals from bark", LSC grant 09.1547 and the European Social Fund within the project "Support for Magister Studies at University of Latvia".

Separation of Cobalt(II) and Nickel(II) by Liquid Membranes during Electrodialysis

Tatiana Sadyrbaeva (*Institute of Inorganic Chemistry*)

Keywords: **tri-*n*-octylamine, trialkylbenzylammonium chloride, separation of Co(II) and Ni(II), liquid membrane, electrodialysis.**

I. Introduction

Separation of cobalt and nickel is of great practical value. Anion-exchange extraction by tertiary amines and quaternary ammonium salts can be used for Co(II) and Ni(II) separation in HCl solutions, nickel(II) exists as cations, whereas cobalt(II) partially forms anionic chlorocomplexes [1]. The liquid membranes containing amines were used by the author for effective separation of Pd(II) from Cu(II), Fe(III) and Ni(II) [2], separation of Pt(IV) from iron(III) [3]. The aim of the present work is to study the membrane extraction of cobalt(II) from binary hydrochloric mixtures with nickel (II) by bulk liquid membranes, containing tri-*n*-octylamine (TOA) or trialkylbenzylammonium chloride (TABAC) in 1,2-dichloroethane, during galvanostatic electrodialysis and to find out optimal conditions for metal separation.

II. Materials and Methods

The experiments were carried out in a five-compartment Teflon electrodialysis cell in the system:

(−) Pt H_2SO_4	$CoCl_2$ $NiCl_2$	Liquid membrane	HCl	H_2SO_4 Pt (+)

The liquid membrane (thickness 0.5 or 0.8 cm, surface area 7.1 cm^2) was separated from the aqueous solutions by two vertical cellophane films. The cathodic solution was separated from the feed solution by the solid anion exchange membrane MA-40. The anodic solution was separated from the strip solution by the solid cation exchange membrane MK-40.The direct electric current was supplied to the plane platinum electrodes. The feed solution contained as a rule 0.01 M $CoCl_2$ and 0.01 M $NiCl_2$ in 3−4 M HCl.

III. Results and Discussion

It was found out that the application of an electric field allows transferring cobalt(II) through the TABAC-based liquid membranes selectively over nickel(II).

TABLE I

Effect of current density and HCl concentration in the feed solution on the stripping degrees S, flux J and separation factor β

(C_{TABAC} = 0.01 M; strip solution – 0.1 M HCl; l_m = 0.8 cm)

i, mA/cm^2	t, min	C_{HCl}, M	S_{Co}	S_{Ni}	$J_{Co}\cdot10^6$, mol/(m^{2}s)	$\beta_{Co/Ni}$
			%			
8.5	133	3.0	11	0.1	2.6	110
9.9	127	3.0	13	0.09	3.2	145
11.3	111	3.0	11	0.09	3.2	122
3.5	210	6.0	14	0.11	2.0	127
5.0	170	6.0	14	0.35	2.6	40
8.5	110	6.0	12	0.12	3.2	100
8.5	180	1.0	0.5	0.04	0.09	13

TABLE III

Effect of aqueous solutions and liquid membrane composition upon the membrane extraction and separation of metals

(i = 8.5 mA/cm^2; t = 90 min; C_{HCl} = 4.0 M; l_m = 0.5 cm)

C_{Co}	C_{Ni}	C_{TOA}	strip solution (0.5 M)	S_{Co}	S_{Ni}	$J_{Co}\cdot10^6$, mol/(m^{2}s)	$\beta_{Co/Ni}$
M				%			
$5\cdot10^{-3}$	0.01	0.1	HCl	11	0.2	1.9	48
0.01	0.01	0.1	HCl	13	0.3	4.3	45
0.05	0.01	0.1	HCl	12	0.05	20	240
0.1	0.01	0.1	HCl	12	< 0.03	40	> 400
0.01	$5\cdot10^{-3}$	0.1	HCl	11	0.6	3.9	18
0.01	0.05	0.1	HCl	11	0.06	3.7	190
0.01	0.1	0.1	HCl	10	0.03	3.5	330
0.01	0.01	0.2	HCl	12	0.2	4.0	56
0.01	0.01	0.3	HCl	10	0.2	3.5	45
0.01	0.01	0.1	H_2SO_4	16	0.3	5.3	58
0.01	0.01	0.1	$HClO_4$	11	0.2	3.6	48
0.01	0.01	0.1	HNO_3	11	0.2	3.6	50

Maximum separation factor of 145 is obtained in the system containing equimolar mixture at the current density of 9.9 mA/cm^2 (Table 1). The cobalt(II) transport rate increases as the current density and HCl concentration in the feed solution (1.0 − 6.0 M) increase.

When TOA solutions were used as the liquid membranes, selectivity of Co(II) transfer was lower if compared with TABAC solutions. The increase of cobalt(II) content in the feed solution from $5\cdot10^{-3}$ to 0.1 M leads to a sharp rise of the metal flux and to an increase of the transport selectivity, whereas the Co(II) stripping degree practically does not vary (Table III). The maximum separation factor > 400 was achieved for a system containing 0.1 M $CoCl_2$. The increase of nickel(II) concentration in the feed solution up to 0.1 M results in a decrease of nickel(II) stripping degree and a rise of separation factor up to 330, whereas the cobalt(II) flux and stripping degree insignificantly reduce.

The increase of TOA concentration in the liquid membrane from 0.1 to 0.3 M leads to some reduction of cobalt(II) transfer rate and of stripping degree. Composition of the strip solution does not exert significant influence on the membrane extraction of cobalt(II). The transfer of Co(II) proceeds with an approximately equal rate into 0.5 M solutions of sulphuric, nitric, hydrochloric, perchloric acids.

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Activity of CuO, $CuO-CeO_2$, $CuO-La_2O_3$ / Al_2O_3 Systems for Total Catalytic Oxidation of VOCs

Aurimas Urbutis and Saulius Kitrys (*Kaunas University of Technology*)

Keywords **– VOC, catalytic oxidation, activity.**

I. Introduction

Emission of volatile organic compounds (VOCs) from industrial pollution sources is a major concern worldwide. Strict environmental requirements demand low emissions of pollutants. This can be achieved by several ways of VOCs decontamination: adsorption, combustion, catalytic oxidation [1]. Catalytic oxidation is the most convenient and effective process. This process can be carried out under different conditions: stationary process or by using adsorbent-catalyst, which is a material representing adsorptive and catalytic properties in a heterogeneous system. The second type of catalytic process consists of two steps: the first step is the adsorption of VOCs from the flow, the second - thermal regeneration of adsorbent-catalyst and catalytic oxidation of VOCs [2, 3]. Effective operation of adsorbent-catalyst depends on appropriate support selection and active component.

Support selection studies were discussed elsewhere [4]. Activity of (CuO, $CuO-CeO_2$, $CuO-La_2O_3$)/Al_2O_3 systems for total catalytic oxidation of methanol and methyl acetate was evaluated in this research.

II. Experimental

Analytically and chemically pure reagents were used in this research. Catalysts were synthesized by conventional co-impregnation method, which is a general technique for the production of heterogeneous catalyst. Industrially produced aluminum oxide pellets were impregnated with Cu^{2+}, Ce^{3+} and/or La^{3+} nitrate solutions of desired concentration. Impregnated alumina was dried and calcined to drive off the volatile components, depositing CuO, CeO_2 and/or La_2O_3 on the surface of support.

Activity of three different catalysts was tested in the fixed bed quartz reactor under isothermal conditions. Concentrations of methanol and methyl acetate were determined by using *Perkin-Elmer Clarus 500 GC/MS* system. Reactor inlet concentrations of methanol and methyl acetate were in range of 771-1091 mg/m^3 and 2832-3118 mg/m^3, respectively. Conversion α (%) was calculated using the following equation:

$$\alpha = \frac{100 \cdot (C_{inlet} - C_{outlet})}{C_{inlet}} \quad (1)$$

III. Results and Discussion

Synthesized catalysts CuO/Al_2O_3, $CuO-CeO_2/Al_2O_3$ and $CuO-La_2O_3/Al_2O_3$ were used for total methanol and methyl acetate oxidation.

As seen in Fig. 1, CuO catalyst promoted with ceria exhibited the highest activity in the oxidation of methanol. $CuO-La_2O_3/Al_2O_3$ catalyst was less effective than CuO/Al_2O_3. The lower reactivity can be attributed to the higher calcination temperature (600 °C). $La(NO_3)_3$ decomposes to La_2O_3 at 570 °C [5]. Due to lower decomposition temperatures of $Cu(NO_3)_2$ and $Ce(NO_3)_3$ [2, 6], CuO/Al_2O_3 and $CuO-CeO_2/Al_2O_3$ were obtained at 450 °C.

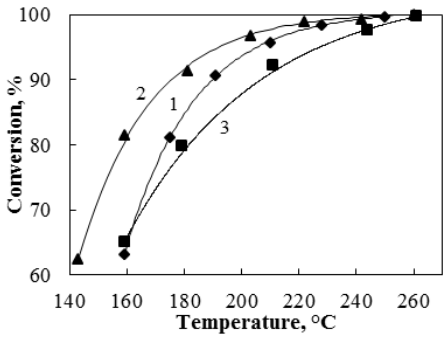

Fig.1. Methanol oxidation over supported catalysts: 1 - CuO/Al_2O_3; 2 - $CuO-CeO_2/Al_2O_3$; 3 - $CuO-La_2O_3/Al_2O_3$. F/W = 4500 ml·g^{-1}·h^{-1}.

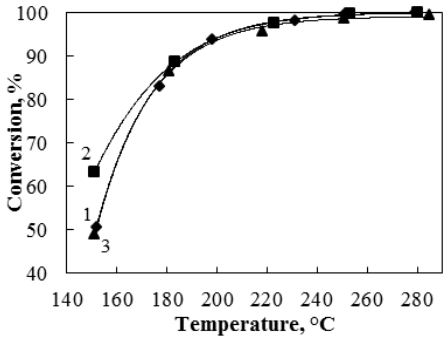

Fig.2. Methyl acetate oxidation over supported catalysts: 1 - CuO/Al_2O_3; 2 - $CuO-CeO_2/Al_2O_3$; 3 - $CuO-La_2O_3/Al_2O_3$. F/W = 4500 ml·g^{-1}·h^{-1}.

However, as seen in Fig. 2, CuO/Al_2O_3 and $CuO-La_2O_3/Al_2O_3$ catalysts exhibited almost the same activity in the oxidation of methyl acetate. Though, $CuO-CeO_2/Al_2O_3$ performed better at lower temperatures, which is a key to use CuO promoted with CeO_2 in synthesis of adsorbent-catalyst for total oxidation of VOCs.

IV. Conclusions

Activities of CuO/Al_2O_3, $CuO-CeO_2/Al_2O_3$ and $CuO-La_2O_3/Al_2O_3$ catalysts were evaluated in the oxidation of methanol and methyl acetate. Compared to the other synthesized catalysts, $CuO-CeO_2/Al_2O_3$ exhibited the highest efficiency. Also it is worth to mention that CuO promoted with CeO_2 and supported on Al_2O_3 performed better at lower temperatures. The influence of different CuO and CeO_2 loadings for the oxidation of VOCs will be investigated in subsequent studies.

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Liquid Fertilizer with Amino Acids

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***Keywords* – liquid fertilizers, microelements, amino acids, properties.**

I. Introduction

Intensification of agriculture requires using not only effective mineral fertilizers containing macro and microelements, but also physiologically active substances, growth stimulants. In the past years, much attention was given to testing various synthetic and natural physiologically active substances as growth stimulants: citric acid, humates, amino acids, etc. The use of amino acids is most often recommended under critical conditions of plant growth: after transplantation, in the flowering period, and also at climatic stresses (night frosts, drought) or plant diseases 1]. Amino acids are particularly effective in fertilizers when used in combination with microelements.

In this study we examined the physicochemical properties of the amino acids concentrate and its effect on the main properties such as density, temperature of crystallization and viscosity of liquid fertilizers 14–7–7.

II. Methods and Materials

Liquid complex fertilizers (LCF) 14–7–7 (NKP) grade were produced using raw materials from industry (Arvi and Co): ammonium polyphosphate solution 11–37–0, potassium nitrate 14–0–46, urea 46–0–0, microelement concentrate "Mikromix" (ME), amino acids concentrate (AAC) and distilled water. As the AAC we used Naturamin-WSP product (DAYMSA, Spain). Content of ACC was given by us in the previous studies [2]. Content of microelements in "Micromix" was (%): 5.8 Fe, 2.1 Mn, 1.0 Zn, 0.3 Cu, 0.1 Mo and 1.2 B.

The content of nitrogen (N), phosphorus (P) and potassium (K) and physical properties of the liquid complex fertilizers was determined by standard methods [3].

III. Results and Discussion

For production of liquid complex fertilizers 10 % solution of AAC and 10 % solution of "Micromix" were produced and physicochemical properties were determined (Table I).

Table I

Physicochemical properties of ACC and ME solution

10 % Solution	ACC	ME
pH	5.10	4.55
Temperature of crystallization [°C]	-2.0	-1.0
Density [g/cm^3]	1.036	1.063
Viscosity [mm^2/s]	1.468	–
Refraction index	1.352	–

Liquid complex fertilizers 14–7–7 were produced in the laboratory. The "Micromix" content in LCF was equal 0.8 % and Naturamin-WSP was change from 2 % up to 8 %. Produced LFC were kept for 3 days at room conditions and the physicochemical properties of LCF and LCF with AAC and "Micromix" were determined. The measured data are presented in Table II.

Table II

Physicochemical properties of LCF, LCF wit AAC and wit 0.8 % ME

Concentration of ACC [%]	0	2	4	6	8
pH	6.54	6.51	6.50	6.48	6.47
Density [g/cm^3]	1.266	1.268	1.277	1.285	1.300
Viscosity [mm^2/s]	2.173	2.282	2.613	2.890	3.635
Refraction index	1.409	1.411	1.416	1.421	1.427

As shown in Table II the physicochemical properties of LCF, such as pH, viscosity, density, refractive index directly depend from concentration of Naturamin-WSP.

Naturamin-WSP contains 12.8 % of nitrogen and depending from amino acids concentration in liquid complex fertilizers total concentration of nitrogen is increased. For example, when LCF contains 8 % of Naturamin-WSP, a grade of LCF is equal 15–7–7. This indicator of LCF is very important on temperature of crystallization. Dependence the temperature of crystallization from concentration of Naturamin-WSP is shown in the Fig 1.

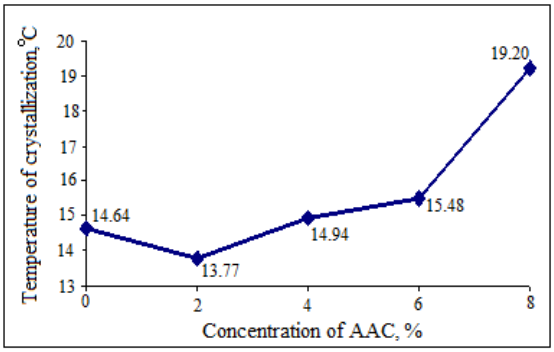

Fig.1. Influence ACC concentration on temperature crystallization.

It is shown, when concentration of AAC is equal 2 % of LCF, temperature of crystallization decreased from 14.64°C up to 13.77°C. When concentration of AAC increased from 2 % up to 8 %, temperature of crystallization also increased up to 19.20°C. It can be argued that the low concentration of AAC has a positive influence on properties of liquid complex fertilizer.

IV. Recommendations

Amino acids concentrate Naturamin-WSP as a physiological active component may be used for enriching liquid complex fertilizers. The physicochemical properties of LCF with AAC vary slightly and will correspond to requirements of fertilization.

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Influence of Activated Carbon Additive to the Parameters of Specific Surface of Catalyst Support

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Keywords **– alumina, activated carbon, specific surface.**

I. Introduction

In recent years the physical and mechanical properties of catalyst surface are have gained a significant interest. As it has high specific surface area, activated carbon can be used as the support in the production of adsorbents-catalysts alas it is not thermally resistant. Therefore it is more suitable to use catalysts with are based on Al_2O_3.

Al_2O_3-C_{act}-(CuO-Cr_2O_3-Co_3O_4) catalyst prepared by sol-gel method was characterized by higher thermal stability than activated carbon [1]. Also 5 % (wt.) additive of activated carbon improved adsorption capacity of the catalyst for alcohol vapours. The activity of above-mentioned catalyst in the oxidation reactions of methanol vapours was α = 47.4 %. The aim of this research was to determine the influence of activated carbon to the surface parameters of Al_2O_3 support.

II. Experimental

The specific surface area was measured by a BET surface area analyzer "Quantasorb" (Quantachrome, USA). The surface area, total pore volume and pore size distribution of a sample were determined by employing the techniques of adsorbing the adsorbate gas (N_2) from a flowing mixture of adsorbate and an inert non-adsorbable carrier gas (He) at 77 K. The specific surface area of adsorbent was calculated by the BET equation [2] using the data of the lower part of N_2 adsorption isotherm ($0.05 < p/p_0 < 0.35$):

$$\frac{1}{X(\frac{p_0}{p}-1)} = \frac{1}{X_m C_{BET}} + \frac{C_{BET}-1}{X_m C_{BET}} \cdot \frac{p}{p_0},$$

where X is the mass of adsorbate, adsorbed on the sample at relative pressure p/p_0, p – the partial pressure of adsorbate, p_0 – the saturated vapour pressure of adsorbate, X_m – the mass of adsorbate adsorbed at a coverage of one monolayer, C_{BET} is a constant which is a function of the adsorbate condensation and heat of adsorption. The total pore volume and pore size distribution were calculated according to the corrected Kelvin equation and Orr, Dalla Valle scheme using entire N_2 desorption isotherm at 77 K.

III. Results And Discussion

Clear arch is seen in isotherms of hysteresis (Fig. 1 A), which shows that N_2 monomolecular layer has formed. Linear BET plots for both samples were obtained and their R^2 are 0.99. The results show that S_{BET} = 280.43 m^2/g for Al_2O_3-C_{act} is about ten times higher as compared to S_{BET} = 30.67 m^2/g for Al_2O_3. Also the calculated value of C_{BET} = 337.83 for Al_2O_3-C_{act} is higher than 250 and it was conditioned by additive of microporous activated carbon.

It is possible to predict the pore form of adsorbents according to de Boer classification of hysteresis isotherms. Slit-like pores are typical to the produced Al_2O_3. The phenomenon of hysteresis ends at low relative pressure of p/p_0 = 0.24, isotherm is narrow and sharply rises. The form of dominant pores is changed by addition of activated carbon: typical spherical forms appear alongside the slit-like pores. Spherical forms of pores prevail and this is indicated by broad bands of hysteresis when p/p_0 = 0.6 – 0.95.

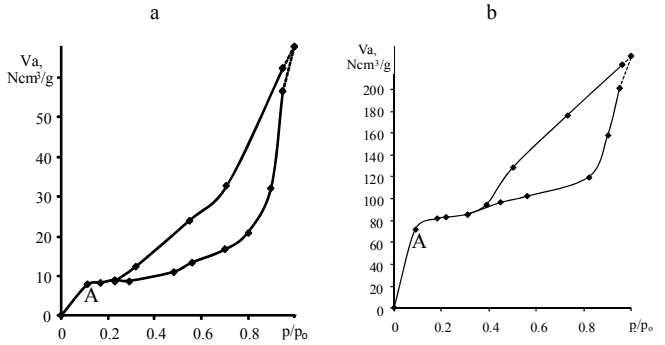

Fig.1. N_2 Adsorption-desorption isotherms at 77 K: *a* – Al_2O_3; *b* – Al_2O_3-C_{act}

This approximate evaluation of the form of pores is supported by the comparison of S_{BET} results with the total specific surface ΣA, calculated according to scheme of C. Orr, J. M. Dalla Valle. It has been determined that S_{BET}= 30.67 m^2/g and ΣA = 73.5 m^2/g for produced Al_2O_3 also S_{BET} = 280.43 m^2/g and ΣA = 239.1 m^2/g for Al_2O_3-C_{act}. These results show that we have evaluated the form of pores of Al_2O_3-C_{act} adsorbent rather accurately, while Al_2O_3 can be characterized by the polydispersal structure when the slit-like pores are supplemented by the capillaries of bigger radius. These assumptions are confirmed by the calculations of integral and differential distribution of pores according to their diameters (Table I). The pores of 16 – 20 Å radiuses prevail in Al_2O_3-C_{act} adsorbent, and there are not much of pores of other radii. Contrarily, Al_2O_3 has the pores of 10 – 15 Å and 25 – 45 Å radii.

TABLE I

PARAMETERS OF SPECIFIC SURFACE OF ADSORBENTS

Adsorbent	Mean radius of pores $\overline{r}_p$, Å	Total volume of pores ΣV_p, cm^3/g	Total surface area calculated according to hysteresis isotherm ΣA, m^2/g
Al_2O_3	32.13	0.118	73.5
Al_2O_3-C_{act}	20.02	0.332	239.1

IV. Conclusions

The 5 % addition of activated carbon increased the specific surface area of catalyst support about 10 times. Also Al_2O_3-C_{act} can be characterized by smaller size spherical pores which account for its higher total volume.

V. References

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Characterization of Mo-O-Se Films Prepared by Electrodeposition

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Keywords **– Electrodeposition, thin Mo-O-Se film, XPS analysis, optical properties.**

I. Introduction

Se doping in transition metal oxides has recently been explored as means for improving energy storage properties whereas Se doped transition metal oxides is a promising candidate for use in photovoltaic applications [1]. The electrosynthesis of nanometric Mo-O-Se materials and their applications in a wide variety of technologies are just beginning to generate a tremendous interest. MoO_2 possesses the metal-like electrical conductivity [2] and its doping with Se could produce potential semiconductor for solar cells.

In this study Mo-O-Se films obtained by electrodeposition have been characterized for their composition, morphology and optical properties.

II. Experimental

The Mo-O-Se films were synthesized on Se pre-deposited SnO_2|glass plate as reported in our previous paper [3].

X-ray diffraction analysis was carried out under a Bragg-Brentano geometry on a diffractometer Dron-3.0 using the CuKα radiation. A Kratos Axis Ultra X-ray photoelectron spectroscopy system and CasaXPS software were used to determine the elemental composition of thin films. Atomic force microscopy was performed using the Asylum Research MFP-3D AFM instrument and a rectangular silicon cantilevers (NSC15/Al BS). The spectra of films were recorded using a UV–VISIBLE Spectronic Genesis spectrophotometer Perkin Elmer Spectrum GX. The spectra were taken using the SnO_2|glass plate as a reference.

III. Results and Discussion

AFM images of films show a transition between amorphous MoO_2 film (Fig.1 S_2) and well defined particle size Mo-O-Se films (Fig.1 Se_3 and Se_4). The root means square roughness values of Se and MoO_2 film were 4.1 and 8.9 nm, respectively, while for Mo-O-Se films it increased up to 50 nm.

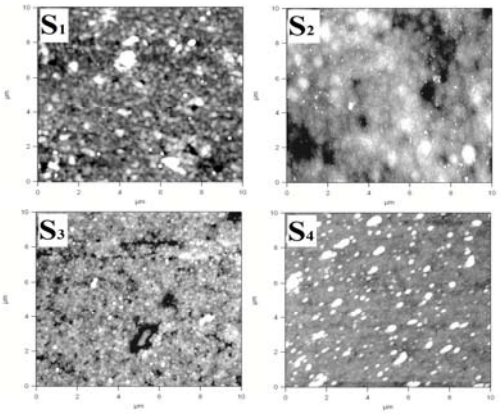

Fig.1. AFM images of obtained films. Sample labeling and deposition conditions are given in Table 1.

The characterization of Mo-O-Se films by XRD analysis revealed their amorphous nature.

A predominant species in all XPS spectra with $Mo3d_{5/2}$ peak located at 229.3 eV was assigned to Mo(IV) in MoO_2. This was the majority product found in all Mo-O-Se films synthesized after surface layers were removed. Se3d binding energy of Se(0) in pure selenium film was 54.6 eV and shifted to higher value of 55.2 eV in Mo-O-Se films. The quantitative information on XPS results is summarized in Table 1.

TABLE I

Results of XPS characterization of Mo-O-Se films electrodeposited in 0.2M Na_2MoO_4 + 0.22 M $C_6H_5Na_3O_7$ at 20 °C

Sample No.	Deposition conditions	Composition at., %			Compounds found in film
		Mo3d	O1s	Se3d	
S_1	*	-	6.85	93.15	Se
S_2	E= 1.0 V, τ = 30 min	33.56	66.44	-	MoO_2
S_3	E= 1.0 V, τ = 5 min	18.59	39.1	42.31	MoO_2-Se
S_4	E= 0.9 V, τ = 10 min	36.75	59.37	3.88	MoO_2-Se

Se*- electrodeposited on SnO_2|glass plate in 0.01 M H_2SeO_3 + 0.22 M sodium citrate electrolyte. j_c = 0.222 mA·cm^{-2} for 10 min.

The optical constants of Mo-O-Se film were determined from transmittance spectra applying Tauc model. The films are highly absorbing and show a direct band to band transition. Obtained optical constants were compared to these of Se (S_1) and MoO_2 (S_2) films (Table 2).

TABLE 2

Optical Constants of Se, MoO_2 and Mo-O-Se film

Sample No.	Thickness, nm	α x 10^{-4}, cm^{-1}	E_g, eV	E_U, eV	B
S_1	90	16.6	3.64	0.47	0.23
S_2	100	4.36	2.53	0.24	59.4
S_3	130	4.77	2.88	0.83	81.0

IV. Conclusions

The Mo-O-Se films prepared by electrodeposition were amorphous and composed of MoO_2 and Se.

The films showed a direct band to band transition and the band gap value of these films decreased from pure selenium (3.64 eV) to pure MoO_2 (2.53 eV).

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Effect of Chemical Treatment of Illite Clay on Phase Composition and Properties of Ceramic Products

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Keywords **– illite clay, chemical treatment, properties.**

The deposits of clays are one of the dominating parts of mineral raw materials of the Phanerozoic sedimentary cover of Latvia. Quaternary clay deposits mostly are of glacial origin and were formed in the glacial melt water basins. The clay minerals dominate by 2:1 lattice mineral - illite (75- 90%) with admixture of chlorite and kaolinite.

The ability to attain the geopolymers of alumosilicate lattice minerals by proper mix with alkaline solution is well documented [e.g. 1]. The mainly used in the preparation of geopolymers is 1:1 layer lattice alumosilicates – kaolinite. Attempts to produce a complete reaction of alumosilicate geopolymers from 2:1 lattice mineral - pyrophillite have been unsuccessful. Dehydroxylation of pyrophillite at 800^0C produces significant changes in the Al coordination, but does not form a viable geopolymer. It was suggested that inability to form viable geopolymers may be due to the retention of the crystalline 2:1 layer structure in pyrophillite and its dehydroxylated phase.

Investigations on illite-smectite clay and its possible reactivity for geopolymers are less known of.

The present study investigates of alkali activated not dehydroxylated illite clay for low temperature ceramic products, characterized by bulk, density, shrinkage, open porosity and compressive strength.

Quaternary clay samples taken in the Laza pit (Latvia) and KOH 1M to 6M KOH solution were the starting materials for treatment of clay.

For each treated clay part XRD, IR-spectra, DTA as well as compressive strength measurements and ceramic properties for sintered samples were determined.

It is shown that by chemical treatment XRD reflections of illite and weakly pronounced from kaolinite is somewhat reduced with an increase of concentration of used KOH solution. Relatively small changes can be observed also for quartz, dolomite and calcite.

Compressive strength of ceramic samples grows with the sintering temperature ranged from 300 to 600 ^{0}C (Fig.1) and remarkably for the ceramics treated by 3M to 6M alkali solution. It is believed that for chemical treated clay samples in this temperature range remarkably amorphous (glassy) phase to promote increase of strength increases as well. The impact of molar concentration of KOH solution in range of 1M to 4M on presence of pores of sintered samples is relatively negligible; the sintering temperature is of a more significance (Fig.2.)

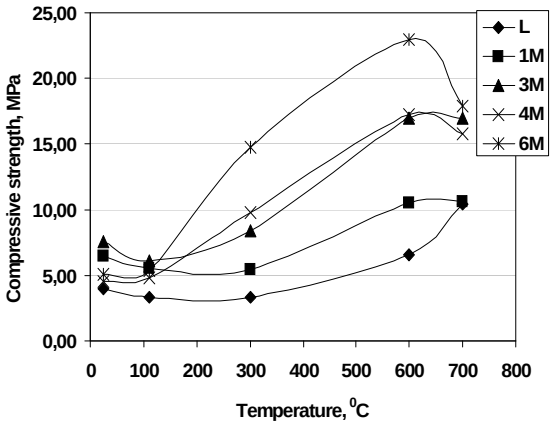

Fig.1. Relationship of compressive strength and molar concentration of KOH solution by sintering of ceramic samples.

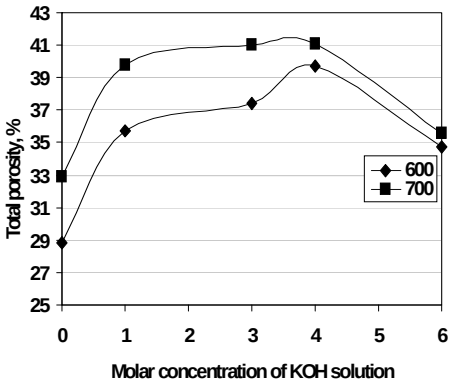

Fig.2. Total porosity dependence for sintered at 600 and 700ºC samples on molar concentration of KOH solution.

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Investigation of Relationships: Microstructure, Mechanical Properties and Chemical Resistance of High Performance Concrete

Janina Setina, Julija Petrova, Linda Krage and Janis Baroninsh *(Riga Technical University)*

Keywords **– high performance concrete, super plasticizer, compressive strength, mineralogical composition, porosity chemical resistance.**

I. Introduction

High performance concrete (HPC) and Ultra high performance concrete (UHPC) are modern perspective building materials, which are increasingly used in civil engineering. The main characteristics of new materials are high mechanical strength and long-term performance [1,2]. The objective of this study is to provide some experimental data that could be useful in engineering practice in order to produce HPC using conventional constituents and ordinary mixing and curing practices. The influence of the polycarboxylates based super plasticizer (SP) "Semflow MC" at dosages 1.0%, 1.5%, 2.5% by weight of cement to microstructure and properties of HPC was investigated.

II. Materials and Methods

In the frame of given study three groups of HPC samples with additive of 1.0%, 1.5%, 2.5% SP by weight of cement were produced and compared. The recipe of HPC is summarized in Table I.

TABLE I
RECIPE OF HPC

Material	Density, kg/m^3	Dosage, kg/m^3
Cement "Aalborg White" CEM I 52.5 N	3150	650
Sand "SaulkalneS"	2640	538
Granite fines "Nybrogrus AB"	2700	1021
Microsilica "Elkem-microsilica-920 D"	2400	100

SP was added to mixing water according to recipe.

The mineralogical composition of concrete specimens were analysed by X-Ray Diffraction using $Cu_{K\alpha}$ radiation in different depth.

Morphology of samples was observed using stereo microscope *Leica M420*. Porosity measurements were made by mercury porosimeter *Quantachrome Poremaster* with effective range from 0.01 to 1000 μm.

Absorption of water and solutions containing sulphate ions (0.25 M H_2SO_4, Na_2SO_4, $MgSO_4$ solutions) was tested. Chemical resistance was evaluated after the exposure of concrete in sulphate solutions for 12 months under static conditions.

III. Results and Discussions

The properties of fresh concrete as cone test as well as compressive strength after maturation of concrete increase with increasing amount of SP:

HPC 1.0 – 112.73 MPa;

HPC 2.5 – 154.04 MPa after 90 days.

After 12 months of exposure in water the compressive strength of concrete had increased by 11 %. This means that maturation process of concrete is still an active system.

The amount of capillary absorbed water and sulphate containing solutions of HPC depended on amount of SP; absorption of HPC 2.5 did not exceed 0.34%. The extent of penetration of solution in the samples decreased with the increasing amount of SP.

After 12 months exposure of HPC in sulphate containing solution the following was established: weight increase up to 1.70% due to carbonation and hydration processes could be observed in neutral solution; in the solution of sulphuric acid the weight loss up to 2.10 % due to aggressive action of acid and as a result of $Ca(OH)_2$ elution from concrete samples could be observed [3,4].

Analysing the formation of crystalline phase during maturation the following relationship was found: increasing testing time from 7 to 28 days decreased the amount of portlandite and calcium hydrosilicate is formed.

By X-Ray analysis in profile to a depth of 25 mm after exposure for 12 months in sulphate solutions, the following crystalline phases were detected: quartz, plagioclase, calcium silicates (hartrurite and tobermorite), less portlandite and carbonate. It was observed that after exposure such concrete minerals as tobermorite and hartrurite are still present. The corresponding salt (from solution) compounds were not identified in all depth of concrete. It could be regarded, that the investigated concrete has high chemical resistance to solutions containing sulphate ions.

The porosity of HPC samples varies linearly depending on the added amount of SP. After exposure in solutions the number of micropores increases (6.10^{-3}…10^{-2} μm) for all concrete samples but the pore distribution in range 500 to 1000 μm did not change.

IV. Conclusions

The obtained results indicate that workability of HPC has been increased significantly with the addition of SP.

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Porous Ceramic from Latvian Clays

Visvaldis Svinka, Ruta Svinka, Liga Dabare, Laimons Bidermanis and Andris Cimmers *(Riga Technical University)*

***Keywords* – Devonian and Quaternary Latvian clays, expanded clay, porous granules, sorption activity.**

I. Introduction

The clays are natural resources of Latvia. There are more 200 investigated clay deposits. Devonian and Quaternary clays are used by production of well-known materials such as ceramic bricks and blocks, pottery, etc. Production of porous clay ceramic is important economic sector with different practical using possibilities. In present work the new manufacturing technology of expanded clay and extended raw materials basis were investigated. The possible obtaining of highly porous thermal insulating material by casting of concentrated suspension was also investigated. Porous clay ceramic is an important material in the environment technologies by purification of water and air and by gathering of organic pollution

II. Materials and Methods

Devonian clay of deposits Liepa and Tuja are investigated as raw materials for the production of expanded clay granules in the one stage thermal treatment technology in opposition to two stages technology used today by manufacturing of expanded clay granules. Wood sawdust in amount of 2 vol% is used as combustible and pore formation agent by firing of granules. Granules are fast fired at temperature 1150 - 1200˚C depending on the clay type. Formed from plastic clay mass the dry granules are put in the kiln with a corresponding temperature. The holding time at this temperature is 10 min.

Devonian clay of deposit Liepa and Quaternary clays of deposits Lielauce and Spartaks are investigated for the possible producing of highly porous clay ceramic with good thermal insulating and filtration properties. Highly porous ceramic structure is formed in result of chemical reaction of metallic aluminium powder with water by pH of suspension ≥ 8 in the presence of clay minerals. .

Devonian clay of deposit Liepa and Quaternary clay of deposit Laza are investigated for obtaining of porous clay ceramic granules. From plastic mass by additive of 2 wt% of wood sawdust with Ø ≤ 2 mm formed granules are fired at various temperature in range 700 - 1050˚C by temperature rise 200˚C/h. Porosity, pore size distribution and specific surface area of granules are determined with mercury porosimetry (Quantachrome Instrument, USA), mineralogical composition is determined with X-Ray phase analyse (Rigaku Ultima+, Japan). Sorption properties of sintered granules are determined concerning to molecular and ionogenic inorganic substances in water solution by titrimetry method depending on the holding time factor in the solution.

III. Results

Expanded clay granules are important lightweight semi-finished material with good thermal insulating properties which are used for production of lightweight concrete. In the last 15 years expanded clay granules in Latvia are not produced. Classical approach of production of such granules provides two stage technology and the raw material is clay with content of clayey fraction ≥ 60 %. As the result of our investigation it was determined that production of expanded clay granules in one stage process is possible and basis of the raw materials which could be more lean clays. It is possible to regulate the expanding coefficient and bulk density of the granules depending on the conditions of thermal treatment.

The reaction of aluminium with water in the presence of kaolinite is well known from our previous works in field of porous high temperature oxide materials [1]. Latvian Devonian and Quaternary clays are illitic clay and contain kaolinite as secondary clay mineral in amount of 5 – 20 %. Formation of highly porous structure by solidification of clay suspension with additive of alumina and 0.1wt% of aluminium powder is investigated. Open porosity determined by hydrostatic weighing of sintered materials at temperature 800 - 1000˚C was 39 – 44 %. Porosity determined by mercury intrusion ws similar. Specific surface area determined by this method was enough large 10.3 – 22.9 m^2/g and depended from sintering temperature as well as clay type. Pore size distribution shows that the larger amount of pores are located in the 0.1 – 0.01 μm and covers a large specific surface area. Volume of pores depended on the sintering temperature and clay type.

Porous clay granules often are used as sorbent by purification of wastewater as well as air. In Latvia ceramic sorbent is imported mainly from Norway. Our investigations show that Latvian Devonian and Quaternary clays are usable for the production of porous ceramic sorbent. Sorption activity of granules are determined regarding to iodine, ammonia cation and chromate anion in water solution content. The best sorption activity all fired granules have regarding iodine. At the same time sorption activity depends on the firing temperature of granules. Granules fired at temperature 700 - 900˚C are much more porous (open porosity determined by mercury porosimetry 16.2 – 17.9 %). Firing of granules at temperature above 900˚C decreases the open porosity because the sintering process will be rapid and volume of pores as well as the specific surface area decreases. Granules obtained from Quaternary clay of deposit Laza and fired at temperature 700 - 900˚C during 10 days absorb all iodine fully. Sorption activity of granules produced from clay of deposit Liepa is lower and absorb till 95 % of iodine from solution. The sorption activity of obtained granules concerning to ammonia cation and chromate anion is considerably lower and absorb <6% and <3.2% respectively from starting amount.

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Swelling of Gelatin in Solutions Made on the Recipes of Folk Medicine

Tatjana Borisova (*Riga Stradin`s University*)

Keywords **– adsorption, swelling, aloe, sucrose, gelatin.**

I. Introduction

The attention of the author of this text was paid to the recipe "Syrup from the egg" in the book of folk doctor A. M. Tartak [1]. She recommends it against cataracta, especially at its beginning. Investigation of the Syrup and first results [2] follow us the necessity to soak gelatin into solutions of electrolytes and those made after a folk medicine recipes.

II. Experimental Part

Gelatin was taken as a model substance for swelling *in vitro* as collagen splitting product. The degree of swelling was accounted. Salting in and out ability was evaluated for NaCl, KCl, NH_4Cl, sugar, glucose solutions; onion sap, aloe sap, honey solutions. The dependences of swelling on the concentrations of electrolytes and substances: glucose, sucrose, aloe-emodin (swelling isotherms at 20°C) were used to calculate salting in coefficients k and cation exchange constants K ($K=k_2/k_1$) for electrolytes and effective constants for non electrolytes. Swelled biopolymer exists at equilibrium with its saturated solution. This fact allows accounting adsorption Γ of counterions and non electrolytes on the surface of swelled gelatin taking the first derivative on the logarithm of concentration of substance in solution on the isotherm. The degree of coating of surface is Γ/Γ_{max} for given isotherm.

III. Results

The swelling is maximum for solutions: 10% sugar solution, 10% glucose solution, onion sap, 50% onion sap solution, 10% aloe sap solution (salting in). All solutions containing a honey and 40% sucrose solution do not provide maximum dissolving of gelatin (salting out). Swelling of gelatin in solution: aloe sap + 0,15M (0,9% isotonic solution) NaCl corresponds to swelling in background electrolyte independently on aloe-emodin concentration. Keeping of aloe at 8 – 10° C during 10 days follows a decomposition of aloin on two non adsorbed compounds aloe-emodin and arabinose.

Gelatin is negatively charged at the physiological pH (7,2 – 7,4). By their effects on the swelling cations of MCl and substances can be arranged in the following order:

$$\text{aloe-emodin} > Na^+ > K^+ \sim \text{sucrose} > NH_4^+.$$

This arrangement is the reverse of the Hofmeister lyotropic series.

Value 1/k has a dimension mol/L and is $4{,}3*10^{-3}$ M for aloe. It corresponds to the solubility of charged form of gelatin. Usually used in practice 1% solution of gelatin is made at room temperature and it corresponds $2*10^{-4}$ - $3*10^{-5}$ M solutions (at molar weight 50 – 300 kD. The increase of solubility $4{,}3*10^{-3}/2*10^{-4}=21{,}5$ conforms the value S/So = 20,9. It means the manner of evaluation of presented in Table 1 parameters is good enough.

The degree of coating of surface by aloin is 72 – 45% around point 0,15 M NaCl on the isotherm. It corresponds to the degree of braking of increase of tumour 60 – 43% using aloe sap [3]. Aloin will cover about 40% of cell surface, 40% of proteins on it. Cells will stop to divide.

Table I presents salting in coefficients k; exchange constants of Na^+ on other cations and substances K ; these constants relatively the most lipophylic cation (NH_4^+) K*; increase of common solubility of gelatin S/So in solutions comparing to water (So).

TABLE I

	Aloe	**Na^+**	**K^+, cukurs**	**NH_4^+**
k_2	233	$13 = k_1$	7	5,5
lg k	2,36	1,11	0,85	0,74
K	17,92	1	0,54	0,42
lgK	1,25	0	-0,26	-0,37
lgK*	1,62	0,37	0,11	0
S/S_o	20,9	29,5	22,4; 17,4	19,5

IV. Conclusions

Counterions traditionally named as salting out agents possess salting in activity on the surface of gelatin and probably on the surface of a cell. Adsorption and salting in ability is maximum for aloe sap containing surface active substance aloin comparing its compound parts and electrolytes.

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SIA SAKRET and Riga Technical University – Mutually Fruitful Collaboration

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Keywords **– production, university, collaboration, education, research.**

I. Introduction

Prosperity of each country depends on production development and export of the products to international markets, i.e. creation of new, competitive enterprises and products. Such mission is successfully carried out by the production company of dry and ready to use building materials SIA SAKRET.

"SAKRET" brand was created in USA, year 1936, by building engineer Arthur Avril. Today it is the brand of dry building materials that are produced on franchise contract basis in more than 60 plants in different countries.

In Latvia "SAKRET" brand appeared in 2003 as SIA SAKRET which was established as completely national enterprise. The plant started its work in Latvia on 2004 by creative development and fulfilment of the acquired franchise licence. On July 2007 the SAKRET plant in Estonia started working but in August 2008 – in Lithuania. Presently SIA SAKRET is one of the fastest growing enterprises of Latvia that successfully conquers the markets of CIS and Northern countries.

The aim of SAKRET is to provide high quality, wide nomenclature and application, competitive building materials, offering not only building mixtures but also complex systems with special and additional products, ensuring full scale of products for interior and exterior decoration.

II. Resuls and Discussion

Successful development of each enterprise is connected with generation of new, innovative ideas, their realisation and of human resources that are able to embody the new ideas in real product and promote them in market. Thus essential importance for further development is collaboration with universities and research institutions, including Faculty of Materials Science and Applied Chemistry (FMSAC) of Riga Technical University (RTU) that has already been realised by SAKRET in long term. For achievement of desirable results, this collaboration should be mutual and it cannot be a one-sided activity.

The main interests of SAKRET in this collaboration are to obtain qualified specialists and to participate in their education and training so that they could quickly and actively be engaged in the production processes. Thus it is essential to improve the bachelor's, master's and doctor's study programs' content in chemistry, chemistry technology and materials science and to adjust them according to the production and innovative research directions of an enterprise and together with FMSAC or other research institutions to realise innovative, scientific outputs and tests of finished products, involving students and academic personnel in the process. SAKRET management has had this chance by participation in RTU as well as FMSAC convent structure. SAKRET has always supported all the activities, organised by FMSAC that are connected with the teaching of potential students in secondary schools and the education and training of potential specialists (chemists, technologists and materials scientists) in the Faculty. These are year awards for secondary schools' teachers and grants for most successful students.

The interests of the Faculty are connected with the fulfilment of study programs according to the demands of employers, the opportunity to the students to practice in real production conditions, decreasing the gap between theoretical knowledge and real production. The collaboration in scientific field has not expanded presently mostly because of the large inertia in research as the Faculty research staff is busy in different EU projects, maybe even because of idleness. One of the potential ways to attract new employees in production is the work out of bachelor's and master's thesis in SAKRET that successfully develops step by step.

The gateway of success for SAKRET is well-considered development strategy, coordination of activities and incentive. Not less important role plays the competence of specialists that work in the enterprise, including the investment of RTU FMSAC graduates. Output of several new, innovative materials to a certain extent is because of the studies of the leading specialists in RTU FMSAC Silicate Material Institute, specializing in silicate materials' technology and conservation of cultural heritage. Such are the innovative materials for renovation of historical buildings – group of historical plasters HM, recovery lime facade filler SFP, cement facade filler CC, cement lime and lime dry colours, silicate primer and silicate paints. SAKRET produces prosthetics materials for repair of limestone architecture objects as well, for example the castle park ensemble in Cesis, cement binders for repair and colouring of sculptures, light filler material dry mixtures for renovation of historical cornices, bas-reliefs and other decorative elements. The cultural heritage maintenance is still topical to the whole world and production of new materials is still current for development. This direction of production and production of materials could hardly develop in SAKRET, if the importance of the cultural heritage in our lives would not be understood and if the further building development directions would not be seen.

III. Summary

Drawing the general conclusion, it is clear, that development of an enterprise and an university will be effective only in case of their close collaboration that will allow to solve problems both in production and training of specialists.

Materials Science and Applied Chemistry

Textile and Clothing Technology

Nettle fibers grown in Latvia as one of the potential natural raw material for textile

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Keywords **– nettle, Urtica dioica L., nettle fiber, fiber production, fiber strength, natural textiles, renewable resources.**

I. INTRODUCTION

People in Europe used wild nettle plants for fiber obtaining already from the 12th century [1]. Especially they were used during times of political or economic crisis. Mostly from these fibers domestic handcraft textiles were produced.

The first attempt to commercialise the production of nettle fibers was in Germany at the beginning of 18th century, but serious research in the cultivation was started in 19th century, but it was not very successful. Only in 1927 to 1950 Dr Gustav Bredemann selected plants of Urtica dioica and produced several high fiber clones that could be cultivated [2]. The criteria for selecting the plants were that they should be frost – resistant, have long, straight stems with minimal branching and high percentage of fiber in the stem.

During the First and Second World Wars nettle fibers used instead of cotton. In the 1940s about 500ha of nettle was cultivated in Germany and Austria for fiber production.

The research work on nettle clones was started again 1990s in Germany, Austria and Finland [1]. Nowadays this interest is connected with the:

• wish to decrease toxic residues in textiles because of negative health impact and requirement to the conventional unsustainable textile fibers;

• positive experiences and increasing demand for textiles made of organic cotton, flax and hemp;

• development of new fiber materials that can increase the supply of organically grown domestic fibers in addition to flax and hemp;

• possibility to transform commonly wild plant in to commercial profitable;

• usage of all plant parts in different industrial branches (for example, cosmetics, food industry, pharmacy, farming) as it is for hemp (Cannabis sativa L.).

The nettle fiber is the research object in many commercial projects in Europe and the main task is to develop technology to get nettle more successfully and cost effectively. At the same time the use of wild nettle is still also possible. In territory of Latvia there are two types of wild nettle plants. It is Urtica dioica which grows in forests, near the rivers and settlements, where is swampy and with nitrates rich soil, and Urtica urens, which is traditional weed in the gardens.

II. MATERIALS AND METHODS

For the experiments there were used nettle fibres from the straws which were obtained from the fields of Upyte Experimental Station of the Lithuanian Research Centre for Agriculture and Forestry. The scientists of this center already several years work on nettle breeding from clones especially for fiber production. The nettles were planted in two different years - 2007 and 2008 with the different distance between plants.

Obtained nettle straws were retted on the field 10 days. After that they were dried in the room temperature for several weeks. Then the fibres were separated mechanically with the hands.

There were prepared fiber bundles with the length – 50mm and mass - 0.75 mg ± 0.25 mg. The tensile properties for fibre bundles were determined using Instron Universal tester (Model 2519-107).

III. RESULTS

There were determined:

- Sraw length;
- Bast content in the straws;
- Nettle fiber tensile properties.

For fiber production useful nettle straw length was from 100 till 181cm. There can be used approximately only 80% of the straw length. The bast content in the straws varies from 19 till 24%. The less was straw length – more were bast content in them. The tensile strength varies from 11 till 120cN/tex. It was higher for the fiber bundles which were obtained from the fourth year nettle straws to compare with the third year ones.

IV. CONCLUSIONS

Nettle fibres can be used for textile production. To obtain greater amount of fibers special nettle clones from Urtica dioica L should be used. The obtained yield of fiber is less than of flax and hemp, but nettle don't need planting every year. It can be breed for several years.

V. ACKNOWLEDGMENT

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for new functional properties of smart textiles development and integrating in innovative products" (ESFNr2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148).

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Metal Coated Textile Testing with GDV Method: Raw Material Influence on the Parameters of GDV Electrogramms

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Keywords **– Gas discharge visualization, nano metals, textile coatings, textile testing methods.**

I. Introduction

Spectrum of metal nanoparticle use in recent years has increased rapidly. Despite such positive impacts of copper as antibacterial, antifungal, analgesic, improving the blood flow effects, cannot be overlooked that copper is a heavy metal which in living organisms is necessary in small quantities, but large quantities can cause toxicopathy and pollute the environment. That must be taken into account in product design, manufacture, use and removal. Numerous studies on metal nanoparticles impact on human and environment has shown that metal nanoparticles destroy benign bacteria species used in wastewater treatment systems for ammonia elimination [1], if penetrated into mammalian cells, they can even cause damage to the genotype [2].

This research presents copper nanoparticle coating stability during modified textile use and care, and analysis of different textile materials' effect on the parameters of gas discharge visualization electrogramms. The overall objective of the study is to establish an alternative, less resource consuming method for measurement of textile metal coating resistance.

II. Experiment Methodology

In experiment used 9 samples of three different fabrics (samples 7-1; 7-1A; 7-1B – polyester; 7-2; 7-2A; 7-2B – viscose and 7-3; 7-3A; 7-3B – wool). Six samples (7-1A; 7-1B; 7-2A; 7-2B; 7-3A; 7-3B) coated with copper nanoparticles (60 – 70 nm) film using magnetron sputtering technology, which lasts for 2 seconds.

Washing samples in distilled water for 5 minutes, the copper coating partially segregated from the sample, as shown by the water color changes from clear, colorless to muddy pink. Samples without copper nanoparticle coating had also been washed in distilled water, to evaluate from the sample separated fiber, textile size chemicals, printing color etc. finishing materials effect on electrogramms parameters. Each sample size was 70 x 90 mm and 60 ml distilled water was applied for one sample washing. For comparison used pure distilled water (legend: Control). Water stored in locked glass containers.

Before the GDV electrography session container with water is thoroughly shaken up to disperse the sludge. Prepared solution (0.2 ml) is sucked into a syringe and a syringe fixed on a stand above the GDV camera lens. From one sample obtained 5 static GDV electrogramms. The experiment is repeated 8 times, resulting in a 40 pictures of the same time interval (5 seconds) between electrogramms fixing moments. Equipment test results [3] suggest that sufficiently reliable data requires a minimum of 40 measurements per experiment object.

GDV electrogramms fixed with the gas discharge visualization camera "GDV Camera Pro" using toolkit "GDV Mini-Lab" for liquid analysis. The data recorded in a computer program "GDV Capture" and processed in the program "GDV Scientific Laboratory". The resulting parametric analysis performed in "Microsoft Office Excel" software.

III. Results

Obtained area results of electrogramms (Table 1) show that the presence of copper nanoparticles in water appears as increased pixel amount: compared to the water in which was washed fabric without copper coating (sample 7-1, 7-2 and 7-3), water, in which was washed samples with copper coating (7-1A; 7-1B; 7-2A; 7-2B, and 7-3A; 7-3B) has greater electrogramm area. But taking into account the fact that the results of electrogramm area represents in the washing process separated fabric fiber quantity and textile finishing materials (Control water is even less area than samples without copper coating – 1 038 pixels), the difference between samples with and without copper coating describes the amount of copper nanoparticles in water. That is very important fact that must be taken into account creating testing methodology of metal coated textile.

TABLE I

COMPARISON OF GDV ELECTROGRAMMS AREA

Polyester		Viscose		Wool	
	Area, pix		Area, pix		Area, pix
7-1A	1 767	7-2A	2 486	7-3A	2 628
7-1B	1 520	7-2B	2 359	7-3B	2 568
Average	**1 644**	Average	**2 423**	Average	**2 598**
7-1	**1 463**	7-2	**2 035**	7-3	**2 248**
Difference	**181**	**Difference**	**388**	**Difference**	**350**

IV. Acknowledgement

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for new functional properties of smart textiles development and integrating in innovative products" (ESF Nr 2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148).

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Thin-Coatings on the Raw Cotton Textile Deposited by Sol-Gel Method

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Keywords **– raw cotton textile, sol-gel method, zinc oxide, thin-coating finishing.**

I. Introduction

Special attention has been focused recently on the UV transmission of textile because of the growing demand in the marketplace for light-weight apparel that offers protection from UVR, while fostering comfort [1].

The absorption spectra of semiconductor such as zinc oxide show strong absorption in the UV region of the light spectrum but only very slight or no absorption of visible light. In comparison with the organic absorbers conventionally used in the textile industry, inorganic materials show no significant degradation and are therefore extremely stable and the oxides are classified as non-toxic materials [1, 2]. The zinc oxide is harmless, that is why it is used in cosmetics such as sun creams. For the above-mentioned reasons, the zinc oxide seems to be ideal for the preparation of highly UV-absorbing, nanosol based coatings [2].

II. Materials and Methods

A. Materials

Raw woven plain weave 100% cotton fabric with the surface density 147.36 g/m^2 from yarns of linear density 33.6 Tex has been used in the experiment. The thickness of the fabric is ~ 0.36 mm; the measurement was taken by the textile thickness tester "TH-25".

B. Sol-gel method

One of the advantages of this method is the possibility of preparing thin layers on various materials. Sol-gel layers can cover all fibers with enough high adhesion [3].

C. Preparation of sol

Sols were prepared by a controlled hydrolysis, by adding ethyl alcohol slowly into TEOS with continuous stirring, after adding deionized water and hydrofluoric acid, stirred for 30 minutes, after mixed in the first case with zinc acetate and in the second with zinc sulphate with continuous stirring 10 minutes.

The one part of the fabric samples were dipped into the prepared sols, soaked for 10 minutes at room temperature and the second part was sprayed with the sol from the distance 20 cm, then samples were dried at 50 ºC for 10 minutes and after cured in an oven at 100 ºC and 120 ºC for 5 minutes.

D. The non-contact optical method of surface examination

The non-contact optical method hypothesis is based on the difference between the uncoated and the coated fabric surface light reflection mechanisms. In order to get a detailed insight into the textile surface changes after the application and the exploitation of the coating, the surfaces of the samples were examined with the non-contact optical method.

III. Results and Discussion

A. Microscopic observation of the fabric surface

The morphological changes of the natural textile as a result of coating with the zinc oxide and after its washing have been investigated using the scanning electron microscope (SEM) Tescan, Mira//LMU Schottky.

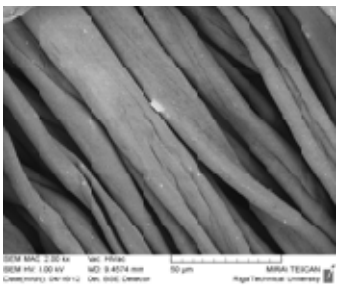

Fig. 1. The coated cotton textile sample dipped in sol for 10 minutes: TEOS concentration 3%, zinc acetate concentration 2.5%.

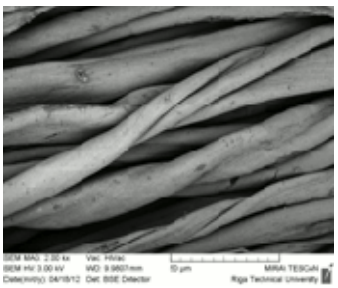

Fig. 2. The coated cotton textile sample dipped in sol for 10 minutes: TEOS concentration 3%, zinc sulphate concentration 7.5%.

IV. Conclusions

The sol-gel method for sol preparation used in this research to implement the zinc oxide coating on the fabric surface is a simple process that can be easily transferred to the textile industry, sol can be also applied by conventional coatings techniques used in the textile industry – the application can be implemented both by simple dipping and spraying process.

V. Acknowledgement

This work has been supported by the European Social Fund within the projects "Support for the implementation of doctoral studies at Riga Technical University".

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Mechanical properties of hemp fibre bundles

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Keywords **– Renewable raw materials, hemp fibre bundles, mechanical properties.**

I. Introduction

Since today's world increasingly focuses on renewable raw materials, including hemp, usage, which is source for a wide range of products, also in Latvia is deliberate efficient hemp processing opportunities in innovative materials. Complex studies needed for the problem solving, required for successful assessment of obtaining potential raw material resources. The revival of hemp fibres production in Latvia dates from year 2008 [1]. In this study have been reported results of in Latvia grown hemp cultivar Bialobrzeskie fibre bundles mechanical properties, such as, fibre bundle diameters determination and fibre bundle length distribution.

II. General Regulations

Hemp fibre bundles used for this study is of the ES registered monoecious industrial hemp variety "Bialobrzeskie" obtained in the year 2010 from hemp stems harvested from a trial plot in the Vilani district in Latvia. In sample preparation process bast fibres from woody core are separated mechanically with following bast fibres combing to separate large fibre bundles into single fibres and small fibre bundles. Afterwards fibres bundles were carded. Random fibres bundles with mass of 150 grams were picked up for fibre bundle length distribution determination. Fibre diameters were also evaluated, where fibres bundles cross section were dyed and pasted into the resin to make it visible in microscope.

III. Results and Discussion

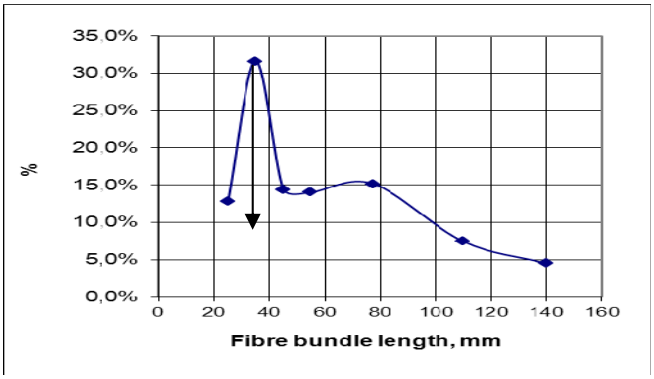

Fig. 1 Fibre bundles modal length distribution, mm

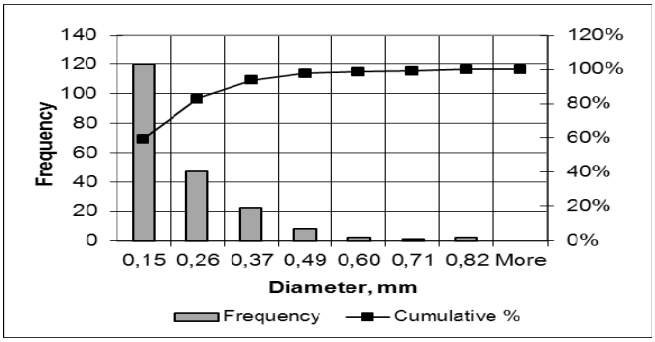

Fig. 2. Fibre bundles diameters distribution, mm

The results of fibre bundle length distribution can be seen in the Fig.1. 11,9 % of fibres bundles remain long, they are in the range of 90 up to 150 mm, which means that they were not carded well. 35 is the modal length corresponding to the interval 30 - 40 mm. For fibres in the range from 20 till 40 mm, modal interval is 44%, suggesting that the fibre bundles are separated to individual fibres. The remaining 58.9% is the fibre complexes. Fibres up to 50 mm are divided till elementary fibres. Results for fibre bundle diameters are shown in Fig. 2 where can be seen clearly stated left asymmetry. 2% fibres, with a diameter greater than 0.49 mm are poorly distributed, 97.5% are less than 0.37 mm. The biggest part - 59 % diameters are in the range from 0.04 up to 0.15 mm, 82 % does not exceed 0.26 mm. In the literature hemp fibre bundles diameters are in the range from 0.02 – 0.2 mm (20 - 200 μm) [2].

IV. Conclusions

Fibre bundles modal length distribution is in the range of 25-140 mm. Fibres up to 50 mm are divided till elementary fibres. 58.9% is the fibre complexes. Fibre diameters are in the range from 0,04 mm till 0,82 mm. The biggest part - 59 % diameter are in the range from 0.04 up to 0.15 mm.

V. Acknowledgment

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for new functional properties of smart textiles development and integrating in innovative products" (ESF Nr 2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148).

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Camouflage protection quality of the combat individual protection system within electromagnetic spectral band range of 3 μm to 12 μm TIR (thermo infra-red)

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Hanna Torbicka 4 (*NFM Group 4*)

Keywords **– CIPS, camouflage, protection, thermo infra-red, IR, TIR, combat clothing, electromagnetic spectrum.**

I. Introduction

Research was made on the evaluation of the thermo infra-red (TIR) camouflage protection quality of the combat individual protection system (CIPS) in order to define actual level of the TIR protection of the CIPS as well as suggest clothing systems solutions to increase actual level of the TIR protection.

II. Materials and Methods Used

General methodology of the evaluation was applied according to STANAG 2138 PCS "Troop trial principles and procedures – Combat clothing and personal equipment" [1]. Eleven combinations were evaluated on the distance of 30 m, 130 m, 276 m un 426 m and separately in conjunction with sleeping bags – 5 m. Environmental conditions of the Adazi military camp training outdoor area, Echo sector under the weather conditions in day time were cloudy, raining and wet snow, air temperature +2ºC till +4ºC, north-west wind 7-14 m/sec. TIR reflectance was measured by Dual Channel Day/Night Thermal Binocular with Geo-location Recon B2-FO. Level of the TIR protection quality was calculated by using newly developed method of the calculation areas of the color rectangles representing actual level of the TIR reflectance.

III. Results

Evaluation showed high quality of the CIPS combination clothing No.2 and No.11, see Fig. 1. Both combinations are based on the clothing specially designed for the purposes of the camouflage in the visual spectrum of the electromagnetic field. Combination No.2 is specially design suit for the camouflage in the snow environment.

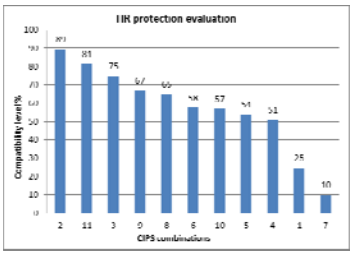

Fig. 1. TIR protection quality evaluation.

Combination No.11 is combat jacket and pants of the snipers and reconnaissance personnel. However both don't have any integrated solution for the TIR reflectance level decreasing. Shemagh is evaluated as CIPS element with high quality TIR protection. All combinations in conjunction with sleeping bags have high quality TIR protection. CIPS combinations with large area of the trapped air in the layering as well as multiple layers itself were evaluated as with high TIR protection quality.

IV. Discussion

There is no standardized procedure in NATO relevant documents for the evaluation of TIR reflectance for the individual protection systems representing multiple layering clothing systems. Developed evaluation system by calculation areas of color rectangles can be applied for the further evaluation of the different clothing systems under the different climatic conditions. Methodology is very cost effective and can be applied by military clothing evaluators and military personnel. CIPS combinations making TIR evaluation closer to the real battlefield situation and real using of the garments, taking into consideration not only layering but also design features, compared with textile package evaluation.

V. Conclusions and Future Works

CIPS evaluation showed acceptable level of the TIR protection quality, without using specially designed camouflage suits with integrated TIR protection. Design features of the CIPS, increasing camouflage protection in TIR were identified and should be implemented in operational activities of the military personnel as well as integrated in the further upgrading of the CIPS. Based on the research CIPS-Mod1-SNIPER/RECON-system was established. Additional garments were suggested to implement into supplying norm to increase TIR protection in the specific zones of the body for the personnel of the military reconnaissance and sniper units. Developed methodology of the field trial and following calculation of the colored rectangles should be implemented in the quality evaluation procedures and should be used every time there will be integration of any new developed elements into CIPS.

VI. Acknowledgment

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for new functional properties of smart textiles development and integrating in innovative products" (ESF Nr 2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148).

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Quality of the procurement models and supplying norms of the Combat individual protection system

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Igors Šitvjenkins 2 (*National Armed Forces 2*), Ausma Viļumsone 3 (*Riga Technical University 3*)

Keywords **– CIPS, military procurement models, protection, military supplying norms, combat clothing, long term costs, full life circle, soldier systems.**

I. Introduction

Research was made on the evaluation of the effectiveness of the applied procurement models and supplying norms of the combat individual protection system (CIPS) in order to define procurement and supplying norms strategy of the CIPS for long term planning perspectives.

II. Materials and Methods Used

Procurement models were evaluated during period of time 2005 until 2012 by administrative system documental analysis and identifying procurement models used during full life circle applied to the CIPS as well as soldier systems. Architecture inventory of the individual protection materials was provided in order to compare requirements of the supplying norms 73-NOT and actual situation in the Army supply with CIPS elements. Newly developed CIPS-supplying norms were compared with 73-NOT supplying norms by evaluation of the long term costs within period of 10 years.

III. Results

Evaluation showed high weight of the exception type procurement models being in use during CIPS and soldier systems full life circle management. From the perspectives of CIPS sub-systems for the artificial threats protection procurement models of the exception type were in use during full life circle management. Procurement models of exception type – negotiation procedures with acceptance by Procurement Supervision Bureau (PSB) were applied for the several textiles protection systems as well as camouflage pattern. There is also basis identified for the further approvals as the exception type of the procurement models for the all elements in the CIPS architecture see Fig. 1.

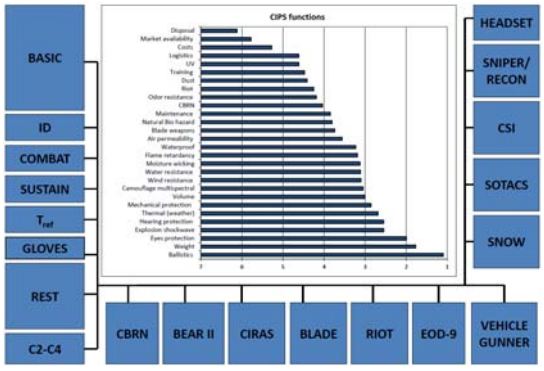

Fig. 1. CIPS architecture.

Differences between 73-NOT supplying norms and actual situation in the Army supply with CIPS elements, sets and sub-systems. Long terms costs comparing between CIPS-supplying norms and 73-NOT supplying norms identified economy, accordingly CIPS-supplying norms 33.8 million LVL and 73-NOT 52.0 million LVL within period of 10 years see Fig. 2.

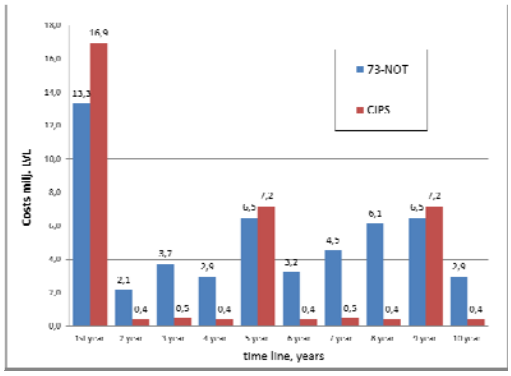

Fig. 2. CIPS and 73-NOT costs.

IV. Discussion

There are no available researches in the open source about administrative management of the CIPS and Soldier systems. However Army supply doesn't exist without supplying norms and connected long term costs. Efficient management of the supplying norms significant decreasing costs of the CIPS. Management of the procurement models within the full life circle aloud to increase combat ability in supply of the high quality CIPS and avoiding deficit in the supplying funds.

V. Conclusions and Future Works

Since 2005 Latvian Army has applied mostly exception type of the procurement models in the CIPS full life circle management. Applying of the open type of the procurement models in many cases caused delaying in the supply procedure and guided procurement officials to apply exception type of the procurement models. Such procurement policy supported with scientific work secured NAF combat ability and avoided deficit in the supplying funds. Efficient management of the supplying norms significant decreasing long term costs of the CIPS. Influent of the integration new developments into CIPS should be evaluated from the perspectives of the long term costs as well as procurement model should be developed.

VI. Acknowledgment

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for new functional properties of smart textiles development and integrating in innovative products" (ESF Nr 2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148).

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Durability for Smart Clothing with Wearable Energy Source

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***Keywords* –abrasion resistance, smart garment, washability, waterproof protection, electromechanical converter.**

I. Introduction

An energy harvester for generating electricity during human walking has been recently developed in Riga Technical University [1]. Our device has a planar structure. Electrodynamic converter consists of three groups of flat, spiral-shaped coils (see Figure 1) and an arc-shaped magnet and all elements can be deployed on a variety of clothing items.

Wearable energy sources, as well as garments must be comfortable in use and wearing. The concept of smart garments focus on their high performance regarding durability, comfort, safety, appearance retention, functionality and other properties. During usage, clothing comes into contact with various factors (physical, chemical, mechanical and biological) which cause deformation and wear. For the owner and user of the garments, the most important thing is that the products retain their properties both before and after dry-cleaning or washing procedures. It is very important to be able to wash the clothes with integrated generator easily.

The purpose of this research is to estimate durability for garment with energy harvester. Under investigation is:

-the influence of inductive elements on the clothing fabric abrasion resistance;

-the influence of washing or dry-cleaning on the inductive elements with different waterproof protection and various structures (see Figure 2).

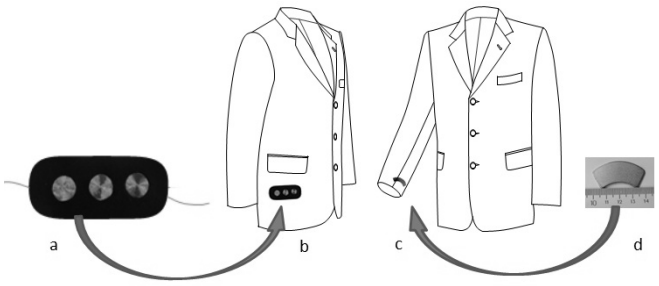

Fig. 1. Jacket with the part of electrical generator: a - set of flat spiral shaped coils, b - location of the inductive elements, c - location of the magnet, d – permanent magnet.

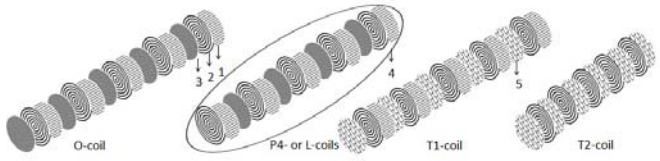

Fig. 2. Various structures of 5 - layers coil

II. Experimental methods

Washability of the samples was tested using procedure 6A of ISO 6330 [2].

The durability criterion for inductive element, which determines coil unsuitability for further operation selected: unsatisfactory resistance of the coil and corrosion or destruction of the coil structure.

Martindale test was used to assess the effect of clothing fabric abrasion, which involves sample abrasion until a predetermined end-point such as a hole takes place, and record of number of cycles till this occurs[3].

III. Results and conclusion

The preliminary washing test results showed that the structure of the coils with thermoplastic adhesive coating (T) did not destruct. Also the coil with lamination (L) did not destruct. The disadvantage of the present coil with lamination was an increase in linear dimensions and stiffness of coil. L- and T-inductive elements did not change the electrical resistance.

Inductive element has a significant negative impact on the clothing fabric abrasion resistance.

IV. Acknovledgmen

This work has been supported by the European Social Fund within the project “Establishment of interdisciplinary research groups for a new functional properties of smart textiles development and integrating in innovative products" (ESF Nr. 2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148).

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Incorporation of Light Emitting Diodes in the Clothing

Ingrida Shahta 1, Ilze Baltina 2, Sanita Leitane 3 (*Riga Technical University 1-3)*

Keywords **– smart textile, light emitting diodes (LEDs), light emitting elements, in the textile integrated electronics.**

I. Introduction

Over the last ten years the traditional textile industry has changed its strategy from the improving of textile quality and manufacturing technology to the creating of innovative new products [1] Textile with integrated electrical systems is one of the research areas that combine innovations both in textile and electronics sector.

Smart textiles with integrated electronic systems provide ample opportunities that may be realized in the textile industry, in the fashion and clothing sector, as well as in the technical textiles sector. These developments are a result of active collaboration between the varieties of disciplines: engineering, different areas of science, for example, chemistry or IT, design, business or marketing.

The integration of Light emitting diodes in the textile products allows assign additional functions, such as the visibility on the street, or may serve as a fashion design.

During the conductive system integration in the textile structures there should be find the solutions for approximation of both electronic and textile physical characteristics (for example, flexibility, elasticity etc.).

The aim of this research was to analyze integration possibilities of light emitting diodes in the clothing.

II. For the integration into Clothing suitable light-emitting elements

Light-emitting dresses designs usually are developed for the creation of different visual effects. Mostly for the textiles to obtain light effects such integrated electronic devices are used:

a) In the clothes integrated compositions of separate light diodes (Light Emitting Diode - LED, SMD LED - Surface Montage Device LED);

b) In the clothes incorporated light-emitting displays (LED, SMD LED, OLED - organic light-emitting diode) that change colors, symbols and patterns;

c) In the dress integrated laser diodes;

e) In the garment integrated optical fibres. [2; 3]

III. Integration methods of light-emitting elements

Depending on the type of light-emitting element and their construction, a variety of integration and incorporation technologies have been designed. Some of them are summarized in the table 1. Using the solder method, there are a high-quality, reliable electrical connections produced, where the connection point is durable and has a good electrical conductivity, however the mechanical properties are not suitable for textile characteristics - it is not flexible and is subject to breakage and disconnection of the electrical circuit. The use of conductive adhesives is more suitable than soldering method, since they conduct the electricity very well, are durable and flexible, they comply with a folding of textile and cover electronics parts. Popular and appropriate method for electronics incorporation in the textile is attaching by sewing, using conductive threads.

TABLE I
Light Emitting Elements

No.	Type of element	Visual effect	Method of incorporation
1.	**LED**	a dotted accent; could be grouped in the areas or zones	sewing, soldering
2.	**SMD LED**	a dotted accent; could be grouped in the areas or zones	sewing, soldering
3.	**Laser diode**	the beam of light	it requires a special frame; melting/gluing
4.	**OLED**	square area	sticking
5.	**Optical fibres**	glittering effect of whole fabric; radiation form of separate loose fibre ends - point	weaving, sewing
6.	**Electrolumi nescent wire**	line rhythm, varied by wire curvature form	sticking, sewing

In the figure 1, the LED's incorporation into the textile by combining sewing and sticking is shown. For this purpose a special "foot" of 3 layered textile square (15 x 15 mm wide) coated with adhesive and affixed to 0.5 mm wide fabric copper coated strips is created. The LED is inserted in the hole of the "foot" center and stitched on with an electrically conductive thread.

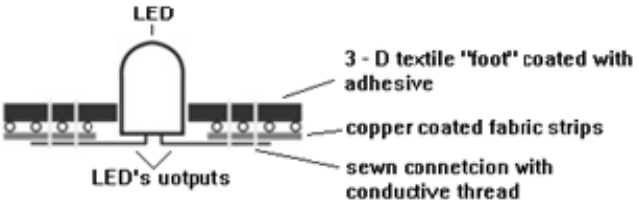

Fig. 1. For the sewing on the textile integrated circuit created LED with a textile “foot”

In such way created LED provides a good connection with the sewn circuit integrated in the clothing fabric, due to the enough wide conductors, while 3-dimensional foot material protects the LED of mechanical defect potentialities and provides a necessary stability for electrical circuit.

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Apparel manufacturing logistics process modeling

Inese Ziemele 1, Dana Belakova 2, Jekaterina Aleksejeva3 (*Riga Technical University 1-3*)

Keywords **– retail enterprise, CAD/CAM department, time norms, PERT web graph.**

I. Introduction

The modern logistics include practically all business fields; thereby logistics is an impressive weapon in the arms of the company. Logistics helps organizing and control the activity of the company, allowing the company to be competitive and make profit.

Nowadays apparel production companies are forced to adapt to the unstable economical situation in the world and survive in the fierce competition. The relationship between companies and related logistic chains become more and more complex and demand for higher mobility, efficiency and a creative approach.

It is important for apparel production companies to operationally manage model designing and their large-scale production order execution times to be able to function effectively in the common – already traditional – integrated multi-company partner logistics chain within the order flow from the artistic design to the end user.

Research goal: to design and analyze large-scale apparel styles production orders preparation and execution schedules for basic types of women outdoor clothing, basing on the work organization and everyday activity of an apparel production integrated logistics chain member – one of the Latvian constructive and technological apparel designing company.

II. Case Study

The style designing and production processes and events have been analyzed basing on an average complexity women's coat model designing work or the sequence of tasks in time.

Basing on the analysis of the designing and production process, a project graph has been developed using the PERT (Program Evaluation and Review Technique) web method.

The analysed project outlines 46 tasks with a maximum procedure time and determines the task execution possibility, namely, the set in of which event determines the process possibility of the next task/event. The sequence of tasks between the first and final event of the web that is the longest, is the critical task execution sequence. Critical are also all events and tasks which have settled on this path [2].

The PERT web graph of the woman's coat designing and production three homogenous stages can be separated – I, II, III (Fig.), where the following can be distinguished:

1) The task execution process from the first event to a finished prototype of a style (stage I) in the case of classical designing work organization happens almost sequentially, adding up to about 45 working hours. Almost all events are located on the critical path. Therefore it is important to determine precisely and follow the duration of each event. The determination and control of a patterns designer `s working time expenditure is very essential. (A time saving possibility – to hire a designer with the skill of a patterns designer);

2) Web graph stage III (Fig.1) – in the final stage after the preparation of the markers to handing over the finished order to the consumer a sequent task chain is being accomplished too, where every event is important in terms of duration – all events are allocated on the critical path. To save time production units often refuse to produce a test series, which is risky for orders over 300 pcs. The level of risk and cost of risk have to be evaluated carefully. The women's coat assortment event process total time in stage III will take up to 15 hours for one unit if a test series is produced in advance and only 2.5 hours, if a test series is not produced;

3) In the middle part of the graph, stage II (Fig.), there are events which are dedicated to the improvement of a style's construction before production, material supply and handing over for production. Four possible critical paths can be separated here:

First The production is planned for another company (not the company where the style designing takes place). The critical time is the relocation of the order to another production unit. The duration of this stage will be at least 15.8 hours.

Second – The production is planned in the same company where the designing takes place. Duration of the stage is at least 14.6h.

Third – A style is designed without a preliminary production order and it has to be distributed via wholesale. The length of a stage is at least 13.9h. The critical event is multiplication and distribution of the model, which can take additional 50h or more.

Fourth – Planned cloth and accessory delivery delays, no stable cooperation with suppliers. The critical path shifts to the material collection event, which can be up to two months. The duration of the stage is at least 11.8 h.

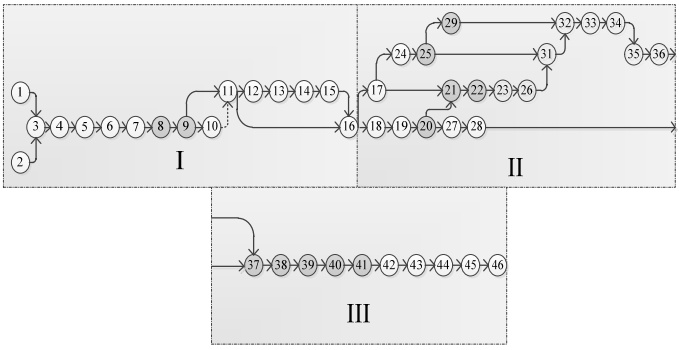

Fig. 1. PERT web graph of a woman's coat designing and production

III. Conclusion

The types of critical paths are determined by model designing and further production conditions. The pronounced sequential course of almost all events visible in the web graph stages I and III, directs to organize and supervise all events deliberative also from the working time expenditure point of view. This especially applies to the duties of constructors and technologists, since their work evaluation in time is bothersome and therefore hard to control.

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Wearable PPG Device for Pulse Wave Analysis

Viktorija Mečņika 1, Edgars Kviesis 2, Zbignevs Marcinkevičs 3, Ivars Krieviņš 4 (Riga Technical University 1, 4), (Institute of Atomic Physics and Spectroscopy of Latvia University 2), (Department of Human and Animal Physiology, Faculty of Biology of Latvia University 3)

Keywords **–wireless biomonitoring, wearable electronics, photoplethysmography, pulse wave analysis.**

I. Introduction

Cardiovascular and related disorders are one of the urgent problems in the health care sphere due to population aging and growth of risk factor patient [1]. Commercially available biomonitoring garments and body area networks for cardiovascular activity registration mostly permit heart rate (HR) monitoring. Registration of heart electrical activity takes one of the crucial points in the multi-disciplinary research designated to cardiovascular assessment, and at present ECG signal acquisition by textile electrodes entirely integrated into a garment is available. Still assessment of circulation system and monitoring of dynamics of haemodynamic parameters requires application of different methods. Objective vascular assessment of haemodynamic responses is significant for specific patient groups, which are mostly aging patients. Evaluation of haemodynamic changes is significant also for observing patients' physiological response during exercise within cardiac rehabilitation programmes and athletes [2, 3]. Currently non-invasive haemodynamic monitoring by commercially available medical equipment requires clinical or laboratory environment and assistance of a specialist.

This study investigates the opportunities of haemodynamic monitoring by photoplethysmography (PPG) signal acquisition by application of wireless wearable technologies. The study covers the issues on improvement of the PPG device design to ensure easy integration into textiles and further attachment of the garment to the body for reliable physiological data acquisition during exercise. Therefore, series of measurements have been carried out in order to evaluate the quality and accuracy of the signal registered from various body sites. Evaluation of the obtained physiological data has been held hereby to define appropriate types and construction of garments regarding the signal registration specifics. The analysed data has been used as a pre-study of a garment development with embedded PPG device for haemodynamic assessment.

II. Materials and Methods

Photoplethysmography (PPG) is a non-invasive measuring technique, which provides an estimation of blood flow based on optical detection of blood volume changes with heart periodic contractions and relaxations in the researched tissue probe [4].

Pulse wave analysis permits assessment of cardiac and hemodynamic activity and processes. It includes evaluation of parametric values of the pulse wave amplitude, its temporal features, e.g. length of foot-to-foot interval that corresponds with ECG R-R interval, heart contraction frequency, time of pulse wave reflection etc. [5]

The developed PPG device provides opportunity of subsequent evaluation of cardiovascular and haemodynamic parameters, i.e. heart rate variability and pulse wave parameters the probe-covered (Fig.1).

The signal capture and real-time monitoring is performed by custom developed software DataScope. Further processing of the acquired data is accomplished by custom developed software for analysis of haemodynamic parameters of pulse wave.

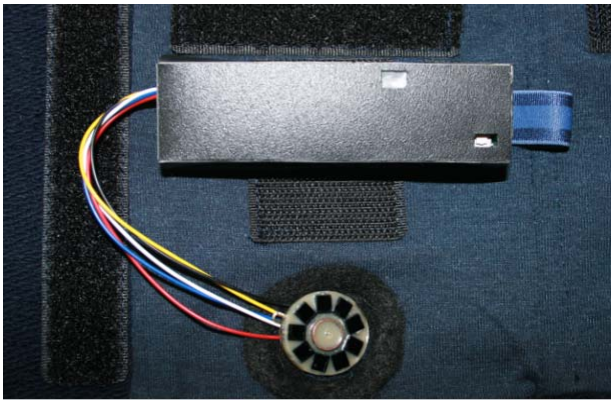

Fig. 1. Wearable PPG device prototype.

III. Results

Physiological data was acquired from six volunteers in rest condition and during exercise within several measurement series. The measurement series were referred to evaluation of the signal accuracy acquired from different body sites in rest condition and during exercise. PPG signal was registered simultaneously with ECG signal. ECG reference signal was recorded by TLC5000 12 Channel Holter ECG Monitor System (Contec Medical Systems). Analysis of the physiological data analysis evinced that the most accurate data was obtained from the superficial temporal artery. Therefore, PPG signal registration during exercise was carried out from the superficial temporal artery.

IV. Conclusions and Discussion

The developed device potentially provides a unique opportunity of wireless monitoring of haemodynamics and may be applied as a low-cost and express method in clinical research. Several prototypes of textile bandages have been developed for the signal registration from different body sites. The developed PPG sensor body area network may be applied for more sophisticated non-invasive wireless vascular assessment.

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General Performance Tests Development of Uniform Prototypes for State Police

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Keywords **– State Police uniform, quality.**

I. Introduction

The State Police of Latvia is planning to enforce a new type of uniforms. It is necessary to define adequacy of new uniforms to the specific requirements of State police. Till now the State Police of Latvia do not have standardized general performance tests protocols.

The purpose of this research is to develop the general performance tests of uniforms for State Police to evaluate optimal convenience of new type of the uniforms for working conditions.

II. Performance Test Development

There is abstract of general performance tests plan (Fig.1).

-Define test target and scope.
-Define necessary test equipments and standards.
-Define preliminary test preparation conditions.
-Compose test procedures structure and order.
-Perform test procedures.
-Summarize and analyze test data.
-Presentation of test data.

The test target and scope is examination of new type of the uniforms for performance, durability, reliability, sizing, fitting, donning, doffing, wearing test and physically mechanical characteristics.

Necessary test equipments and standards depend from particular test procedure.

Preliminary test preparation conditions:

-during the trial wearing field test condition should align with official wearing duties,
-should be obtained anthropometric measurements of participants,
-recommendation of test duration is around one year,
-describe specification of the uniforms,
-develop questionnaires,
-describe care rules of uniforms during wear trial period.

Test procedures structure and order:

-primary quality control of the uniforms,
-uniforms' static anthropometric conformity,
-uniforms' dynamic anthropometric conformity,
-uniforms' donning and doffing comfortableness,
-uniforms' thermal resistance,
-uniforms' water vapor permeability,
-uniforms' set harmony,
-uniforms' trial wearing field test,
-uniforms' controlled wearing test,
-physically mechanical characteristics of fabric,
-uniforms' quality control at the end of test.

The task was to determine performing methods and required measurements for each of test procedure and perform the test procedures accordingly the defined conditions and standards.

Test data results and conclusions are presented in tabular, graphical and textual overview format.

During performance testing it is possible to make corrections and additions to the test plan and also eliminate disadvantages to it.

Test result shows summary of indications what appoint to adequacy of new type of the uniforms to State Police requirements or improvements necessity.

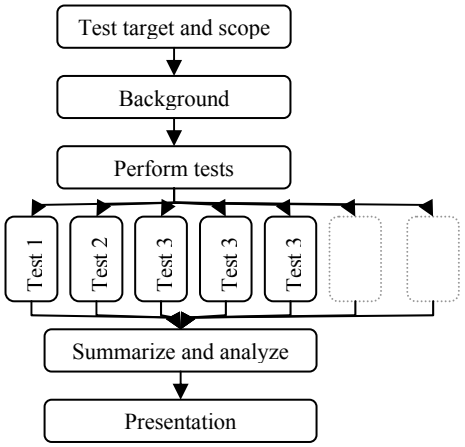

Fig. 1. General performance tests plan.

III. Acknowledgement

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for a new functional properties of smart textiles development and integrating in innovative products", No.2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148.

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Applications of Biomonitoring Clothing

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Keywords **–biomonitoring clothing, wearable electronics, textile based sensors.**

I. Introduction

Non-invasive assessment of related health problems by continuous monitoring of physiological parameters is a research area, which unifies such disciplines as biomedical engineering, information technologies and medical sciences. Due to unique textile physical properties and clothing functions in general, many researches of the sphere also involve material sciences and textile technology studies for a wearable electronic system implementation and smart or intelligent wear development [1]. Developments in the field of intelligent biomedical clothing and textiles for healthcare include textile based sensors and wearable electronics systems embedded into textiles, which enable both registration and transmission of physiological data, and wireless communication between a user and an operator, for example, medical personal. Integration of electronics systems and wireless data transferring ensure patients' mobility, so that providing a higher level of psychophysiological comfort, when a long-term biomonitoring is required [2]. Thus, remote non-invasive monitoring of vital parameters within a garment integrated e-system could be an advantage for elderly and patients with chronic diseases, when the control of physical activity and monitoring of physiological data is required**.**

The paper presents an overview of developments of garments for telemonitoring of physiological parameters and physical activities. The aim of the current study is to summarize available information on most significant developments according to their applications, functions and methods used for development and production of biomonitoring garments.

II. Types of Biomonitoring Garments

Generally wearable textile-based developments for healthcare may be divided into three groups, which are garments for telemetric registration and monitoring of physiological parameters, auxiliary wearable systems for disabled persons, and garments or textiles for physiotherapeutical applications. More specific applications of each group of garments may vary according to the specific application sphere, for example, monitoring of physiological parameters and other activities for wireless assessment of cardiovascular diseases and related health problems of risk patients or therapeutical monitoring of patients of rehabilitation programmes.

A biomonitoring garment sometimes may be also considered as a sensor body area network due to the variety of performing functions and complexity of developments. Usually such developments are implemented both with wearable electronics and textile-based sensors. Hence, types of sensors and e-components, which are used for biomonitoring garment developing, vary according to their physical properties and functional application. For example, textile-based sensors, which are usually implemented by such traditional methods like embroidery, weaving and knitting, still mostly are applied in research developments, while monitoring of physiological data that requires more sophisticated approach and high measurement accuracy is obtained by integrating electronic components into textiles.

III. Applications of Biomonitoring Garments

The study has covered available information on the most significant developments and commercially available products for telemonitoring of physiological parameters. The reviewed clothing assortment has been grouped according to their technological and technical implementation, which is also sub-divided into groups according to the method of registration and sensor type. The Figure 1 presents quantitative distribution of the covered clothing assortment according to the registered parameters (Fig.1).

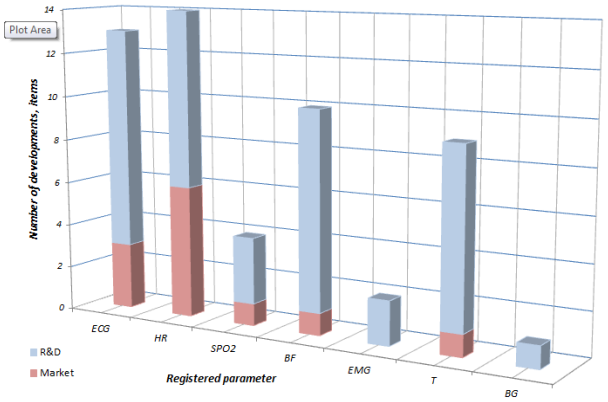

Fig. 1. Grouping of the reviewed biomonitoring clothing according to their functions.

IV. Conclusion and Discussion

Considering functions and methods of technological implementation of the reviewed biomonitoring garments, the primary function of such clothing is to provide long-term telemonitoring of physiological data and body activity with optimal comfort for the wearer enabling biofeedback with the wearer or/and communication with a system operator. Although recent researches in material science and textile technology have gained development of textile and textile-based sensor, accomplishment and operation of the system is not possible without wearable electronics. There is still a limited number of biomonitoring garment products available for a wider range of consumers, and mostly those provide only heart rate registration for sports activities. More sophisticated body area sensor networks for preventive healthcare and therapeutical purposes as Lifeshit® and Vitaljacket® still are implemented with non-elastic traditional biomedical sensors.

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Universal Design and Sustainable Spatial Development

Andra Ulme (*Riga Technical University*)

Keywords – Universal design, historical development, sustainable spatial development, environment accessibility, sustainable environment.

I. Introduction

Looking at the problem concluded that Universal design can be considered as a tool of social policy that would allow anyone to incorporate, in any environment.

Working methods and materials: qualitative and quantitative research methods were used for article writing, and graphic methods where used to capture the results of the inquiry. Order of the research, analyze. Deals with scientific research centers on international studies, summarizes the results and making proposals for improvement of situation in Latvian.

II. General Regulations

This article summarizes the historical development of Universal design, focusing special attention to the situation in USA and Europe. USA can be considered as the birthplace of Universal design, but situation in Europe influences developments in Latvia, as the member state of the European Union.

In 2011 two social surveys were made in Riga Latvia, the first survey focused on the general knowledge of Universal Design in Latvians. The results of this survey are depicted. The second survey however was made among disabled people with the goal to understand the true situation of Universal Design in Latvia. The results of this survey are depicted.

The first survey concluded that Latvians do not have enough information about Universal design. The second survey concluded that half of the respondents are informed about Universal Design but on an everyday basis face real problems due to the lack of it.

The next chapter called Universal Design Development in USA focuses on the historic development of Universal Design in its birthplace. Ron Mace, creator of the term "Universal design," was an articulate architect and a determined lawyer who influenced international thinking about design. Definitions together with R. Mace created the University of North Carolina Universal Design Center.

Starting from the first idea about environment arrangement and people's welfare was not used the term "Universal design", but, for example, accessibility, environment free of obstacles, barriers (barrier free). The term "Universal design" appeared only in 1985, and its creator was the architect Ron Mace, who was a member of the American Institute of Architecture (American Institute of Architecture) [1], later in the chapter the main documents that regulate the people's accessibility to environments in the USA.

The next chapter called Universal Design in Europe logically follows the prior one, and talks about the term "Universal design" and people with disabilities environment problem solving in Europe [3] came from the United States. "Americans with Disabilities Act" was taken for a base informational document for many countries, when they created their own guidelines for laws to protect people with disabilities and creates an accessible environment. In this chapter the situation is more broadly studied in the following countries: Great Britain, Greece, Germany, Portugal, Scandinavian countries and Latvia.

A crucial role in the implanting of Universal Design principles in factory manufactured products can be played by local, renewable, natural recourses, examples shown in full paper.

III. Conclusion

The article is an important research about Universal design introduction to life in different countries around the world. Looking at the problems concluded that Universal design can be considered as a tool of social politics that would allow anyone's adaption in any environment. Successful Universal design can be described by its invisibility, such as ramp to the stairs or bigger entrance doors, because Universal design is a «early project», not an idea after the project's realization. Starting from the first idea about environment arrangement and people`s welfare, didn't use term «Universal design», but «Accessibility», «Barriers (barrier free)», «Environment free of obstacles».

To improve the situation in Latvia we need to use «Latvia sustainable progression principle Convention» [2]. In Latvian society only few people know the term "Universal design" and "accessibility", but they are interested in this area. People want to know more about Universal design, it`s principles, law and regulation. The most significant problems are associated with public transportation, public buildings and public facilities. The good practices depicted in the paper show the possibility of sustainable environment following the Universal Design principles.

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Placement of Accelerometer in Cyclist's Jacket

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Keywords **– accelerometer, motion capture, wearable electronics.**

I. Introduction

Herewith a fast rising number of cyclists, the safety problems of cyclists become topical. The cyclist's visibility remarkably can be improved by integrating the light reflective and light emissive elements in the cyclist's suit [1].

The prototype of cyclist's belt with pockets and light emissive elements has been constructed at Riga Technical University. While the cyclist is riding with a constant speed or is in the rest state, the LEDs are blinking, but when braking - the LEDs light up constantly (like stop signals), which are activated by a signal coming from the sensor (accelerometer), placed in the central back pocket.

Fig. 1. Front and back of cyclist's belt

II. Experimental

A. Problem and the goal

During the time of approbation it was defined, that the placement of sensor on the back of the belt, does not provide a proper activity of stop signals, due to high level of addition movements of cyclist during the riding.

The goal of the research is to identify the least immobile point of the back during riding by bicycle at different speed and in 2 positions of the bodice.

B. Method

The motion capture technology was used in the study. The digital cameras of installed system recorded human's motion of anatomical points in 3 dimensions [2].

Infrared ray reflective markers were attached to definite points of back of the body. Six infrared light cameras send infrared beam and detect reflection of spherical markers. The trajectory of motion of the back points in 3 dimensions were registered and coordinates in time of reflective markers were calculated.

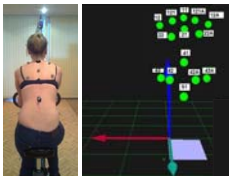

Fig.3. Placement of the markers on body and virtual repres entation of markers

C. Processing the data

Eight experimental 'rides' were made at different speeds and in two slopping positions of the body. Each 'ride' lasted 10 seconds.

Using special software and cameras, each coordinates in time of the markers were automatically registered and calculated (TABLE III).

TABLE III

The example of calculation of total acceleration of marker 12 (increasing speed from 15 to 30 km/h)

Nr.	x	v_x	a_x	y	v_y	a_y	z	v_z	a_z	v	a_{kop}
1.	20,79	0,31	-0,26	352,32	-0,03	-0,001	1397,75	0,09	0,01	0,32	0,26
…	…	…	…	…	…	…	…	…	…	…	…
2400.	5,27	-0,52	0,21	340,21	-0,25	0,04	1399,49	0,14	0,04	0,59	0,22
min			-0,90			-1,58			-1,41		0,002
max			0,92			1,58			1,24		2,14
min - max			1,82			3,16			2,65		2,14

III. Results

The least total amplitude of acceleration and amplitude of acceleration of y axis direction (which corresponds with riding/braking direction) at different speeds and 2 positions of the body, were characterized for markers 22, 22A, 21, 11 (Fig.7).

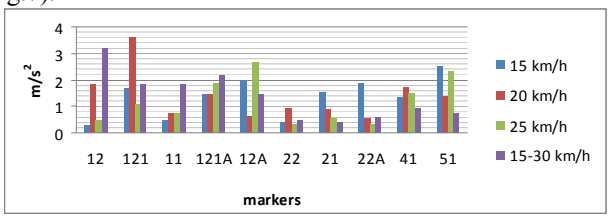

Fig.7. Amplitude of total acceleration of axis y markers, in position A

IV. Conclusions

The motion dynamics of markers depended on the position of the body and riding speed.

The motion sensor must be placed in the middle of the back upper part of the designing cyclist's jacket.

From the point of construction of clothing the point can be placed on the back central seam, where the sensor can be easily integrated, placing it on seam allowances, as the sensor parameters are 10x15x2 mm.

From the point of safety, considering anthropometrical features, the sensor is less influenced mechanically, as there is concavity between scapulae.

V. Acknowledgement

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for a new functional properties of smart textiles development and integrating in innovative products", No.2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148.

ESF EIROPAS SOCIĀLAIS FONDS — INVESTING IN YOUR FUTURE — EIROPAS SAVIENĪBA

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Annual Renewable Resources Potential Use

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***Keywords* – annual renewable resources, hemp, stalks.**

I. Introduction

A renewable resource is a natural resource with the ability to reproduce through biological or natural processes and replenished with the passage of time. Biomass comes from renewable organic materials and it is available everywhere. Annual renewable resources as agricultural plants like flax and hemp could build up a potential for development of ecologically, biodegradable and energy-efficient products, help to sustain climate change, and decrease greenhouse gas emission. Furthermore the increasing interest in hemp in part is being driven by environmental concerns about harvesting of forest resources. [1], [2]

This article relates to fast growing renewable and multi-purpose resource industrial hemp (*Cannabis sativa*) that main parts of stalk are fibres and woody core (known as the *hurds* or *shives*). The cross section of a hemp stem is presented in Figure 1 that showing the different layers of each layer. The hemp stalks are presented in Figure 2, fibres – Figure 3, but shives – Figure 4. [2], [3]

Total fibre content is approximately 25-35% of stem dry matter, depending on variety. [2], [3]

The primary- and secondary fibres of hemp stalk are commonly used in textile production (clothing, upholstery and household goods). The bast fibres of hemp stalk contain almost 80% cellulose and are perfect for paper production, building materials and creating composite materials used in auto manufacturing and even bullet-proof vests.

Whereas industrial hemp shives are suitable for use in a wide range of industrial products (animal bedding, mulch, chemical absorbent, and etc.) and high-quality building materials (fibre board, insulation, concrete) and paper. As the woody core of the stalk is the bundle of cellulose-laden short fibres that can be pressed to make biodiesel and other fossil fuel products too.

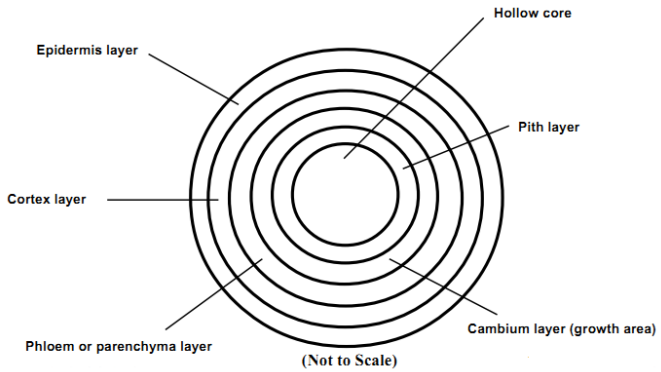

Fig.1. The Hemp Stem (Cross Section). [2]

Fig.2. The Hemp Stalks.

Fig.3. The Hemp Fibres.

Fig.4. The Hemp Shives.

Certain applications enable the stalk to be processed whole, the most compelling use being that of an alternative source of energy. Depending on variety and growing conditions, hemp is a very effective producer of biomass. The whole plant can also be used for fuel, i.e. the production of alcohol, although this is not common today. The hemp stalk use in erosion control blankets too. [2]

II. Materials and Methods

The purpose of this research was to investigate a potential use of annual renewable resources grown in Latvia.

Various mixtures of specimens were prepared for investigations. Local, renewable resources hemp stalks from agriculture were used in this research.

The different properties of specimens were carried out using electromechanical testing machines.

Statistical analyses have been carried out using the *Microsoft Excel*.

III. Conclusion

The results of pilot experiment of this research shows that annual renewable resources hemp could be suitable for different applications such as paper and composite materials.

However, future research could focus on the properties of Latvian grown hemp components and their processing possibilities, which could increase the hemp potential use into products with added value.

IV. Acknowledgements

This work has been supported by the European Social Fund within the project "Support for the implementation of doctoral studies at Riga Technical University".

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The Golden Triangle and the Golden Square in Fashion Design

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Keywords **– golden triangle, golden square, fashion design.**

I. Introduction

It is considered that proportion of Golden section is a symbol of the beauty and harmony. By this reason this ratio is used in design for creation of aesthetically beautiful and harmonic forms.

The paper presents the application of the Golden section in fashion design and pattern making with the help of the Golden triangle and Golden square.

II. The Golden Triangle and the Golden Square

In mathematics, arts, and design, two quantities are in the Golden ratio (φ) if the ratio of the smaller quantity to the larger one is equal to the ratio of the larger quantity to the sum of the quantities. Expressed algebraically – formula (1):

$$\varphi = \frac{a}{b} = \frac{b}{a+b} = 0{,}618\,. \qquad (1)$$

In formula (1), φ is the golden ratio, a – the smaller quantity, and b – the larger quantity.

The Golden triangle and the Golden square are built by the proportion of the Golden section. The Golden triangle, presented in figure 1, is an isosceles triangle with the ratio of the base to the leg is equal to the Golden ratio. The ratio between the sides of the Golden square is the same.

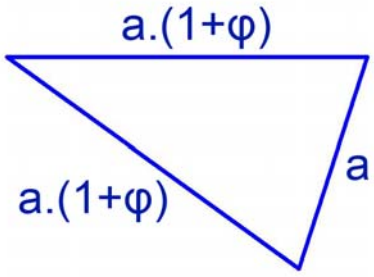

Fig. 1. The Golden triangle

III. Application in Fashion Design

In fashion design and pattern making the Golden triangle and the Golden square can combine proportioning and forms creation and they can be used as frames of designing of clothing details and elements.

For example, a lady's jacket with a collar around an asymmetric neckline is presented in figure 2. The neckline is formed with the help of a golden triangle. The stage of the pattern making of the model with the application of the Golden triangle is presented in figure 3.

Figures 2 and 3 show the use of the Golden section and especially the Golden triangle in design of an asymmetric neckline, but by the same way the Golden ones can be applied in design and pattern making of varied kinds and varied forms of clothing elements – border lines, decorative seams, and details – details of bodice or sleeve, collars, lapels, etc.

Fig. 2. A lady's jacket with a collar around an asymmetric neckline

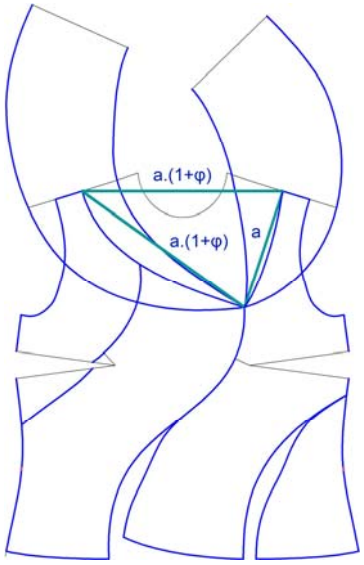

Fig. 3. Pattern making of the neckline with the use of the Golden triangle

IV. Conclusions

The application of the Golden triangle and square in fashion design is a precondition of aesthetic and harmonic forms in clothing. The inside lines (lines in Golden proportions too) of the Golden ones and the combinations between the figures can be bases of interesting models.

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Application of Interactive Presentation Systems in Education in Fashion Design and Technologies

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Keywords **– interactive presentation systems, fashion design, clothing technology.**

I. Introduction

As the lecturers practice shows the classic style of educating already bore the students who use actively the achievements of the IT society. More and more students attend the lecture courses and exercises with their laptops, tablets and smartphones and by this reason the lecturers have to use more and more IT technologies in their teaching activities. The application of interactive presentation systems in student education leads to increasing of their interest to the educational material.

The paper presents the application of interactive presentation systems in the students' education in fashion design and clothing technologies subjects in the specialty of Design, Technology and Management of Fashion Industry at Faculty of Technics and Technologies of Yambol, Trakia University, Bulgaria.

II. Application of Interactive Presentation Systems in Fashion Design and Clothing Technologies Subjects

Interactive presentation systems are used in the more of the design and technological subjects in educational process of the specialty of Design, Technology and Management of Fashion Industry at Faculty of Technics and Technologies of Yambol, Trakia University of Stara Zagora, Bulgaria.

Figure 1 presents an application of an interactive presentation system in the lecture course and exercises of the subject of CAD Design of Clothing, especially the theme of CAD design of constructional base of lady's jacket.

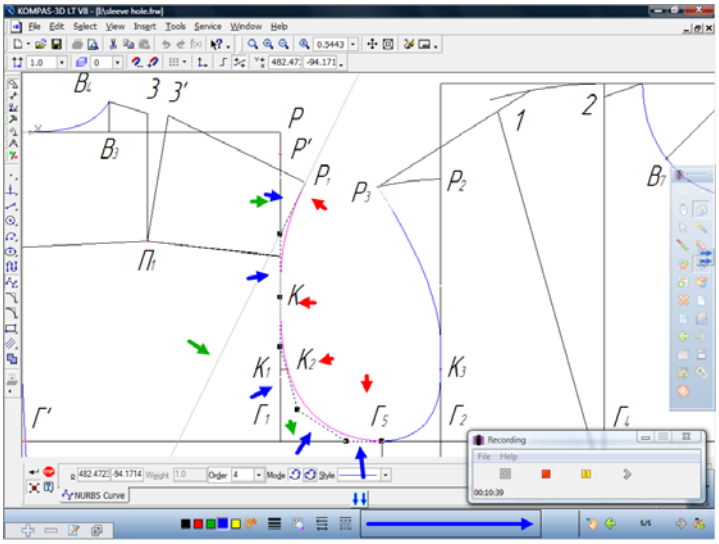

Fig. 1. Application of an interactive presentation system for pattern making of armhole of lady's jacket

The education of CAD design of clothing at faculty of Technics and Technologies offers to student possibilities for automated pattern making with two systems – Microdor Designer, which is specialized one for clothing design and CAD system Kompas – a universal CAD system. Figure 1 presents the application of an interactive presentation system for pattern making of the armhole with NURBS lines in CAD system Kompas, as the use of b-splines is the accent. The interactive presentation system uses the hardware of interactive white board eBeam and software of other interactive board Interwrite Dual Board. Notes and annotations in the time of the lecture course are set with the help of the software tools – darts, freehand lines, etc. The interactive stylus is used as mouse for work with drawing tools and tools for modification in CAD system.

Every action on the board by the armhole patternmaking is recorded of video file (.avi). The students possess access to the learning video files by the system of e-learn education and e-manuals.

The video file about pattern making of the armhole of the lady's jacket can be watched on: http://youtu.be/Zu40OzD3GUc
Or the video can be seen with the use of QR code:

By the QR codes the student can gain access to video files from traditional paper manuals.

Other application of interactive presentation systems in fashion design and clothing technology subjects will be presented in the full paper.

III. Conclusions

The interactive presentation systems give lecturers in fashion design and clothing technology new possibilities for presentation of educational material. It is too important and useful for the subjects of work with specialized software, graphics and schemes like it is in fashion design and clothing technology subjects. The new possibilities are more attractive and educational and lead to the increasing of students' interest.

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Design of ladies dresses in fitted silhouette

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Keywords **–fashion design, ladies dresses, fitted silhouette, close fitted silhouette.**

Introduction

The aim of the presented work is the creation of designer collection ladies' dresses. The main idea in the created collection was dresses to be designed in fitted and close fitted silhouette with clean lines without unnecessary extravagance. Draperies, pleats and creases were used in the shaping of the silhouette and focus in the figure.

I. DESIGN OF LADIES DRESSES IN CLOSE FITTED SILHOUETTE

The basic idea in creating dresses is designed to be close fitted silhouette with clean lines without unnecessary frippery.

In design solutions present symmetry or asymmetry, and the rhythm in classical compositions is linear, radial or parallel transmission.

Fig. 1 Model 1, 2 and 3

Colour choice is resolved in a calm pastel colors or bright colors in order to broadcast extravagant, but colored to highlight the effect of the elements forming the silhouette

Fig. 2. Ttechnical drawings of the designed models

Developed basic design of women's dress in succinct shape, built in method M. Müller + Sohn, which is modeled on three of the designed model.

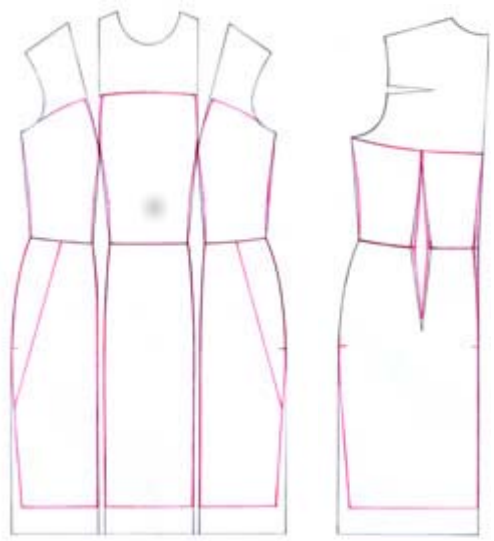

Fig. 3. Modeling of design models

Fig. 4. Tailored dress- photo

II. CONCLUSIONS

Design 3 models ladies dresses. Design projects focus on the silhouette and its morphology using drapes, pleats and creases. The modeling of dresses used the advantages of CAD systems.

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Design of Ladies' Dresses on the Base of Constructional Elements of Bulgarian National Costume

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Keywords **– Bulgarian national costume, classification, women's costumes, decorations, colors, constructional elements.**

The main types and variants of Bulgarian national costume are [2, 3]: with two aprons, with one apron, soukman (low-cut sleeveless dress) and saya (long dress), these being women's costumes, while men's costumes are belodreshna (predominantly white clothes) and chernodreshna (predominantly black clothes).

The Bulgarian national costume impresses with decorations, colors, constructional elements and for this reason make it asset source of creative inspiration for fashion designers [1].

The purpose of this paper is the use of constructional elements from Bulgarian national costume in design of ladies' dresses by reasons:

- The decoration of Bulgarian national costume has a big application in contemporary design. Therefore, study and analysis of elements in construction of Bulgarian peasant garments is a true challenge.
- The dresses are a kind of garment with a great diversity of design – combination of decoration and constructional elements. Figure 1 presents classification of constructional elements in Bulgarian national costume. On the base on this classification and analysis are made inferences:

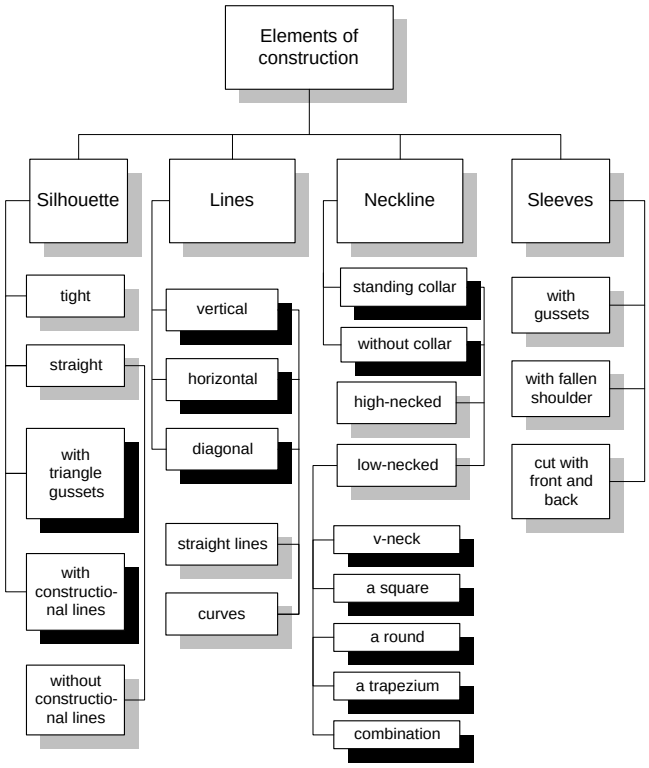

Fig. 1. Classification on constructional element in Bulgarian national costume

- Design of ladies' dresses may use with success following elements of Bulgarian peasant costume: silhouette with triangle gussets and constructional lines, necklines: v-neck, a square, a round, a trapezium, standing collar, sleeves: with gussets, with fallen shoulder and whole cut with front and back.
- Constructional elements in Bulgarian national costume have three functions: aesthetic, comfort of garment and a base for decoration.
- This study looks at two functions of constructional elements: aesthetic and a base for decoration.

Fig. 2. Dress

Fig. 3. Constructing of dress

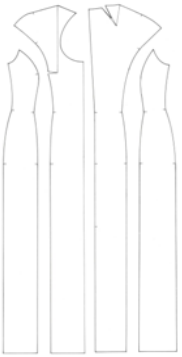

Fig. 4. Details of dress

Figure 2 presents a dress in tight silhouette, a round neckline without collar, and flare sleeves with fallen shoulder. The neckline and sleeves are decorated with edited traditional embroidery. The front and the back forms symbolize soukman. White flare sleeves symbolize sleeves from traditional Bulgarian shirts. Figure 3 presents the constructing of front and back and sleeve of model. Figure 4 presents details of front and back of model.

This paper presents two models of different dress silhouettes with elements of the Bulgarian national costume - combination of decoration and constructional elements. For two models are complete set of details constructing – patterns of front and back and sleeve, details of front and back and sleeve.

The combination between Bulgarian peasant costume and contemporary fashion inspire new life for Bulgarian national traditions. In this way a nation can preserve its national identity in today's global world.

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Influence of Pectinases Enzyme Retting On Hemp Fiber's Quality

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Keywords **– hemp, enzymes, retting, fibers quality.**

I. INTRODUCTION

The analysis of hemp cultivation and usage trends in the world and Europe shows that hemp cultivation and processing in Latvia has good perspectives. The usage of hemp fibers in traditional and technical textiles expands [1]. Bast fibers are separated from the natural gum and woody matter of the plant stalk in retting process. The retting processes are based on combined action of bacteria and moisture. Old methods are dew (stems are exposed on grass field), pool and stream (the bundles of plants are submerged in stagnant or flowing water) retting. Chemical retting with enzymes use allows a more controlled degradation of the fibers and a reduction of effluents [2].

II. EXPERIMENTS

The aim of this work is to study the influence of pectinases enzyme pretreating of Latvian hemp fiber "Purini" quality.

A. Methods of production

Hemp steam pretreating was realized in two temperature conditions 25°C (I) , 55°C (II) and 2(2), 5(5), 24(24), 48(48) hours retting.

A separation of fibers from the stem after roll influence was done manually.

B. Methods of testing quality

A quantity of fibers and sheaves was fixed gravimetrically.

Properties of untreated and enzyme treated hemp fibers were compared with use of color differences, TG analysis and physico – mechanical tests on INSTRON pulling device.

Color coordinates were evaluated in RGB system with Easy Color QA device, which allows determining L*, a* and b* values in CIELab - 76 color space (a*, b* - coordinates of color vector in a color space, L* - brightness) and calculate brightness difference (ΔL), common color differences (ΔE), saturation (S), hue differences (ΔT) with common formulas:

$$\Delta L^* = L^*_{sample} - L^*_{standard} \quad (1)$$

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \quad (2)$$

$$S = \sqrt{(a^*)^2 + (b^*)^2} \quad (3)$$

$$\Delta T = \sqrt{(\Delta E)^2 - (\Delta L^*)^2 - (\Delta S)^2} \quad (4)$$

Selected samples SEM pictures were fixed.

III. RESULTS

The results of experiment show that maximum of amount of fibers (32,0 wt. %) were obtained without enzymatic treatment. Small decrease of fiber quantity (31,3 wt. %) was observed after 5h enzyme retting at both temperature regimes.

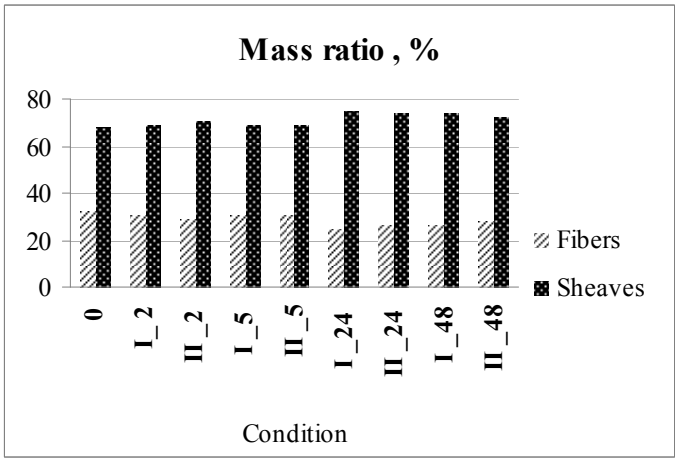

Fig.1 Comparison of mass ratio of fibers and sheaves for untreated (0) and pectinases treated (I_2- II_48) hemp stalks.

It can be explained with influence of enzyme on non cellulosic substances within hemp and their separation, which causes smaller fiber bundle formation (asserted with SEM pictures) and changes of single fiber tensile – elongation characteristics. Mass lose of hemp fibers at 100 °C /TG analysis/ connected with moisture lose after enzyme retting is insignificant in comparison with untreated fibers and was ~ 5 %.

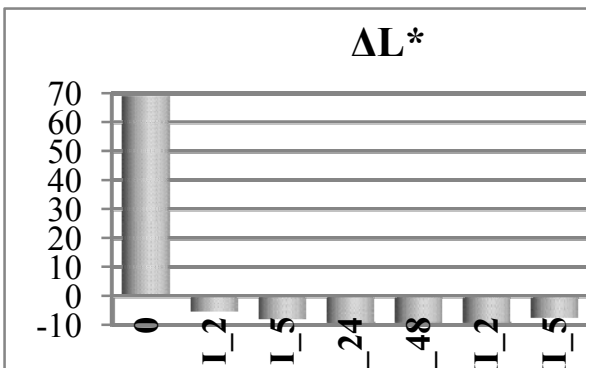

Fig. 2 Influence of treating conditions on brightness of hemp fibers

Color differences analysis showed the influence of enzymatic treatment on the color characteristics of the fibers. The certain temperature influence of enzyme treatment was observed.

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Classification of Textile-Based Sensors for Smart Garment Application

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***Keywords* – textile sensors, wearable electronics, application, classification.**

I. Introduction

Highly durable, flexible, and even washable multilayer electronic circuitry can be constructed on textile substrates, using conductive yarns and suitably packaged components [1].

Since clothes are the objects that stay closest to the human body 24 hours a day, they are the best platform to consistently measure biomedical signals without bothering wearers [2].

Sensors are essential for all monitoring applications. Designing wearable systems for physiological and biomechanical parameters monitoring, it's important to integrate sensors that are easy to use, comfortable to wear and minimally obtrusive [3].

Sensors can be categorized by several criteria, for example:

- sensor type by input and output data;
- sensor type by transduction method;
- measured parameters;
- location of sensor;
- material of sensor;
- possibility to be directly integrated in textiles;
- application.

In this paper textile-based sensors are summarized, analysed and categorized considering the above mentioned parameters. Classification of textile-based sensors could make it easier to design smart garments and to select required constructions and type of sensor for specified application. Especially it would be helpful for textile / clothing designers and technologists who are related to smart garment designing.

II. Classification of Textile-Based Sensors by Measured Values and Type of Integration

According to signal measurement sensors can be divided into two large categories: biomedical signals and environmental signals [2].

Biomechanical sensors can be used to record kinematic parameters of body segments [3]. EMG, ECG, EEG and GSR are frequently used biomedical signals that are measured with electrodes. Such biomedical signals like respiration, pulse, gesture, body temperature and moisture etc. are often measured as well [2].

Environmental sensors integrated in clothing can detect, for example: environmental temperature and moisture, humidity, pressure, light intensity, sound, solar rays etc.

Some part of sensors can be designed as multisystem fabric using only conductive and non-conductive textile materials. Another part of sensors cannot be fully replaced with textile materials, therefore it is important to consider their integration, so that they would be stably fixed to fabric, providing good signal transmission and keeping well comfort properties in garment.

III. Classification of Textile-Based Sensors by Type and Application

By application sensors can be categorized both by field of usage (medicine, entertainment, safety etc.) and by type of sensor (pressure sensor, moisture sensor etc.).

For example, pressure sensors depending on their type often are used both in biomedical measurements and to measure environmental signals. Pressure sensors can be categorized in the following way:

Piezoresistive pressure sensors are based on resistive principle. They consist of materials that change their electrical resistance according to pressure. Examples of application:

- detection of sitting posture in a wheelchairs
- intelligent carpets for analysing dance movements
- pressure distribution on the human body

Capacitive pressure sensor is based on capacitive coupling which takes human body capacitance as input. Application is similar as for piezoresistive pressure sensor. Touch sensor is another field of application [2].

Mechanical pressure sensor is based on principle of creating a circuit with a breaking point. At braking point it is possible to reconnect the circuit and to determine whether connection is active or not. Applications for such type of sensors are soft pushbuttons and keyboards that are made of 3 layers – two conductive parts and perforated insulator between them.

IV. Acknowledgement

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for a new functional properties of smart textiles development and integrating in innovative products", No.2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148.

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Textile Moisture Sensor for Enuresis Alarm System

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Keywords **– enuresis alarm, textile sensor, comfort, conductive yarns.**

I. Introduction

Bedwetting (Nocturnal Enuresis) is a common problem throughout the world, it has a very high prevalence in the preschool population and the prevalence slowly falls during childhood. Statistic data shows that at age 4½, 30% of children still wet the bed, 21% infrequently and 8% of these more frequently. Several therapies exist to solve this problem, one of them is enuresis alarm, which is a primary and an effective nocturnal enuresis treatment method for children.

II. Description of Alarm Systems

Enuresis alarm is a small device that is attached to a child's pyjamas or is placed under the child and signals, when the bed becomes wet. The drawback of the currently used systems is that (1) the attached systems are rigid and usually have wires attached to them, which may cause discomfort or additional stress; (2) sensors placed under the child are rather small and are made out of plastics, which prevent the skin from breathing and can cause discomfort.

During research existing enuresis alarm systems are overviewed, their drawbacks and advantages are analysed. The system is improved by making it more convenient to use.

III. Improvement of Alarm System Sensor

It is important to choose an appropriate size of the sensor – if the sensor is too small, then it may not detect the urination, but if it is too large, it may cause discomfort when it is worn [2]. The sensor must be placed in the area, which is mostly exposed to contact with the first drops of urine. Consequently, a solution that ensures greater comfort and detection efficiency is a direct sensor integration into briefs crotch area and using conductive material, which is incorporated into the fabric structure.

It is possible to integrate conductive contacts or circuits into textile structure, using various non-traditional techniques, such as: printing or laminating of conductive materials, interweaving, knitting, sewing or embroidery with conductive threads [3]. As a result it is possible to obtain a flexible sensor with characteristics of a textile product, which covers the entire area subject to wetting.

The aim of this research is to develop an enuresis alarm system with textile moisture sensor (electrode), which is more suitable for textile garments. Authors propose to design sensor by embroidery using conductive yarn. Conductive yarns are a preferable material for enuresis alarm sensors, since they blend with the textile structure of underwear and bedding sheet, inducing less stress on the treated person.

In order to assess suitability of such threads for the application envisioned, it is necessary to develop a suitable sensor configuration and to test the longevity and stability of the materials used.

Variable factors of the experiment and their variation levels are presented in Table 1.

TABLE I
Factors of the Experiment

	Variable factors	Variation levels
1	Yarn type, nr.	N1, N2
2	Sensor configuration, nr.	Comb-like (A), spiral (B)
3	Distance between electrodes, mm	5, 10, 15

As it was found in a previous research, conductive yarns behaviour can be influenced by several factors and various yarns can obtain very different properties. Within the framework of the research several sensor samples with different electrode configurations will be produced. Form configuration with 10 mm distance between traces of embroidered electrodes is shown in Fig.1.

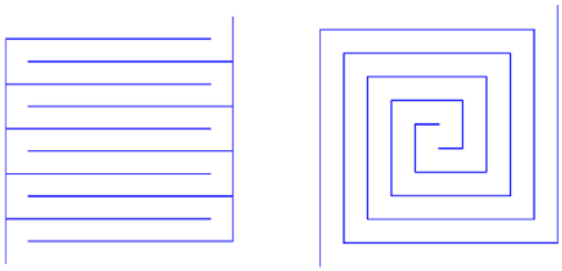

Fig. 1. Form configuration with 10 mm distance between traces of embroidered electrodes

In the result of research the most proper and effective solution of sensor type will be established, that will be used in further research for enuresis alarm system improvement and development.

IV. Acknowledgement

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for a new functional properties of smart textiles development and integrating in innovative products", No.2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148.

ESF EIROPAS SOCIĀLAIS FONDS — INVESTING IN YOUR FUTURE — EIROPAS SAVIENĪBA

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Modification of Microclimate Monitoring Jacket

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Keywords **– microclimate jacket, comfort, smart garment, wearable electronics.**

I. Introduction

Smart and interactive clothing is a novel industrial area, which gives clothing additional functional properties. Such innovative garments are used in different areas – sports, medicine, entertainment, etc. Smart or interactive clothing often function with integrated electronics and as a result garment can respond in adaptive way to external stimuli, process them and output as new signals [1]. During previous research [2] the child's jacket with embedded electronics was developed that reacts to microclimate changes with the help of integrated electronics, signalling about the temperature and relative humidity data. This article describes improved version of jackets with some modifications.

II. Improvement of Jacket Comfort Conditions

As the first imperfection of jacket prototype distribution of electronic elements can be mentioned, that didn't fully conform to ergonomic principles both due to system placement and size of elements. In a modified prototype electronic elements were placed in zones where influence of inner and outer strain to clothing and body is lower (based on analysis of studies [3]). Technical drawing of modified jacket prototype is shown in Fig.1.

To provide better under-garment microclimate, membrane is used as jacket basic material that is breathable and air permeable/waterproof. Membrane works both as a protective shell for electronics, protecting electronics from adverse contact with environmental moisture conditions (snow, rain), and provides good hygienic conditions for children body as well.

In addition ventilation areas in jacket are foreseen – in the back of jacket and in jacket underarms zippers are sewn that can be opened if it is too hot for a child.

III. Electronic Components and System for Microclimate Monitoring Jacket

In order to optimize weight distribution and decrease risk of injuries, the electronic system is divided in two main functional parts and is placed on both sleeves. Other elements include temperature sensor, placed in the back, which senses the temperature inside the jacket, and two LED panels in the frontal and in the rear part of the jacket, which can be used both for microclimate monitoring and for safety/decorative purposes. Mode switching is provided by an embroidered touch sensitive switch placed in the collar – it can be used to switch operational modes of the jacket.

IV. Acknowledgement

This work has been supported by the European Social Fund within the project "Establishment of interdisciplinary research groups for a new functional properties of smart textiles development and integrating in innovative products", No.2009/0198/1DP/1.1.1.2.0./09/APIA/VIAA/148.

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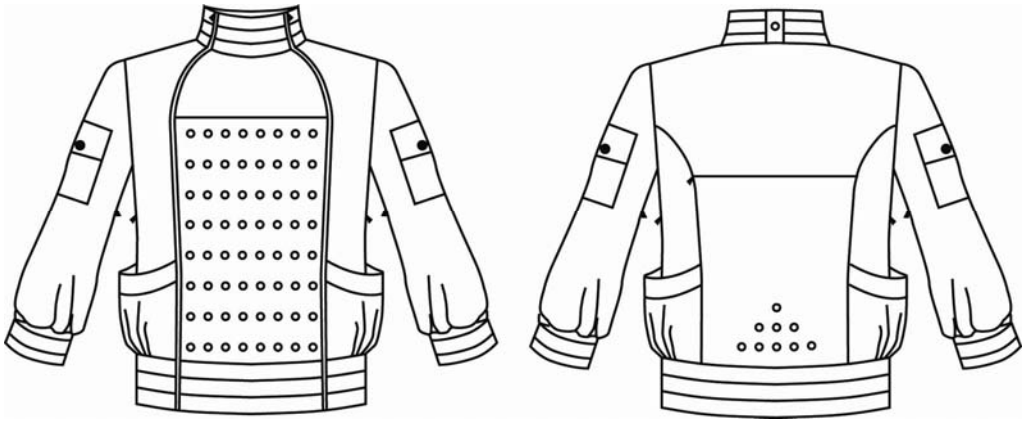

Fig.1. Technical drawing of modified jacket prototype

Steam explosion as pretreatment method of lignocellulosic biomass

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Keywords **– steam explosion, lignocellulosic, biomass, hemp, lignin.**

I. Introduction

Lately, there has been study of novel nanomaterials manufactured from renewable resources. An important class of nanomaterials has been nanofibers and fibrils from different cellulose sources, which have been shown to result inunique properties when incorporated in different polymers. The sources of these nanomaterials have been wheat straw, bacterial cellulose, kraft pulp, sugar beet pulp, potato, swede root [1], and also local renewable resources grown in Latvia – hemp and flax.

The aim of this article is to estimate steam explosion auto-hydrolysis (SEA) influence on hemp fibres and shives and flax shives microstructure and influence of pre-treatment intensity, steam explosion process temperature and pressure on disintegration level of lignocellulosic biomass. The acquired results are discussed and interpreted by Fourier transform infrared spectroscopy (FTIR) and scanning electron microscope (SEM).

II. Materials and methods

Disintegration of fibers and shives from different hemp varieties (Purini, Bialobrzeskie) and flax grown in Latvian Agricultural Science Centre of Latgale by alkali treatment and steam explosion were investigated.

As first method alkali treatment of fibers under investigation with 4 wt. % NaOH during 1 h at a temperature 80°C is used. Second applied method is steam explosion auto-hydrolysis (SEA).

SEA being one of the most prospective pre-treatment technologies facilitates separation of the lignocellulosic biomass components in a single course of action providing the source for biofuels, chemicals, and nano-materials [2].

Since the lignocellulosic material, under conditions of steam explosion, can provide "selfsufficient" chemical and physical transformation [2] both the processes, hydrolysis and defibration, can be achieved without any additional reagents (except steam). Further fractionation [4] of the biomass products after SEA is rather simple (Fig. 1).

All SEA products have a variety of applications [4]. Hemicelluloses, during the SEA can be hydrolysed to sugars – xylose, mannose, arabinose, etc. and used as molasses, the substrate for fodder yeast or bio-ethanol. The xylose sugar can be hydrogenated to xylitol (sweetener) and can also be dehydrogenated to furfural – an excellent feedstock for chemical processing [2].

III. Results and discussion

Morphological and spectroscopic analysis of treated and untreated fibres were carried out and found that fibres and shives treated by SE could be usable for futher nanotechnologic processing. Results of this study have shown that SE treatment combined with following hydrothermal and alkali treatment allow to remove partly constituents from hemp fibers and shives including hemicelluloses, pectins/waxes and oils covering the external surface of the shive cell wall and depolymerizes the native cellulose structure.

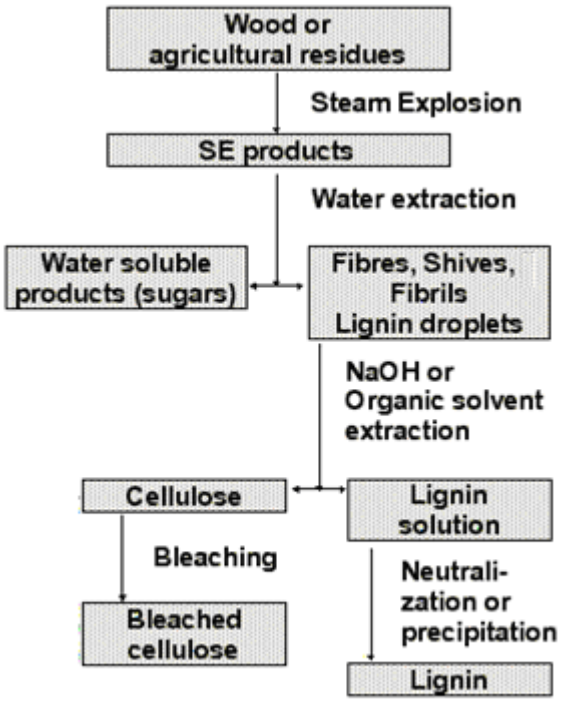

Fig. 1. Fractionation of steam exploded biomass. [4]

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The Role of usage of latest Clothing CAD/CAM Systems in Education

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Keywords **– CAD/CAM, clothing design, pattern making, garment virtual try-on.**

I. Introduction

Modern computer aided designing software provides the possibility to avoid small operations and manual work, to raise precision, productivity and organize information flow (1). The usage of garment designing systems excludes the time consuming manual preparation of patterns, creation of layouts and relocation of written information. The computer systems are meant for the execution of every single process and the integration of all processes into one joint flow, for the organization of logistics and the mobility of work tasks (3).

The computerization of different processes in the garment industry is necessary to reduce the costs of a product and raise the competitiveness.

Computer systems allow making two dimensional as well as three dimensional product illustrations and visualizations (2). It is possible to create computer aided garment constructions, as well as gradations, and create a virtual first pattern of the model - such computer aided operations significantly decrease the time consumption and cost necessary to design a product. The costs of the product itself can be calculated with the help of the product management systems following the development parameters, the layout of patterns, textile expenditure, model complexity and specification, as well as previous experience of the company stored in a data base.

Although computer systems significantly facilitate the development of a product, the knowledge and skill of the user are still very important.

II. Usage of clothing CAD/CAM systems in education process

Recently with the demand of made to measure garment design, it becomes a trend to extend 2D clothing CAD systems into 3D CAD's. 3D garment virtual display is one of most interesting branches in the clothing field – as 3D virtual representation of clothing provides high potential for design, garment development and marketing: catalogues, e-commerce, made to measure, etc.

To learn CAD/CAM systems there are several systems teached in Department of Clothing and Textile Technologies: Grafis, Comtense, Staprim, Lectra, Gerber and Koppermann. 3D virtual clothing imitation is provided by CAD system Lectra. Goals and objectives of the course are to give knowledge and skills to work with CAD system Lectra, Introduce to 3D garment designing. Students should learn the structure of clothing CAD system Lectra. Development principles and functions on the basis of Modaris. The principles of clothing construction and pattern design. The rules of pattern grading by sizes. Definition of a model and variants. Marker making subsystem Diamino. Choice of models and sizes. Create markers on fabrics with definition and changing of parameters. Choices of process. Preproduction garment specifications using KaledoStyle. Preparation of pattern blocks for 3D imitation in CAD Lectra Modaris 3D Fit.

III. Role of CAD/CAM systems in Education

One of the most important garment creation stages is constructing. The systems providing full garment development and production cycle are important to the manufacturing and hence for educational purposes.

Tasks for the students working with CAD systems are combined manufacturing tasks: to create computer aided garment constructions, as well as gradations, and create a virtual first pattern of the model. Within these tasks students are able to learn CAD/CAM systems (as Lectra – Modaris, Diamino, Kaledo, Modaris 3D Fit).

Students get examples, lessons and tasks to do for gaining learning outcomes (to be familiar with CAD system).

The course is started with introductory lecture: description of CAD Systems and garment 3D development. At the next lessons the development processes in the garment CAD system Lectra and its structure is described. For gaining external pattern blocks (from CAD system Grafis) Import and Export of pattern blocks in different CAD systems are described. Editing of graphical objects in CAD system Lectra module Modaris and creating of graphical objects in CAD system Lectra module Modaris, Internal lines, seams are described. And preparation of pattern blocks for 3D imitation in CAD Lectra Modaris 3D Fit, simulation of fabric design is learned.

After the course students are able to Import and Export of pattern blocks in different CAD systems, can create and use grading tables for garment designing, can create model pattern blocks using graphical edition, able to create patterns from model or basic blocks. Ability to work with such functions has been shown in Labs in computer class

Students are able to create patterns from model or basic blocks and models technical specification. Ability to create logical and effective steps of designing and development, also to use development principles and functions of system and changeable parameters of pattern has been shown in study project. Can create model patterns and do 3D simulation in CAD system Lectra. The ability to create correct garment 3D simulation, error solving and visual design has been shown in study project.

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Humanities and Social Sciences

Learning Motivation

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Keywords **– education, motivation, motive, student, study process.**

I. Introduction

In the academic year 2011/2012 the total number of enrollees in the undergraduate programs was 24457, including 17800 commencing their full-time studies, yet a part of students will terminate their studies. The latest statistics on student attrition available for analysis dates back to academic year 2008/2009. This year's total attrition rate for full-time students in Latvian highest education establishments was 14.9%, with LU – 15.9%, RTU – 16.65%. The majority of applicants have graduated from secondary school within the last five years and it can be assumed that their study and cognitive skills have remained at a sufficient level. Consequently, it is necessary to define the factors causing academic failure, even if it is not resulting in student attrition. The scholars [2] agree that study motivation plays a major role. There is an important distinction between study motivation in the general education setting and at the university level, explained by the weakening of parental authority and control of daily academic performance, less frequent assessment; transition to different educational environment, disappearing of social control interventions and more pronounced anonymity accompanied by insufficiently developed self-control.

Motivation is a system of all interrelated motives determining the behaviour of an individual.

Motive:

- a reason for a certain action or behaviour,
- an incitement for individual's action, substantiating the reasons why the action is performed.

Extrinsic motivation

Influenced by external recognition (rewards, fear, opinion of reference group, scholarship, rotation etc.).

Intrinsic motivation (discovering something yet unkown, becoming more intelligent incl. cognitive interests etc.).

II. Motivation for commencing studies

Globalization, expanding labour market and study opportunities have changed the applicants' motivation commence their studies. The formation of motivational structure in higher education area becomes less and less influenced by the state policy and other macro factors, but the role of micro factors, such as the significance of individual's free choice, tends to increase. The role of the state in study motivation is solely related to the number of state-funded study places and the state budget allocated.

The major factors for commencing studies are:

- willingness to become a student;
- interest in a particular area; occupation;
- striving to become independent and move out of the parents' place
- possibility of living and working in larger towns (capital) and not returning back to the countryside;
- accepting an advice of a close friend and enrolling for studies together;
- continuation of family traditions;
- fulfilling parents' dreams and expectations and submitting to pressure that studying is compulsory.

Research studies have acknowledged also the gender differences in motivation:

- young women find more important the social significance of the profession, wide demand for experts of the particular profession on the labor market, possibilities of getting involved in amateur art activities during study period, solid salary prospects;
- young men are more likely to choose the study program according to their own interests and family traditions [2., 264-265].

Studies have shown that the enrollment rate can be increased by convenient accessibility to studies due to less competitive admission requirements, prestigious diploma, keen interest in several study courses included in the study programme.

III. Motivation in the study process

The problematic aspect of motivation is interlinked with the quality and efficiency of the study process. Motivation in higher education can be classified as follows:

- Motivation based on professional and cognitive learning activity;
- Intrinsic and extrinsic motivation.

It is hard to distinguish one separate motive. Actions are usually polymotivated. Study motivation in professional study programs is in a great measure influenced by the aspect of luck, which is related to the control process leading to positive assessment. Consequently, the student self-assessment tends to be positively oriented.

The motivation of cognitive learning activity as an inner motivation is oriented towards mental activity.

IV. Study motivaton of students of RTU and LU

A research aimed at acknowledging the study motivation of students of full-time undergraduate programs in RTU and LU was conducted in the academic year 2011/2012. The following research methods have been used – focus group discussion and questionnaire. The focus group discussion allowed acknowledging determinative motives to initiate studies. Questionnairing was implemented with the use of two questionnaires designed according to the module principle, thus devising them to be similar in content and different for the students of the first and the last study year.

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Social Studies Teachers' Attitudes towards Teaching Strategies

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***Keywords* – social sciences, professional competence, constructivism, instructionism.**

The development of professional study programmes in higher education is an urgent task in recent years in the system of education in Latvia. This concerns both the optimization of the content of the existing study programmes and the organization and development of new topical programmes.

The dynamics of the social processes determines the necessity to facilitate preparation of high quality professionals for teaching social sciences and improve the professional competence of the currently working teachers.

Professor L. Lyubimov notes that already in the 1970s it was discussed that pedagogical technologies of the transmission type (based on transmitting information teacher→learner as well as memorizing and reproduction) have exhausted themselves. These technologies have been denoted as "instructionism" by *learning studies*. They are characterized by the following peculiarities: 1) learners master a new topic without any relation to prior knowledge; 2) learners do not integrate the accumulated knowledge with new ideas and cannot find mutual correspondences; 3) learners memorize facts, events, and processes without understanding their sense; 4) learners memorize information without reflecting on the goal and strategies of learning; 5) learners do not understand dialogue as a process, cannot judge, evaluate the logic of arguments, argue. Instructionism is transmission of knowledge within which teacher (subject) affects learner (object) [1].Teacher instructs, controls, evaluates.

Accepting the dynamic of the contemporary society development, the rapid progress of modern technologies, opportunities and challenges offered by globalization, constructivism is positioned as the most adequate learning strategy that originated in the first half of the 20th century. Within constructivism there is reorientation from teaching to learning [2]. It is based on the idea of learning as an active process in the course whereof learners actively construct knowledge proceeding from their own experience. Knowledge is not offered to learners in a "ready-made" manner but instead favourable pedagogical conditions are created to secure acceptance of individual needs of each learner and respect his or her opinion [3]. Learner (subject) becomes an equal participant of the process of learning. Teacher in this context is a counsellor who organizes problem based learning and coordinates it. Teacher models the conditions that stimulate the development of learner's critical thinking (using clash of opposed opinions, revealing contradictions in the process of discussion, etc.). Constructivism as a learning strategy is productively applicable in acquisition of social science.

In the spring of 2012 a survey was organized with the aim of investigating the personal professional experiences of social science teachers by studying: 1) teachers' opinion of the principles of organizing the process of learning; 2) teachers' attitude towards instructionism and constructivism; 3) teachers' professional aptitude for the implementation in their professional activities basic positions of constructivism.

132 respondents who are the holders of the qualification of teacher of social sciences participated in the survey.

- Teaching only social sciences- 37 (28%);
- Teaching social sciences and history- 64 (49%);
- Teaching social sciences and other subjects (biology, chemistry, sports, Latvian language and literature, geography, etc. - 31 (23%).

Respondents' age was from 23 to 80; teaching experience – from 1 year to 52 years (half of respondents – more than 17).

IBM SPSS Statistics 19 version software was used for data processing.

As a result of processing the empirical data it was stated that on the whole teachers have a positive attitude towards their subject and prefer constructivism as a strategy of teaching in the organization of the process of learning.

In the chapter on teachers' attitude towards constructivism and instructionism in the process of teaching social sciences practically all respondents (except 3) supported constructivist approach.

Teachers consider that in their professional activities they could successfully implement standpoints of constructivism.

Nevertheless, the analysis of a particular pedagogical situation within which the position of teacher-instructionist or teacher-constructivist had to be adopted, 28 (21%) of respondents supported traditional, instructionism based approach, while 85 (64%) prefer the model of lesson based on constructivist approach, but 19 (14%) take a neutral position.

The analysis of 4 aspects (cognitive approach, emotional, action, and ecological approach) reveals two clusters: 70.5% support the positioning (U) and support the approach of constructivism, while 29.5% do not support the positioning (U) and position themselves as instructionists.

Cluster analysis gives an opportunity to state that teachers-instructionists are not many in number but they are more assured of the rightness of their position. Teachers-constructivists, in turn are less assured of their position. This may be accounted for by the fact that supporters of constructivism share the basic positions of this strategy but unfortunately they lack deeper understanding about its practical implementation in the process of learning.

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Formation of a Personal Worldview in Learning Environment of Vocational School

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***Keywords* – world view, personality formation, educational environment, vocational education.**

I. Introduction

The world view can be looked upon as a part and goal of the educational process, which could enhance education for sustainability of the society. That makes formation of the world view a topical task of education. World view as a strategy in personality formation and development through formation of personal attitudes in educational environment is one of the tasks in the vocational education. Many young people discontinue their formal education after vocational school, and world view as the main attitude towards world helps them to find meaning of life and motivation for further activities.

II. World View and Education

World view is an individual paradigm, constructed on the base of experience [5] and centered in values. It is connected to social reality and beliefs of the human being. It allows a person to formulate an attitude towards life [3] and express it through personal attitudes. The attitudes are the result of education and personality formation and are influenced by environment [8] including educational environment.

Educational environment is a broad concept of places, spaces, time, activities, people, adventures and reflections met by the student in his/her education [8] in vocational school. It might be coincidental or formed with the purpose to educate, to provide new experience, both cognitive and emotional.

III. Analysis of World View in Vocational School Students

The study presents results of the analysis of world view of vocational school students in Latvia. 40 documents for analysis per year were randomly chosen from 4700-5000 exam essays in Latvian language and literature, written in 2004, 2007 and 2011, 120 essays in total. *Weft QDA* software was used for content analysis. Results of the analysis were discussed in interviews with teachers (6) and experts of education (3).

The formation of world-view can be indicated by student's attitude towards oneself, nature and society (history) and presence of values and internalization in analyzed texts.

TABLE II
World View Construction According to Texts Obtained in 2004, 2007 and 2011

Year	Internalisation and values (%)	Internalisation and constructive attitudes (%)	Internalisation, constructive attitudes and values (%)	No values indicated (%)
2004	23	25	15	40
2007	50	40	35	15
2011	65	53	53	10

During the study it was determined that world view construction is more clearly and distinctly expressed in texts obtained in 2011, in comparison to documents obtained in 2007 and 2004, because in texts obtained 2011 presence of internalised values and constructive attitudes can be identified. However, Table 2 confirms that formation of world view still is a process, not the result of the process at the final stage of the vocational education.

IV. Educational Environment

Interviews with teachers reveal that teachers are aware of the significant role the world view construction plays in development of personality. Teachers are trying to stress the role of the family, as well as deficiencies in vocational education curricula (reformed in 2004-2007) and educational process, thus trying to distance themselves from responsibility in this matter.

The opinion of experts (two principals and an expert from the National Centre for Education) was voiced during partially structured interviews after introducing experts with the results of the study.

Experts admitted that students' world views are constructed as a result of and interaction with the educational environment, including families, schools (teachers) and community. They indicated the significance of teacher's competence, personality, world view, as well as his/her skills to blend studies (theoretical and practical) with extracurricular activities in a united process. Physical and socio-economic environment in school and society has its impact on construction of students world view, therefore the need to create appropriate preconditions for students' ability to establish relations with society outside the school and learn about cultural heritage is emphasized. The integration of adventure education in vocational education is an opportunity to make it possible for students to gain new experience in relations with different environment. Experts also highlighted that families fail to get involved in forming the experience of values, but schools have limited possibilities to compensate for what the families have failed to provide.

V. Conclusions

- The world view of the vocational schools students is more clearly expressed in 2011 than in 2007 and 2004.
- Formation of world-view depends more on the educational environment and teacher's personality than on the content of curricula.
- Interaction between school and community, broadening of educational environment by including adventure education elements may help in student's world view construction.

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Competency-Based Curriculum Development at Higher Education

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***Keywords* – competence/competency, levels of competence, competence-based education, Bologna strategy 2020, curriculum development, competence-based curriculum.**

I. Introduction

Competency-based education (CBE) is a common European strategy which is caused by social and economic, political and educational conditions. Many higher educational institutions experience a growing gap between their curriculum and the demands from society and business for a more flexible workforce with high skills (competencies) in problem solving, team work and project management [1].

CBE is oriented to professional practice and is focused on outcomes (competencies) that are linked to workforce needs, as defined by employers and the profession. CBE is **not** an emphasis on trying to teach skills - rather an emphasis on skill development within a learner-centered environment where the learning process is central. CBE has a constructivist approach. The constructivist paradigm together with the concepts of competence forms the backbone of competence-based education. CBE provides a project-based education which allows students to take risks and develop their own creative solutions to problems; give the leadership opportunities and teamwork applications. In CBE the role of the teacher is that of a "cognitive guide". CBE has learning environment focused on the development of competencies and assessment oriented on competencies.

II. Definition of Competence

The notion of competence is at the centre of competency-based education. Competence as defined by European bodies, as well as by educational experts throught the Europe, consists of three interrelated components:

- a knowledge component (the understanding part),
- a behavioural component (the overt behavioural repertoire) and
- a value component (including values, beliefs and attitudes).

Competence consists of combination of knowledge, skills, attitudes and behaviours required for effective performance of a real-world task or activity. Competence is defined as the holistic synthesis of these components. Competence is multi-dimensional and dynamic.

Competency and competence can be defined as follows:

- **Competency** is the capability to choose and use (apply) an integration combination of knowledge, skills and attitudes with the intention to realise a task in a certain context, while personal characteristics such as motivation, self-confidence, willpower are part of that context.
- **Competence** is the capacity to realise „up to standard" the key occupational tasks that characterise a profession (1). Key occupational tasks are the tasks what are characteristic for a profession.

Five levels of competence in competency development can be mentioned: novice; experienced beginner; practitioner; knowledgeable parctitioner; expert [2]. Competencies should be reviewed regularly and redefined to reflect the changing needs of labour market.

III. Bologna Strategy 2020 and Curriculum Development

Bologna strategy 2020 is oriented on solutions of problems facing European economy. The short-term priority is successful exit from the crisis. Five EU targets for 2020 will be translated into national targets: employment; research and innovation; climate change and energy; education; combating poverty. One of the priorities is developing an economy based on knowledge and innovation. Education system has to facilitate the entry of young qualified people to the labour market. The delivery of Europe`s 2020 strategy requires improved quality of higher education. One aspect of the reforms should aim at a strengthening of the knowledge triangle between education, research and business. Programs are challenged to focus on professional competencies as the outcomes of education and training.

IV. Competency-Based Curriculum Development

High quality and "labour- market relevant" education requires changes in the traditional approaches to designing and delivering curriculums. In the CBE curriculum development is based on the elaboration of profiles and identification of competencies.

Curriculum design in steps:

1. Find the set of core tasks that define the profession.
2. Describe each core task in terms of product, process, supportive theory and skills.
3. Determine for each core task the complexity levels to be offered to the students.
4. Determine the contexts in which a professional task is performed.
5. Define the course blocks and position them in the curriculum blueprint. A course block is defined by the combination of core task, complexity level and context.
6. Formulate the guidelines for assessment and for creating rich learning environment [3].

Regarding to the implementation of the curriculum it is extremely important that intended learning outcomes (competencies), teaching and learning approaches and assessment are aligned.

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Pedagogy and ICT as the Basis of Interdisciplinary Subject

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***Keywords* – ICT, Pedagogy, language, interdisciplinary.**

I. INTRODUCTION

E-learning has emerged as a new paradigm for learning in the modern world. However, nowadays, e-learning expects the learners to use a lot of materials by means of ICT while studying a concrete discipline. Besides the Pedagogy for e-learning has still been a research theme. The educational process of discipline should be considered with a suitable pedagogy associated with e-learning. Therefore, it is important to note the interconnection of disciplines associated with the educational process of concrete subject.

II. PEDAGOGY AND ICT AT THE INTERSECTION OF DISCIPLINES

With the development of powerful online technologies ICT is increasingly becoming a key medium for many distance educational domains or disciplines; among them is language learning and teaching or e-learning/teaching of foreign language on the base of ICT. Several disciplines are usually involved in the educational process, i.e. ICT, Course of Study and Pedagogy.

ICT is the means available for delivery of knowledge. Hence, it forms the base subject or medium of information interchange, where search of information and communication processes take place. Otherwise ICT **(**Fig 1, zone 1) is the use of computers or electronic equipment to collect, store, use, and send data electronically. ICT refers to technologies that provide access to information through telecommunications. It is similar to Information Technology (IT), but focuses primarily on communication technologies. This includes the Internet, cell phones, and other communication mediums. The ICT expression was first used in 1997 in a report by Dennis Stevenson to the UK government and promoted by the new National Curriculum documents for the UK in 2000 [1].

Area of knowledge, which is studied in school, college or university, is called **Subject of Study** (zone 2). It composes a key discipline which determines the purpose of studying to acquire academic or professional skills.

Pedagogy is about how to teach/learn (zone 3), i.e. it is the study of teaching methods, including the aims of education and the ways in which such goals may be achieved. The field relies heavily on educational psychology, or theories about the way in which learning takes place [2].

The zone 123 determines interdisciplinary subject, in other words a branch of knowledge as a course of study, i.e. e-subject.

The broad range of terms and abbreviations are used to characterise this zone number 123. In case of subject 'foreign language studying' this e-subject is called e.g.:

CAVL – Computer Assisted Vocabulary Learning.[3];
NBLT – Network-Based Language Teaching;
WELL – Web-Enhanced Language Learning;
CALL – Computer Assisted Langguage Learning;
TELL- Technology-Enhanced Language Learning.

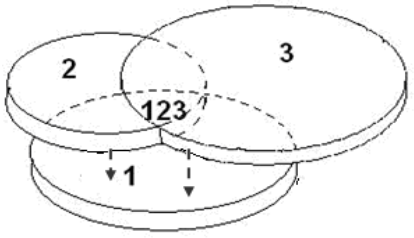

Fig.1 Information and Communication Technologies, Study Course and Pedagogy are the components of common e-subject
Where: 1 - Information and Communication Technologies; 2 – Subject of Study; 3 – Pedagogy; 123 – ICT **and** Study Course **and** Pedagogy

III. IMPACTS OF ICT ON PEDAGOGY

In an analysis of the contributions of ICT to the teaching and learning process in the university the following findings can be mentioned:

- New technology - ICT can stimulate the development of intellectual skills.
- Students using new technologies concentrate more than students in tradidtoional settings.
- ICT promotes collaborative learning
- ICT can contribute to ways of learning knowledge, skills and attitudes, although this is dependent on previously acquired knowledge and the type of learning activity.
- ICT spurs 'spontaneous interest'more than traditional approaches.

The rapid growth of information and communication technologies has provided new opportunities for knowledge acquisition. It is a new pedagogic reality, which empowers both teachers and students and provides wide access to information and versatile sources of knowledge. The leading role belongs to Pedagogy as an educator leads the teaching process directed to the self-study of definite subject on the base of ICT application.

Studying a Subject, i.e. Course of Study by means of ICT and impact of Pedagogy, composes a united e-subject, which can not be considered and treated separately .

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Perspectives of Social Prognostics in Modern Society

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***Keywords* – prognostics, "Black Swan", theories of apocalypsis and chaos, social progress, postmodern epistemology.**

This study is based on two theoretical sources – "Black Swan" by the experienced financier and publicist N. N. Taleb and "Liquid Modernity", a monography by British sociologist Z. Bauman. This main question this study addresses is why during the last decade society has not been prepared for cataclysms of economical, political and social nature and why explanation for these events has been looked for only *post factum.*

The book "Black Swan" by N.N.Taleb became very popular among both professional financiers and people unrelated to economics. The author asserts that in our modern ever-changing society it is impossible to come up with accurate social prognosis. The allegory "black swan" is used to describe an event which meets the following criteria: 1) The event is an anomaly because it had not been predicted by anyone; 2) The event has a major impact; 3) Due to human nature we seek an explanation for the event *post factum* and rationalize it by hindsight, although it was first perceived as unexpected. When speaking of human consciousness and its limited abilities, Taleb uses the term "triplet of opacity". It consists of the following components: 1. An illusion or fictitious belief that people are aware of all events in a world that is more complicated than it actually seems; 2. Distortion of events in retrospective which is a natural tendency to estimate events *post factum* and give them the most desirable meaning; 3. Exaggeration of the significance of a fact, mostly as a result of the act of "platonization" done by scientists where they create theories in hindsight which turn out to be fictitious. Taleb mentions the stock market crash of 1987 as a notable example of the "black swan" phenomenon – no one had predicted the crash and it did not become a good example for future reference [1]. Postmodern sociologists have a similar fatal opinion on social prognostics. Postmodern epistemology is described by four basic postulates: 1) De-fundamentalism – questioning of the fundamental basis of being. Symbolic systems and mass media culture are pushing the real object out and replacing it with "culture text". Boundaries between ideas and objects, truth and error are being broken. Truth is no longer determined and complete. 2) "Death of the hyper-narrative" – people no longer believe in "privileged" knowledge. In the final instance truth is being replaced by pluralism of opinions and a variety of interpretations. There are no general criteria for truth and credibility. 3) Fragmentarism – the development of knowledge in postmodern society is not continuous and progressive. Knowledge has a situational nature, and the process of cognition ends at some point. The process of knowledge and cognition is not based on general principles and criteria. 4) Constructivism – knowledge is not based on real world images but rather on cognitive schemes of interpretation. Everyday notions overrun scientifically-based knowledge. An important factor is narrative – a socially accepted type of story-telling which defines the parameters of everyday and scientific discourse.

Z.Bauman, who is far from being a radical postmodernist, is also sceptical towards the modern man`s ability to influence the shape of events and predict them. In his opinion, progress is not marked by the quality of historical events but rather by **self-assurance** regarding current events. Understanding of progress is based on two principles: 1. "Time is on our side"; 2. "We control the course of events". However, if self-assurance serves as the only basis of belief in progress, it seems that there is no force that would move the world forward – the main modern question is not "what should be done" but rather "who is going to do it". Bauman compares our experiences with those of flight passengers when they realize that the cockpit is empty. He also conludes that all models of a "happy society" have turned out to be utopian. When speaking of progress, Bauman concludes that it has become individualized – unadjustable and privatized. It is still unclear whether an innovation means improvement even after the choice has already been made. Bauman refers to another sociologist, the French P. Bourdieu, who also gives a fatal assessment of social planning perspectives. Bourdieu states that in order to plan future one must stick to the present. The only new statement is that a man should stick to his own personal present. Bourdieu assumes that many people have an insecure attachment to present while others have no attachment at all. In his work Z. Bauman confesses a global intellectual powerlessness and declares that attempts on avoiding unpredictable circumstances and events are mere gambling. In Bauman`s opinion, modern science has actually acknowledged the undetermined chaos that runs the world, the important role of coincidence and exceptions and the fact that order and balance does not exist. Z.Bauman speaks of how politicians and economists are unable to avoid chaos and mentions the experience of physics. In his opinion, examples of chaos in physics teach us that several dynamic situations do not lead to balance but rather to chaotic and unpredictable events. Analogously decisions of legislators and officers made in order to reach balance can actually lead to strong mutiny with possible destructive consequences [2]. This conclusion can be attributed to the unsuccessful efforts on stabilizing the social situation and minimizing threats of extremism by politicians and economists all over the world.

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Global Economic Crisis in Latvia: Risks for the Social Security System

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***Keywords* – global economic crisis, system of social security, coping strategies, trust of society.**

I. INTRODUCTION

The global financial and economic crisis has affected many countries, though economic recession in Latvia because of external and internal reasons is one of the most difficult and complicated among EU member states, which makes reduction of social consequences of crisis a serious challenge.

The crisis is affecting all spheres of life and different categories of population, especially those in the risk of poverty and social exclusion. The problems people face have become more complex – decline or loss of income, unemployment, inability to pay for housing, health care, education, loans, etc.

The aim of the paper is to discuss manifestation of crisis, coping strategies, and effects to the system of social security on the basis of statistical analysis and 30 in-depth interviews with members of different household types. The interviews were carried out from 2009 to 2011 by the authors and students from Riga Stradins' University.

II. CHARACTERISTIC OF ECONOMIC CRISIS

Overheating of economy, fast growing domestic demand and state budget imbalances resulted in dramatic downfall, starting from 2008. Reduction of GDP reached its lowest point -18% in 2009 (EU-27 -4,2%). The crisis was followed by the growth of unemployment rate, which significantly exceeded the average (See Table 1).

TABLE I

HARMONIZED UNEMPLOYMENT RATE

	2008	2009	2010	2011
EU-27	7.1	9.0	9.7	9.7
Latvia	7.5	17.1	18.7	16.2

Although the poverty rates were also high in the pre-crisis period, and the threshold of poverty risk at 60% of equivalent income is low, recession has also brought deterioration in this sphere - at-risk-of-poverty rate was 26% in Latvia (17% in EU-27) in 2008 and 2009. Also the number of needy persons was small during the pre-crisis period, but it has increased during the crisis, and has grown from 5.3% in 2008 to 8.6% in March 2011.

The government has taken severe steps to the response of the crisis - borrowing abroad, budget consolidation and structural reforms.

III. EFFECTS ON SOCIAL SECURITY

Social budget cuts during the crisis were significant - serious decrease of social benefits, the reduction of the old-age pension amount etc. Though the solutions to reduce the budget deficit chosen by the Government were - the heaviest burden of the crisis was borne by the poor and working people with low and average incomes.

A. Social Insurance

Government decisions which concern social insurance principles, have, in actual fact, reduced the motivation of the population to pay taxes. In view of the fact that the development of the state social insurance system was started in the 90ties of the 20th century and a comparatively long period of time passed for the approbation of the system and gradually the trust of the society in the system was acquired, time and resources will be needed to restore the confidence and trust of the society in government decisions and the system in general.

Inhabitants of the working age who have lost their jobs are to be mentioned as groups most exposed to the poverty and social exclusion risk. In contrast to those countries where in the conditions of crisis those inhabitants who had gone abroad in search of employment, returned, in Latvia it is just the opposite – even notwithstanding the economic decline in practically all member states, the number of inhabitants leaving the country in search of employment abroad continues to grow. So Population census 2011 gives evidence, that Latvia lost significant number of its population.

B. Social Assistance

The crisis increased the need for social assistance. Therefore several new activities to strengthen social security net for the poorest were introduced – GMI benefit was increased, housing benefit was introduced as a mandatory benefit. To improve the situation of the unemployed, a new activity – work practice in local municipalities with grant of LVL 100 – was introduced with the support of EU Structural Funds (ESF). Also several activities were introduced in the health care within the social security net. Although something has been done regarding social protection, the support is too low.

IV. CONCLUSION

Even in 2012 when the government talks about recovery from the crisis, the number of the poor population and applicants for the GMI benefit are very high, and unemployment level is decreasing very slowly with very high proportion of long- term unemployed.

Since 2009, the necessity to dramatically reduce national budget expenditures and the budgetary deficit in Latvia has brought to the foreground the issue of the sustainability of the existing social insurance system and the rapid fall on the revenue side of the national special social insurance budget caused by the consequences of the economic crisis.

So, decisions taken by the government have resulted in the loss of trust of the society not only in the state social insurance system but on the whole social security system of Latvia. All of the taken measures significantly affect not only the current situation, but also have a long-term effect.

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Constitutional Reform Experiences in Eastern Europe and Latvia

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Keywords **– democracy, institutionalization, legitimization, governance system, constitution.**

I. Introduction

Upon initiation of democratization nearly all Eastern European countries have introduced new constitutions. There are only two exceptions: Latvia and Hungary [1]. Feasibly due to the fact that Latvia did not adopt a new constitution and this topic was not subjected to further discussions, the arguments on the necessity of reforming the constitution, which were stirred up after restoration of independence, are still ongoing. Neither the political elite nor academia are able to reach consensus on the matter. The problem has become even more significant due to the insufficient efficiency of the Latvian political system and dissatisfaction of the opponent of the political elite –the people - with functioning of the current governance system.

II. Constitutional reforms in eastern europe

Contrary to political systems in half of Western European countries where monarchs act as heads of state, all Eastern European countries are republics with elected presidents. Even though the makers of constitution of several post-socialist countries were influenced by the U.S. presidential system and have given their presidents considerable powers, yet nowhere in this region would the presidential system follow a precise pattern of the United States. All Eastern European countries employ the principle of separation of executive powers – between the head of state and government led by prime minister. In the majority of countries (with few exceptions) the parliament has the powers to remove the government by passing a vote of no-confidence. Thus it can be concluded that all these systems share a key common feature of a parliamentary system. However, it can be certainly asserted that only nine out of twenty countries (Latvia, Estonia, Czech Republic, Slovakia, Hungary, Slovenia, Albania, Serbia and Montenegro) are operating a parliamentary system. The rest of countries, to a lesser or greater extent, fall into category of semi-presidential systems. The semi-presidential system are characterized by a dual executive consisting of a cabinet, a prime minister and a president who is elected through direct voting and provided with considerable powers. For the sake of concreteness, it has to be noted that following the changes that occurred in 1989-1990, the tendencies of semi-presidentialism appeared widely in the Eastern Europe, being accompanied by discussions on pros and cons of different governance systems. Yet, it needs to be taken into account that such tendencies were often determined by the political practice (complexity of issues, instability of governments, expectancies from society) rather than by a particular constitutional norm. Another recent tendency has been that parliamentary governance systems start taking a more dominant position in Eastern European countries than the presidential ones, which have moved away from the original model. Most of countries have decreased president's authority and initiated changes in constitutional practice. In political systems of Eastern European countries president's position has a wide range of functions- from being solely a representational figure (e.g. in Slovenia) to the presidents empowered with strong executive power (e.g. in Russia) [2].

What conclusions can be drawn when summarizing the constitutional experience of Eastern European countries? Firstly, the constitutions of these countries have taken on different forms and some or even multiple smaller or larger reforms have been carried out. Secondly, a tendency of moving towards a parliamentary system not presidentialism or semi-presidentialism can be observed. Thirdly, the fact that the head of the state is elected by direct election does not mean that the executive powers will concentrate in hands of president, attempts of changing the constitutional norms or usurpation of power by taking the advantage of options provided by constitutional practice.

III. Constitutional reform in latvia: 20-year long discussions

Not only since restoration of independence but, as a matter of fact, already since the years of the First Republic of Latvia, there is an ongoing discussion on the necessity of constitutional reforms.

The reform proposals are varied – starting with an introduction of amendments within the parliamentary system to development of a brand new governance system taking the form of a semi-presidential or presidential constitution. By evaluating the recent proposals for the Satversme reforms, it can be concluded that the institute of the president elected by the people, runs like a golden thread through most of them. This is a common trait among most of proposals. There is not enough consistency about the limits of presidential power and its correlation with other branches of authority. Even though the attempts of moving towards a parliamentary-presidential system tend to dominate, it is possible to find proposals for a presidential system. An assumption is made that election of the president by popular vote could form the basis for further discussions. Several Eastern European countries as, for example, Slovakia and Slovenia, while implementing similar reforms, have found rather non-traditional solutions.

Will our political and intellectual elite be able to reach consensus on the necessity of Satversme reform? Taking into account the regular debate on this issue in Latvian politics and dominating orientations in civic political culture, it can be forecasted that solution to this issue will be positive. Since our political culture changes in a slow pace, but the legitimacy of political institute is low, perhaps it is worth changing the rules for the game, what is to be done more easily. If we agree to the opinion that there are problems underlying our political system, it is necessary to give a try to all possible options to increase its legitimacy and efficiency.

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The Beginning of the XXI Century: Transformation of Etiquette Norms

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***Keywords* – development of society, etiquette, behavioural norms, transformation.**

I. Introduction

The article presents a theoretical study of social change taking place in the beginning of the XXI Century and the corresponding transformation of etiquette norms. The social processes are influenced, regulated, harmonized by a range of factors: legal norms, administrative regulations, morality, religion, traditions etc. One of the informal factors regulating social processes is etiquette.

II. Etiquette and its role in society

Although the notion of etiquette has originated from the French language and became more widespread only in the XVII Century, certain politeness norms and rituals existed already as far back as Ancient Egypt, Greece, Rome etc. Due to frequent religious and secular celebrations, festivals and appearing of the carnival traditions, the formation of behavioural patterns was particularly rapid during the Renaissance era in Italy. Therefore there are grounds to assume that Italy rather than France is the country of origin of etiquette.

Etiquette is a set of behavioural norms to be followed by people during the communication process.

Etiquette offers a particular behaviour pattern, standard, benchmark etc., thus contributing to mutual understanding of people engaged in a communicative situation. Since etiquette regulates the person's conduct in all spheres of social and personal life, it can be subdivided into – common, business and diplomatic [1]. With each of those determining a certain specific action.

III. Changes in human behaviour patterns

In accordance with the abovementioned classification, the basic functional level of etiquette - common or human etiquette is used in all forms of interpersonal communication. When characterizing this aspect of etiquette it has to be noted that all significant processes occurring within society – globalization, democratization, urbanization, migration etc. take effect on modern human behaviour. Considering the nature of etiquette, it is necessary to highlight its duality - the most common etiquette standards, which are changing and situational, relate solely to external expressions of behaviour, however, the philosophical substantiation of etiquette – the basic principles and values of ethics and aesthetics, is much more solid and changes only as a result of crucial social transformations.

Nowadays the transformation of common etiquette norms is wide scale and covers such areas as: meeting and greeting rituals, proper use of forms of address , table manners, dress codes, using the elements of non-verbal communication, language etc.

IV. Development trends in business etiquette

Evolution in the standards of common etiquette has caused corresponding changes in business etiquette prescribing standards of professional conduct. Many behavioural norms have become less conservative. Currently occurring changes are also related to technologies entering our households and professional environments, thus significantly redefining the form and nature of human interrelationship and causing a necessity for changing the former behavioural standards and developing new ones (e.g. issues related to the use of cell phones or etiquette of computer networks). Particular innovations appeared in the style and exchanging customs of business cards, creation of visual appearance, guidelines for business formal wear employer-employee behavioural models etc. Customs have changed as well for the organization of formal social events and recreational activities. Human behaviour in professional environment tends to become more democratic.

V. Peculiarities of change in diplomatic etiquette

Diplomatic etiquette or protocol is considered to be a particular form of etiquette, which encompasses code of behaviour for the highest state authorities and diplomats used to perform their duties. First international diplomatic rules of conduct were established in Vienna Congress in 1815. The diplomatic protocol is the more conservative part of etiquette and is less subjected to change. With correlations in international environment, corresponding transformation processes mirrored in diplomatic etiquette [2]. For example, upon the establishment of the European Union and creation of new flag, appeared the need for updating the part of the protocol regulating the flag etiquette.

VI. Conclusions

Since etiquette regulates the human conduct in differing dimensions of social life, its manifold expressions (including changes and amendments) occur with more changing intensity. Nowadays, the most rapid transformation in etiquette is seen in human daily life and business environment, what supposedly will cause adequate amendments in diplomatic protocol. Besides, it must be noted that along with the rising dynamics of social processes, the process of transformation of etiquette norms becomes faster.

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Literature, Language and Personality: Insight into the Problem

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***Keywords* – literature, language, personality, formation of the man of culture, education.**

The economic, social and cultural historical changes that have taken place in Latvia have created serious changes in the education system and the teaching/learning content. General human and national values and ideals become more significant; the formation of an intellectually developed, creative personality becomes more topical [1].

M. Zālīte admits that literature is the study of man, the study of life, the study of love and patriotism, ethics, aesthetics and philosophy, psychology and history. Literature is the study of conscience, honor and self-esteem. It means that literature is closely connected with the inner world of the personality and the formation of the value system. It gives a possibility for the pupil to experience the life of the literary heroes, their fate, different models of people's relationships, moods and emotional feelings as well as enjoy the power of the word and develop the sense of language. Literature plays a paramount importance in the development of a lingual personality [2].

Already in the first half of the previous century the specialists on teaching the language and literature unanimously agree that literature takes a special place in the learning content and it should be taught as the art subject because one of its most important tasks is the education of man and cultivation of the intellectual world. The main task of the teacher in teaching the creative work is to create in pupils deep and true emotional experience, on the one hand, and to reveal the mastery of the language's applicability, to encourage pupils to form their own utterances by learning from the works of language masters.

No literary work can be created without the language means; however, without understanding the nuances of the meaning of the language signs – morpheme, word, sentence, also sound and punctuation marks- being unable to understand the peculiarities of the national world which is revealed in the text, it is impossible to perceive fully what has been said in the literary work and which was kept unsaid, the clear and the foreboding, to feel the content of the text and sub-text, to enjoy the play of words, to refresh the soul and enrich the mind as the literary work is the polyphonic text which most completely reveals the world of national values, the power and beauty of language, its richness and splendor, its complexity and simplicity. Thus It is so important to encourage a serious dialogue between the pupil and the teacher, the pupil and the piece of art in the lessons of the Latvian language and literature, which will result in the formation of the children's and young persons' value system, understanding of the world, the development of their sense of language and the idea that a book is an essential accessory of a modern personality. It is possible to ensure the link between the acquisition of word and text, to master in a complex way the language and speech phenomena, to broaden the pupils' cognitive and cultural world outlook, to ensure the disciplinary and interdisciplinary link by including different texts in the Latvian language teaching materials and working with them in the lessons.

Text is the highest unit of the language system in which all its elements, all its units are combined and arranged in a definite system therefore the text and especially a literary text as a didactic unit gives a possibility to combine three essential aspects of language acquisition – the acquisition of the language system, the speech behavior norms accepted in the national culture, the exploration and perception of the nation's world. Working with the text (both the author's and one's own), pupils along with the logical and language skills also develop their communicative skills.

As it is known the cultural information accumulated in the previous centuries is focused in the literary work. Thus there is a real possibility in the learning process to organize pupil's "dialogue" with the key national values that with the help of linguistic means of expression are reflected in the work, to reconstruct the national notions about the values (e.g., using riddles, phraseologisms, proverbs pupils find out the meaning of different facts, realia, phenomena in the people's life, how our ancestors understood and valued them, compare them with the traditional and modern understanding). Thus pupils can not only include the ethno-cultural values in their world but also see and understand the codes of other cultures, to look at culture through the eyes of people who have created these values.

Unfortunately, the authors of study materials and the language and literature teachers not always value the role of literature as the former of the nation's intellectual life and the educator of the young generation therefore not all the possibilities offered by the literary works are used in the teaching.

The idea that the teacher has to be a personality that is graced with high moral and ethic features, who continuously supplements, renews and improves personal knowledge, that the teacher should have the inspiration and be the initiator is still very topical.

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Type Theory and Socionics: Are they Mutually Complementary Theory?

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Keywords **– Type theory, Myers- Briggs Type Indicator, socionic, individual, sociotype.**

I. INTRODUCTION

A large number of researchers and practitioners in United States of America and Western Europe use Myers-Briggs Type Indicator which is a type theory tool in their works. Research works are carried out in socionics in Russia and Ukraine and its discoveries are used in practice. Both these theories have been formed based on C.G. Jung's theory.

Type theory as well as socionic classifies individuals according to four dimensions: whether they gain energy through interaction with others or through reflection alone; whether they focus on facts or correlations; whether they make decisions impartially, based on logical thinking or emotionally taking into consideration other factors; whether they prefer planned lifestyle or a spontaneous flexible one (tab.1.).

TABLE I

THE NAMES AND NATURE OF THE DYCHOTOMY DIMENSIONS

No	Type theory	Socionics	Internationally recognized codes	Significance
1.	Extraversion/ Introversion	Extraversion/ Introversion	E/I	Indicates psychological activity directed towards outer world or inner world
2.	Intuition/ Sensing	Intuition/ Sensory	N/S	Indicates the type of information gathering and processing
3.	Thinking/ Feeling	Logic/ Ethics	T/F	Indicates the type of decision making
4.	Judging/ Perceiving	Rational/ Irrational	J/P	Indicates lifestyle

There are 16 types of individuals in both theories.

The aim of the article is to highlight the fact that both type theory and socionics are doctrines of the individual and the information is not contradictory but mutually complementary.

II. RESEARCH METHODS AND RESULTS

Author has studied the works of more than one hundred (117) socionic researchers and more than sixty (61) type theory researchers [2].

As shown by the information sources used by the author in her dissertation, research in the type theory using Myers-Briggs Type Indicator MBTI was carried out in many American states, in Europe and Australia.

Now the Kiev socionics school (A.V.Bukalovs, V.V.Guļenko, V.D.Jermaks, G.A.Šulmans etc.), Novosibirsk socionics school (A.S.Filatova, N.J.Jakušina etc.), St. Petersburg socionics school (V.Mironovs, G.Reinins etc.) have contributed extensively to the development of socionics. With the development of socionics there were several definitions and based on these the author offers her own version: Socionics is the theory on individual sociotypes, their interrelationships and management of human potential development. Sociotype is the natural set of individual physic features that determine how the individual gets energy, perceives information, make decisions and structures his/her own life.

The author has carried out a comparative analysis of the dichotomy characteristics in type theory and socionics as well as dichotomy features. The full version of the article is followed by brief description of the dichotomy.

The needs of different students in the study process in both type theory and socionics are defined by the combination of one and the same pairs of dichotomy features in sociotype. The author has worked out a summary of individually differentiated methodological concept of the study process based on the theoretical notions [1;3] on differences in learning styles of students of introverted sensing, introverted intuition, extraverted sensing and extraverted intuition sociotypes that could be applied in the optimisation of the study content, choice of methods and promotion of cooperation in the pedagogical process (fig.1). Introverted inclined sensing and intuition sociotype learning style has a common feature – these students need time for thought while starting a task or giving an answer. There is a common feature in the case of extraverted inclined also – the desire to work in a group. But different inclinations of sensing types as well as the various inclinations of intuition types also have common features. A certain procedure for acquisition of knowledge should be emphasised for sensing sociotype students whereas discovery of knowledge should be emphasised for intuition sociotype students.

Both type theory specialists as well as socionics specialists are also of the same opinion about the correspondence of ST, SF, NT and NF sociotype groups to certain types of professional activity.

III. CONCLUSIONS

To summarise based on the research the author has come to the conclusion that both type theory and socionics have a common theoretical base (C.G.Jung's psychological type theory), different explanations (different explanation of the functional models) and common end results (16 types and their characteristics). Both type theory and socionics information is not contradictory but mutually complementary and can be applied to understand ourselves and others in day-to-day situations, in family, education and work.

These theories are not widely known in Latvia. Globalization processes offer researchers worldwide the opportunity to mutually benefit and enrich themselves if only they are ready to avail these opportunities.

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Career Longevity of a Rescue Worker in Contexts of Pathogenetic and Salutogenetic Paradigm

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Keywords **– emergency situation, crisis, psychological well-being, posttraumatic stress reactions.**

I. INTRODUCTION

Effectiveness of professional activity is a multiple-factor phenomenon. It depends on many variables, which can be hardly tracked in one research. At the same time one criterion – personal pattern of coping with crisis events in professional activity – is beyond question. This criterion is also a multiple-factor phenomenon.

Professional activity of rescue workers is tied to extreme conditions. Extreme nature of the activity is defined by permanent threat to life and health (including psychological) of every rescue worker.

To make prognosis of psychological traumatization of rescue workers after completion of emergency situation (ES) management actions psychologists use relation 1:4. This relation represents rescue workers traumatization level: 80% of rescue workers who have taken part in ES management actions, overcome difficulties using their own resources as well as social support network resources. Others may require psychological help.

Two trends of psychological researches have been singled out. Some researches are concerned in ways and methods of elimination of psychological trauma influence on an individual (symptoms resolving). Such researchers were interested in the group where psychological help was needed. In psychology of health this approach has a catch-all title – **pathogenetic paradigm.** The other researches are concerned in finding resources, which an individual requires not only to resolve symptoms but to put up resistance to such symptoms, and thereby sustain personal growth and development. The researches pay attention to cases of successful personal coping with stressful situations and to searching of factors facilitating stress tolerance [1]. A.Antonovsky called the approach as **salutogenetic**. In the framework of the paradigm such concepts as "sense of coherence" "hardiness", "psychological well-being", etc are covered.

Within the framework of the research we set a goal to solve the following problem: by which means rescue workers should be strengthen in order traumatic effect of ES stress factors could impulse their personal growth. To achieve the goal we have to figure out, among others, the manner in which the above two paradigms are related. Individual research was carried out in this effect.

II. SAMPLE GROUP AND ANALITICAL TOOLS

213 rescue workers aged between 18 and 43 took part in the research. The research was of voluntary nature. Assessment of participants was carried out in small groups. Number of people in groups did not exceed 10. Empirical data collection procedure was carried out in 2012 over a period of approximately four months.

Riff's Psychological Well-Being Scales [2] were used to measure psychological well-being of the rescue workers. *The Mississippi PTSD Scale* [3] was used for the purpose of measuring of post-traumatic stress reactions intensity.

III. RESULTS AND THEIR CONSIDERATION

As a result of statistical analysis of the received data it was discovered that all the *Well-Being Scales* has negative correlation with values of *the Mississippi PTSD Scale* ($p<0,01$). At the same time correlation ratio (Pearson`s r) is within the range from -0.189 ("Autonomy") to 0.475 ("Positive Relations with Others").

The obtained results indicate the following. Firstly, pathogenetic and salutigenetic paradigms should be viewed as complementing each other rather than opposite and independent. It is not enough just to release an individual from post-traumatic reactions. The individual is never going to be the same as he used to be before he was traumatized.

Secondly, for the purpose of rescue workers` mental and psychological health maintenance it is necessary to expand their internal resources to which sense of coherence, psychological well-being and hardiness can be referred.

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Corporate Sustainability and Social Responsibility: Challenges and Opportunities for Protecting a Company's Reputation

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Keywords **– corporate sustainability, corporate social responsibility, social-economic constraints, sustainability-oriented company, company's reputation.**

I. Introduction

The majority of companies in Ukraine are not aware of their role and responsibility in the social-economic development of the country. The social partnership between companies, business, government and community of Ukraine is characterized by fragmentariness and lack of systematization. Nevertheless, the most successful enterprises start to pay attention to aspects such as company's reputation, corporate brand and corporate sustainability. Ukrainian businessmen suggest that social activity can improve the company's reputation but deny the necessity of realization of CSR programs on a voluntary basis.

Taking into account the complexity of ensuring the corporate sustainability in the unsustainable environment [7,8,9], it is important to define and analyze social, economic and institutional constraints that impact for corporate sustainability. Given paper represents the research focused on development of sustainability theory, theory of constraints, CSR models and theories for investigation of the impact of corporate sustainability on company reputation.

II. Challenges and Incentive Measures for ensuring the Corporate Sustainability

Sustainability theory attempts to prioritize social responses to economical, environmental and cultural problems in the modern society. Sustainability theory is based on sustainable development theory, corporate social responsibility, stakeholder theory and theory of constraints. It's an evolving concept that managers are adopting as an alternative to the traditional growth and profit-maximization model. This study is based on results of activities of 57 industrial enterprises in four areas of engineering (heavy engineering industry, chemical engineering, electrical engineering, mechanical engineering) in three regions of Ukraine (Eastern, Western, Central). The results of researches are based on surveys and questionnaires of managers. 175 people were involved in the process of the research, 75 of whom worked as managers in big companies, 46 in medium enterprises and 54 in small firms.

According to survey, we have found out that the main obstacles for ensuring the corporate sustainability are lack of financial resources, absence of the acceptable legislation and low level of motivation in business (Figure 1 in f.v.). In addition, the lack of appropriate tax incentives in state leads to loss of interest in Ukrainian enterprises to implement the social responsible programs. In addition, we have identified the possible prospects of socially responsible business in Ukraine: tax optimization, reduce of regulatory and administrative pressure and so on (Figure 2 in f.v.)

III. Social-Economic Constraints to Corporate Sustainability

The theory of constraints (TOC) is a philosophy of management and improvement of organization's effectiveness. Let's note that under 'social-economic constraints' we understand economic, social and institutional factors that define the limitations of optimal using of company's potential in the unsustainable environment. A measure of sustainability orientation can be evaluated on the basis of bringing into proper correlation between the harmonization of organization's goals and the expectations of managers, staff, investors and other strategic stakeholders. The results of researches allowed defining and systematizing the core characteristics of sustainability-oriented enterprises (Table 1 in f.v.).

IV. The Simulation of the Impact of Corporate Sustainability on Company's Reputation

Corporate sustainability evaluation process of is one of the main conditions in effective simulation of impact of social indicators on business reputation's level. We identified a set of quantitative and qualitative indicators which can estimate the level of socially-oriented business management (Table 2 in f.v.). We have analyzed key performance indicators of industrial enterprises in four areas of engineering (heavy engineering industry, chemical engineering, electrical engineering, mechanical engineering) in Eastern, Western and Central regions of Ukraine during the 2004-2009 years. The complex and ambiguous dependency between different groups of quantitative and qualitative indicators was defined. In such way we decided to use the methodology of fuzzy sets in the analysis of parameters that have indirect statistical relationships among the indicators of measuring of corporate social responsibility. All things considered, there are core factors which make the significant impact for the company's reputation: quality of corporate management system, level of top management competence, business practices in relation to consumers, business practices in relation to suppliers and other business partners, implementation of environmental programs, participation in regional social development programs, charity projects and so on. However, these social factors must not deny the priority of economical interests of an enterprise.

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Family-friendly Workplaces as a Form of Corporate Social Responsibility

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Keywords **– work-family reconciliation, family-friendly workplace, corporate social responsibility.**

I. Introduction

The social dimension of business practices has gained much prominence with the emergence of the human rights movement, environmentalism and gender equality issues etc. As well as the issue of corporate responsibility is at the heart of many of the debates on economic policies around the world. Should corporations simply maximize profits or do they have some obligation to be good corporate citizens as well? Corporate social responsibility goes well beyond companies' traditional involvement with charities; it involves concerns as varied as human rights, family-friendly workplaces, environmental protection and community development [1]. Corporate Social Responsibility is a term commonly used to depict a business' efforts to attain sustainable results by adhering to good business standards and practices. Corporate Social Responsibility initiatives of organizations can be understood from two broad perspectives: (1) externally focused (popular visible level) and (2) the internal policy level. Three broad areas are important in grasping the concept of Corporate Social Responsibility: (1) a company's relationship to its employees, (2) a company's relationship to its particular industry and (3) its relationship to society at large. This paper focuses on the internal policy level examining issues related to an organizations relationship to its employees, particularly on organizational support in employees' possibilities to reconcile work demands and family responsibilities.

II. The concept of family-friendly workplace

Reconciling work and family life is a key challenge in contemporary societies. Many families face conflicts when attempting to meet the requirements of work and home. A crucial role in work-family reconciliation and dealing with work-family reconciliation related challenges is not only for individuals, but also for organizations as workplaces. In order to denote multiple initiatives and provisions of organizations that are focused on helping employees find solutions for work-family reconciliation, scientific literature largely use the term *family-friendly workplace.*

Family-friendly workplace is a sort of working conditions/working environment in an organization created/adapted in order to support and facilitate possibilities of employees to combine work demands and family responsibilities. The concept of *friendly* are conceptualized as favourable, advantageous, beneficial, eligible, convenient, encouraging and the like. Family-friendly provisions include a range of leave, working-time flexibility and child care arrangements delivered through statutory entitlements and formal or informal provisions at the workplace. Different benefits, programs and policies are, perhaps, the most visible indicators of a family-friendly workplace. Although there is no single, widely-accepted approach to the classification of work-family policies and programs, it is possible to organize them into four basic groups: (1) Leave from work for family reasons (maternity, paternity, parental leave, leave to care for elderly dependants or bereavement); (2) Changes in work arrangements for family reasons (home-working, teleworking, flexi-time working, compressed work week, term time only contracts, facility to switch between full and part time working exemplify this category of flexibility); (3) Practical help with child and elder person care (child care facilities, daycare centre, family room, affordable and accessible nurseries and play schemes on holidays); (4) Information, training and networking assistance (availability of information about the existing facilities, assistance for re-entrants and the active promotion of family friendly benefits and entitlements) [2]. Generally, the principles of a family-friendly workplace are universal, but each organization seeks their own configuration of family support strategy.

III. Family-friendly workplaces in Latvia

Based on the research data [3], it is possible to discuss the development of family-friendly workplaces in Latvia. The time period of the development of family-friendly workplaces in Latvia is more or less disputable. We must distinguish two matters: the process of the development of family-friendly workplaces and the aspect that has gained public awareness and is discussed nationwide.

Presently in Latvia we can witness polarisation of perceptions in regard to the existence of family-friendly workplaces. On the one hand, there is an opinion that working environment in Latvia is actually family-unfriendly, based on the fact that there are few organizations that are defined as family-friendly, since the status of family-friendly entrepreneur has been granted up to twenty companies only. On the other hand, the research shows that there are many workplaces in Latvia that are family-friendly in various ways, but they do not popularize or highlight these aspects; besides, some of the family-friendly initiatives are considered to be a norm and they are not appreciated in this aspect. It can be explained both by the work legislation norms and requirements and by the employers' attitude issues and informal practises.

There are particular expectations that the stakeholder groups hold to in connection to the necessity for organizations as workplaces to get actively involved into overall support system of work-family reconciliation.

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Self-Concept of Adolescents with Diverse Centrality in Classroom

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***Keywords* – self-concept, social status, centrality.**

I. Introduction

Positive self-concept is a desirable goal as well as an important means to facilitate the attainment of other favorable outcomes [27]. Therefore, it is necessary to find out how self-concept develops. An important developmental period for self-concept is adolescence. There is evidence that adolescents with different social status among peers have different experiences with peers. Adolescents use their own observations and evaluations they receive from others to build their self-concepts. It is possible to expect that adolescents with different social status among peers should have also different self-concepts. An important dimension of social status is network centrality. Thus, the purpose of this study is to investigate whether there are differences in self-concept for adolescents with different levels of centrality in such peer groups as school class.

II. Method

Participants

Participants in this study were 297 adolescents aged between 14 and 17 years (M = 15.11, SD = .46); 49.5 % of participants were boys (n = 147) and 50.5% were girls (n = 150). All participants were studying in the 9th grade in Russian-language based schools in the capital city of Riga.

Measures

Self-concept. To assess adolescents' self-concept the Russian version of the SDQ-II was used. This version was developed by J.Ļevina and N.Ivanova. The original English version of the SDQ-II was designed by Herbert Marsh. It measures students' perceptions of their ability in Math, Verbal, and General School as well as students' perceptions of their Physical abilities, Physical appearance, Same-sex relations, Opposite-sex relations, Parent relations, Honesty/Trustworthiness, and Emotional stability. The General-self domain measures students' perception of their overall self-esteem.

Peer groups and social status (centrality). To determine adolescents' level of centrality within school class the Social Cognitive Map (SCM) procedure developed by Cairns and colleagues [5] was employed. The students are first asked "Are there some people here in your class who hang around together a lot?". The software SCM version 4.0 (Leung, 1998) was used to identify peer groups within a social network and to determine participants' social status based on the SCM procedure. Each student's social network centrality or his or her status within the classroom (nuclear, secondary, peripherial, and isolated) was determined by combining the centrality level of an individual student's peer group with his or her centrality within that group.

Procedure

The questionnaires administration took place during regular school hours when the teacher was not present. Data were collected in class groups without any time limit.

III. Results

The participants were categorized into three groups: students with nuclear centrality, students with secondary centrality, and peripheral/ isolated students. Univariate ANOVAs revealed significant differences among adolescents with different levels of centrality for Physical Abilities scores [$F(2, 294) = 5.88$, $p < .01$, $\eta^2 = .04$], Opposite-Sex Relations scores [$F(2, 294) = 3.90$, $p < .05$, $\eta^2 = .03$], Same-Sex Relations scores [$F(2, 294) = 12.50$, $p < .000$, $\eta^2 = .08$], and Mathematics [$F(2, 294) = 3.34$, $p < .05$, $\eta^2 = .02$].

TABLE I

SDQ-II DESCRIPTIVE AND CONCLUSIVE STATISTICS FOR ADOLESCENTS WITH DIFFERENT CENTRALITY IN SCHOOL CLASS (ANOVA)

Scales of the SDQ-II	Centrality						
	Nuclear		Secondary		Peripheral / isolated		
	M	***SD***	***M***	***SD***	***M***	***SD***	***F***
Physical Abilities	36.96[a]	9.11	35.22[a]	9.89	27.55[b]	8.61	
Physical Appearance	35.14	7.97	34.23	9.48	30.45	10.98	
Opposite-Sex Relations	35.61[a]	7.52	33.34[b]	8.39	31.00	6.56	5.88**
Same-Sex Relations	48.07[a]	7.96	44.44[b]	9.15	37.27[b]	11.39	1.76
Parent Relations	38.49	7.57	39.79	7.36	39.82	6.52	3.90*
Honesty-Trustworthiness	39.11	6.95	39.02	7.51	40.55	6.50	12.50***
Emotional Stability	37.81	9.20	37.77	10.32	36.82	12.71	.97
Mathematics	38.20[a]	11.83	34.27[b]	11.32	37.91	11.10	.23
Verbal	40.11	9.43	41.13	7.92	42.27	10.81	.06
General School	46.27	8.15	45.00	9.30	47.64	8.98	3.34*
General Self	47.38	7.18	47.85	8.38	47.36	7.03	.59

Note. $*p < .05$, $**p < .01$, $***p < .001$.

[a,b,c] Means in the same row differ significantly in *Post-hoc* comparison.

It appeared that adolescents with nuclear centrality in school class had, first, more positive physical abilities self-concept than peripheral/ isolated students, second, more positive opposite-sex relations and mathematics self-concepts than secondary students, and, third, more positive same-sex relations self-concept than secondary and peripheral/ isolated students. There is also revealed that secondary students had more positive physical abilities self-concept than peripheral/ isolated students.

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artMUSE – How European Transformations Trigger Digital Creativity

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***Keywords* – media art, transformation, Europe, industrial and digital revolution, participation.**

I. Introduction

The European locations of industrial culture, urban history, contemporary art and protohistory in Bocholt, Gdansk and Bitola seem to share many characteristics like work, technology, textile art and social development. What are the characteristics of these histories of industrial revolutions and in which way may they concern us even in our everyday's (digital) reality? The project artMUSE creates a space where experimental creativity of media artists meets European industrial history and today's urban population to look for common patterns, sources of diversity and hybrid traditions.

II. Challenges of knowledge transfer

Essentialism in curatorial work, e.g. the assumption that objects independent from context and interpretation show an "essence" which underlies them, outlasting all changes, determining their "true nature" and causing them to be what they "essentially" are, levels contradictions and disables and prevents citizens from developing a more differentiated perspective [1].

A. Problems of adequate representation

For a long time, conditions for the creation and tradition of knowledge have been determined by the political and social mainstream, whereas individual perceptions of reality were hardly represented by it. In spite of the democratisating effects the dissemination of knowledge via the new media unmistakably has [2], conditions for the creation and tradition of knowledge and memory remain dependent on contemporary hegemonic discourse.

B. Alternative Readings

If one considers the industrial revolution as a concept of migration, of self-exploitation and collective actions, of conflicting interests and values, of diffusion of ideas and creativity, of changing urban spaces – then this concept which has left its marks in the different places intertwined via artMUSE is also transferable to today's creative industries. At the same time, one could re-evaluate the impact the industrial revolution had on Europe's citizens – what seems to have been a matchless victim's plot full of short-change, suppression and sacrifices is leveled by the digital age's reality of people moving and migrating due to the labor market. Young artists looking for new forms of expressions via digital technologies find themselves in a time of European ecological, economical and social transformation. Like the weaving patterns the spinning mills transformed into prints and motives more than a century ago, today's smart media translates digital signals into a matrix of digital visualizations and collaborative sculptures.

C. Objectives of artMUSE and the European Corner

The activities of the M2C aim at initiating processes of cultural translation within projects like "artMUSE". Differences and ambivalences of objects and narration and the norms and values carried by them are questioned and negotiated collaboratively by contemporary witnesses, the interested public and exhibition organizers. The industrial revolution's skeleton of meta-narratives remains to be padded with microhistories – or, to stick to the image – the broken warp threads need to be weaved into the voices of the "other(s)" [3]. This kind of participatory curatorial work in the public space generates an "in-between" or third variable: its core lies neither in any kind of representation of reality nor in a museum's distinct statement, but in the process of performance and reception itself.

III. Visions of European Transformations

The conditions, changes and possibilities of participatory culture in European urban space are made visible by numerous artMUSE events and actions, establishing ties from early industrial culture beyond the presence to a vision of life in a post digital future. At vibrant urban venues of historical and cultural heritage in Bitola, Bocholt, Delmenhorst, Gdansk, Gent and Sofia, citizens become curators, museum directors become part of open avant-garde music space jams, international audio-visual performers transform sites of industrial heritage into public realms of new learning experiences, and visitor's ideas transcend into electronic live VJing installations. For example, in summer 2012, an island in the mid of the Gdansk city centre, sunken into insignificance if not into the River Motława, will be the centre of installations addressing its decayed storage sheds and comparing their former use for shipping trade goods with our digital storage rooms facing ambiguous futures. At the same time, a historical industrial area between the Bocholt city centre and the lake Aa is the focus of creative workshops for interested citizens to collaboratively conserve this unique industrial area and its architecture. Via the transformative character of artMUSE actions and activities, different angles and coordinates emerge and broaden the perspectives from which history and today's urban spirit may be interpreted and taken as stepping stones for future innovations in participatory culture.

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Concept and Transformation of Diplomacy

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Keywords **– Definition of Diplomacy, Foreign Service, Diplomats, Diplomatic Convention, Development of Diplomacy.**

I. Introduction

Diplomacy is a field with weak theoretical foundation. Historians will argue that there is nothing new to say about diplomacy but practitioners will question the usefulness to theorize diplomacy at all.

Diplomatic practice has developed along the lines determined primarily by precedents rather than by the presumptions of scholars of political theory. It is interesting to note that the ones, who have written about diplomatic theory most perspicaciously, are diplomats themselves.

II. Concept of Diplomacy

The concept of diplomacy can either be interpreted in a more narrow understanding as an instrument for the development and implementation of state foreign policy in international relations or in a broader understanding – as a mechanism of international communication and negotiations [1].

In literature, many different definitions of the concept of diplomacy can be found [2].

Until the early 19th Century, each European nation had its own system of diplomatic rank, which was a source of dispute over precedence and proliferation of ranks of the head of mission. The Congress of Vienna of 1815 formally established an international system of diplomatic ranks. However, the issue was settled in praxis only in 1961, when the Vienna Convention on Diplomatic Relations was adopted. It provides a complete framework for the establishment, maintenance and termination of diplomatic relations on a basis of consent between independent sovereign States.

III. Stages and Transformation of Diplomacy

Diplomacy is in a constant change or in an evolutionary process.

Diplomacy as we know it today has developed as a result of correlation of different conditions during many centuries. In literature it is common to speak about the division "old" and "new" diplomacy. Together with the definition of the modern nation state, also two fundamental principles – sovereignty and territoriality, were defined by the Peace of Westphalia in 1648. Therefore also there are major topics, which the old or traditional diplomacy addresses those principles.

The formation of the United Nations following World War II began a process that has generated a "New Diplomacy" that challenges many of the perceptions of the "Old Diplomacy." It is a phenomenon in which citizens play a greater role in affecting international relations. Additional issues concerning not only human rights, but also humanitarian, labour, environmental, trans-boundary and global issues have begun to challenge traditional notions of sovereignty and the sanctity of national boundaries [3].

In three thousand years, the world has transformed dramatically, and as a result diplomacy is in a constant process of modification due to the changing world order. In literature, it is common to classify diplomacy in the following categories – ancient, medieval, traditional and new diplomacy. However, it is also possible to classify the transformation of diplomacy, arisen from the changing nature of the global system; according to historical periodization development phases. What was the road to this diplomatic transformation? What are those major turning points that have allowed a messenger to stay alive today?

1) Ancient diplomacy;
2) the establishment of a Resident Ambassador and first diplomatic missions;
3) the establishment of the first Foreign Ministry;
4) the regulation/codification of diplomacy;
5) World War I, the Peace Conference in Paris, and the rise of multilateral diplomacy;
6) new forms of diplomacy – multilateral diplomacy, conferences, summit meetings, parliamentary diplomacy, etc.;
7) diplomacy after the First World War;
8) contemporary diplomacy;
9) future vision – triangular diplomacy, multilayered diplomacy, second track or multi-track diplomacy, virtual diplomacy, etc.

IV. Reasons of Diplomacy Transformation

The 20th century is marked by the processes of globalisation and democratisation, the revolution of information technology, the establishment of multilateral organizations, two bloody world wars, and changes in the balance of powers. Next to national governments NGOs, various interest and lobby groups and other new actors have visibly appeared on the international stage and insist on being heard and consulted. Countless meetings by heads of state and foreign ministers, and various types of international conferences have taken place. Besides, new concepts and definitions have evolved over the years of what we mean and understand when refer to threats to peace, or speak about security. Those and other processes undoubtedly have influenced the dynamics of international relations, and the new agenda requires new forms and techniques of diplomatic initiatives.

Diplomacy and institutions managing international relations in the course of history have existed alongside with different political regimes, which directly or indirectly have influenced the range of its functions, but diplomacy has always adjusted to changes in contemporary society and international relations. Also the basic principles of diplomatic have remained invariable.

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Periodisation of Latvian Documentary Cinema in the Context of Socio-political Factors (1944-1990)

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Keywords **– Latvian documentary cinema, functions of documentary cinema, periodisation, historical situation, institutional and cultural-historical factors.**

I. Introduction

It is often noted that documentary cinema, more than other basic types of cinema (feature films, animation) functions as a mirror for the society by reflecting on different social, political and economical processes and their expressions both as a whole and in detail. However, this view is rather superficial, because overall the relationship between documentary cinema and society is more complex.

As any other social institution, documentary cinema performs its functions and influences the society by educating, informing, fostering etc., or, on the contrary, degrading the members of the society [1]. It must be noted that movies are created by individual members of this same society – cinematographers are also a product of society. They cannot express a wholesome, objective opinion or worldview, because it will always be more or less biased, rooted in a particular social, ideological, historical etc. context, and is influenced by a range of processes occurring at the time. This ambivalent character of documentary cinema means that the analysis of the documentaries of a certain country must include the context of the concurrent situation in the state and the society.

Based on this notion, the authoress developed a periodisation of Latvian documentary cinema during the so-called soviet period (1944-1990), based on the following aspects:

1) the influence of historical situation on the creation of documentary cinema in Latvia during the particular period – institutional and cultural-historical factors;
2) most important trends of communication and content in documentary cinema during the particular period;
3) the most important works of documentary cinema and the particulars of the stylistic character of their authors during the particular period.

II. Development trends and periods of Latvian soviet documentary cinema

One of the most important and also world-renowned Latvian cultural values is Latvian documentary cinema. Its largest successes, most international acclaim and greatest interest on behalf of viewers were during the so-called soviet period from 1944 to 1990. During this time the famous Latvian documentary cinema school was born and developed; it can be distributed into several sub-trends, such as propaganda documentaries (with authors such as Nikolay Karmazinsky, Vadim and Irina Mass etc.), Riga poetic documentary cinema (Uldis Braun, Aivar Freimanis, Herz Frank etc.), sociological research period in Latvian documentaries (Ivar Seleckis, Juris Podnieks, also Herz Frank, Ansis Epner, etc.), as well as popular science cinema, which was strong in the former USSR (Alexander Griberman, Laimonis Gaigal etc.) [2].

During the forty five soviet post-war years 1220 documentary films and over 2000 cinema journals were created in Latvia. They shape an important part of the cultural heritage of Latvia, with value more than just cultural. Documentary cinema, more than other works of art of the period, is important as a reflection (document) of the social and political processes. This is especially the case because in the first twenty years after the war cinema was the only screen medium (the high popularity of screen mediums has not diminished even now), with works fully preserved until today.

When looking at the in-depth development of documentary cinema, processes such as institutional management of the field, influence of leading political trends and characteristic censure are clearly visible in the content and means of expression of films and cinema journals. The societal functions of documentary cinema were also changing and developing over time – from purely propaganda to deep analysis and research of social processes.

To systematise the large amount of facts involved in the development of Latvian soviet documentary cinema, the authoress developed a periodisation based on **processes within documentary cinema**. Five periods of different lengths were distinguished, characterised by leading trends in the content or artistic style of films and cinema journals.

TABLE I

Periodisation of Latvian documentary cinema (1944-1990)

	Period (years)	Formulation of the leading trend of the period
1.	1944-1956	Development of soviet documentary cinema traditions in Latvia
2.	1957-1960	Transition from soviet documentary cinema tradition to Riga poetic documentary cinema school
3.	1961-1969	Riga poetic documentary cinema school
4.	1970-1982	Research of social problems in Latvian documentary cinema
5.	1983-1990	The search for a new language of documentary cinema, synthesis of previous poetic and sociological documentary schools

Comparing these dominating documentary cinema trends with Latvian historical background of the time, it can be noted that the processes of documentary cinema often coincided and were dependent on the most important historical events in Latvia (with an „ideological momentum” of approximately 2 years). This makes sense given the fact that documentary cinema, more than other types of art and media, reflects the processes in the society [3].

The reason for the „ideological momentum” could be the clumsy, drawn out planning process of film content which had to go through several institutions. Also, cinema as one of the most popular and influential entertainment and art means of the time was especially ideologically supervised. This meant that „just to be sure”, any untested topics of artistic expressions were fully excluded from appearing on the screen.

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Network as an Attribute of Being

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Key words **– Network, attribute, network society, media.**

Ever since man became aware of the world he has observed networks as a particular type of reality, different from compact and homogenous natural phenomenon. Men have also been crafting nets as tools and weapons for a long time, partly imitating naturally occurring nets. Later it became apparent that network structure can be found in various man-made structures where it had not been intended originally. For example, road and associated communication networks (communication and sales networks). Network-like institutional, administrative and control structures can also be found in territorial administration.

A characteristic trait of a network is its dual nature. A network always intertwines a separate being and is therefore able to influence and control it. A network increases its holders` power and ability to influence occurrences which would not be available for manipulation or management through common physical interaction.

However, these original networks could not be viewed as a general trait of being, i.e. an attribute. Social sciences began generalizing the term „network" during the final decades of the twentieth century. Nowadays the term is mostly associated with Internet and mobile communication systems. Along with the development of technologies for distributing information another process has occurred – development of post-industrial or third wave society. An essential trait of these societies or stages of societal development are crucial changes in the role of knowledge and information in all areas of everyday life and activity. It could be said that modern society first became information society, and the intensification of informative processes that came afterwards led to the development of communication networks. Networks, on the other hand, provide with new possibilities for further informatisation of various human activity areas.

Nevertheless, this universal definition of a network cannot be considered a general description of being. The idea of network society, as described by scholars such as *Jan van Dijk* or *Manuel Castells* [1], applies to modern society or society in the near future, not society or being in general. Although philosophy does not deny the concept of network society and the importance of empiric research on the matter, its main task is to understand world from a broader perspective and to base explanations of this and other contemporary events on this understanding.

Philosophy provides with two research perspectives for the understanding of network as an attribute of being. The first perspective is associated with fresh interpretations of traditional philosophy in the context of the network-like structure of being. Traditional philosophy does not speak of networks in terms of concepts and broad notions. Still, problems and aporias in traditional philosophy may be solved using notions on the network-like structure of being. A basic notion of European Thought is the atomism hypothesis put forward in ancient philosophy. It states that all existing matter is composed of indivisible atoms. However, it is difficult to explain changes in a world of indivisible atoms in the context of this concept. This was solved with an additional presumption of an inert void between the atoms which allows them to move and combine in endless clusters. Nevertheless, the question of how new matter develops still remains unanswered. New matter usually develops and strengthens over a period of time. It means that for a certain while atoms are parts of several objects at once. If this is the case, what force keeps atoms together in several configurations at once? In order to solve them, additional hypothesis regarding life force, creativity and spiritual rather than physical beginnings are being introduced.

A potential solution is a presumption that the existence of any object depends on both its contents and the manner of persistent interaction between its elements. This idea is pronounced in twentieth century structuralism and post-structuralism philosophy where a much more important role is given to the activity of subjects that form a structure as well as the wide variety of structures.

The second perspective is based on the theory of symmetrical anthropology by *Bruno Latour* which originated in social philosophy but claims a universal explanation of being [2]. According to this theory, there is no reason to view the European worldview and mindset, where natural, human, social and preternatural entities are viewed separately, as a universal principle of the explanation of being. Europeans have already ceased using it in the research on primeval cultures because of its inadequacy. A universal (symmetrical) view should be based on the principle of primary diffuse nature of being. In every culture being is structured according to action and thinking where it creates solid networks which separate various fields and types of being from each other. Network forming is a process independent of human will since reality formations undifferentiated by the „subject-object" feature play an important role in this process. They act as mediators in the process of network forming and maintenance but they went unnoticed for a long time since attention was focused mainly on end-products of the differentiation process: nature, society, man.

During the final phase of modern culture, the researchers noticed media as information transmitters in an environment of social activity actors. *Marshal McLuhan* noticed that the media itself acts as a message. Instead of transmitting information it programs environment, a sensory system which makes the transmission and perception of other messages possible. This type of media creates various networks in order to sustain itself. In the mean time they serve as basic structures of every form of human being, such as culture.

Modern media environment, which is a prime example of a network-like being, gives new form to both general forms of human senses and borders between objects and phenomenon which reaches new sensory scope and from there – the being of man in aftermodernity.

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Anthropology and Pedagogy of Myth in Late Philosophy of Schelling (an Existential – Phenomenological Interpretation)

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Keywords **- existential pedagogy, pedagogy of myth, personality potentiation, destruction, personality crisis.**

The beginning of modern interest towards the myth and its connection to philosophy and pedagogy can be found in the marvellous work by G. W. F. Hegel called „Phenomenology of spirit" (1807).

Hegel speaks of ontogenesis of an individual subject as part of the Absolute spirit – subject (substance – subject) and, in my opinion, rightly nominates it for being a type of education and educating and repeats this interpretation several times. To quote the preface of „Phenomenology of spirit": "Each individual also runs through the culturally formative stages of the universal spirit, but he runs through them as shapes which spirit has already laid aside... and in this pedagogical progression, we recognize the history of the cultural development of the world sketched in silhouette." It still is a significant fundamental conclusion in pedagogical philosophy which is impossible to „overrate". Pedagogy fits perfectly with such conclusions as a natural, determined and conscious mediator between phylogenesis and ontogenesis, culture and man, society and individual. A different aspect is the level of complexity in this problem which can considerably hinder these efforts on both, philosophical – theoretical and applied pedagogical levels [1]. The aim of this survey is to find new research guidelines for the given problem, and the means for this are to be found in existential phenomenological philosophy and methodology [2].

Modern stems of philosophy of myth – in their earlier stages for now – can be found in the late legacy of Schelling. Significant works include „Philosophy and mythology", „A historical – critical introduction to mythological philosophy" and „Philosophy of revelation" [3]. Unlike Hegel and what has been mentioned in his own earlier work, late Schelling does not view ideal spiritual forms and their terms in particular as opposite of sensuous and material expressions of nature and the world. In a myth objects exist in a, one could say, phenomenologically reduced form. From such a point of view philosophical terms approach values in terms of their meaning and move from the mind to the soul. A descriptive quotation: "...philosophical terms shouldn`t be generalized categories, they should be real, specific entities, and they turn more and more into poetic images if there are many such terms and if a philosopher gives them a real, special life...".

However, it is useless to hope that Schelling`s late philosophy of myth and revelation speaks of direct and conscious efforts to thematise consciousness in a Husserl – like phenomenological discourse. However, it would be incorrect to ignore the impact that Schelling`s late philosophy of myth has had on the accomplishments of 20th century phenomenology and existentialism. This applies specifically to the question of fundamental phenomenological features of the sense of myth which are quite pronounced in Schelling`s philosophy of myth and revelation. My goal is to survey the main features with an emphasis on possibilities of further conceptualization of these features in phenomenological and existential pedagogy.

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Productive Potentials of Kinds of Thinking

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***Keywords* – thinking, kinds of thinking, thinking as a solution to the problem, popular triangle of thinking kinds, historical division of thinking, logical and associative kinds of thinking, logic as a deductive and inductive.**

I. Introduction

There are different terms in connection with thinking, for example problematical character of thinking as a united ability, objective existence of isolation of kinds of thinking, the variety of an isolation of kinds of thinking from the subjective to of practical needs, functional and substantional basis of isolation of kinds of thinking. A productivity thinking of associated with the diverse situations in which, engaging and thinking of which the result is a desired change.

II. He thinking as solution of task

An effective model of thinking associated with understanding the task of thinking as a creative solution, and often the resolution. Any challenge to his conditions for a specific goal to be achieved, as well as the attainment of ways and means. Thinking there is a place where these products and (or) the types of conscious being has not directly given. Thinking is "turned on" to find such means or ways of attracting even a memory or vision.

III. Popular kinds of thinking

Popular isolation of kinds of thinking in literature is one of objective, visual and verbal thinking [1]. The productivity of objective thinking appears in ordinary everyday situations where continuous operation is re-established. Visual thinking is effective in situations where objects are easily imaginable. Such thinking is typical first of all artists and imaginative people to nature. Verbal thinking as a result of a good language to be effective in situations, in which objects are not imagining, such as its abstract nature.

IV. I kant point of a division of thinking

Historically interesting is I Kant's point of view. He divides thinking into forms such as understanding and reason . Understanding objects is given in experience. I Kant considers understanding as ability of finite objects, which expressed concrete as judgement. Next, it is able to unit of the experience. The scope of understanding is limited with the world of the phenomenon - things for us (appearance) [2]. If objects of thinking are not given in experience, we come to the mind field, whose activities often results in the so-called antinomies - contradictions that create appearances that they both share - the statement and its denial is true. I Kant believed that such antinomies come to our reason when it touches to thing-in-itself. I. Kant said about 4 antinomies.

V. Logical thinking as deductive thinking

As one of the results of the division of thinking is logical thinking. The same understanding of logical thinking is at certain issues. If the "logical thinking" is synonymous with deductive thinking, logical thinking, and its potentialities are based on logical laws - an objective, universal, invariant relationship between the substantive terms, statements or their body parts in the process of thinking. Logical laws as opposed to logical rules like other true laws can't be infringed. Having certain facts occurred, the law must operate with the inevitability. Logical law gets a logical necessity. In traditional doctrine of syllogism logical law appears as a logical necessity, to act through certain formal set of conditions. As soon as they exist, the logic law acts. In predicate logic and propositional logic the logical law gets through identically true formulas, or their " fills" - tautologies. Logical laws in the immediacy are without objects and unsubstantial.

VI. Logical thinking as inductive thinking also

Inductive thinking is realized through the inductive arguments findings of modern means of such arguments in which the conclusions from the premises apparent without any logical necessity. If the "logical thinking" is synonymous with the correct thinking, then the logical thinking and its capabilities are based on broad understanding of the idea of the correctness. This correctness are seen very broad, and shows as deductive and inductive correctness. If in a discourse there is an inductive following also such discourse is correct. Inductive following (B from A) is such relation between A and B, if and only if B deductively does not follow from A, and the probability B, under the condition that A is true, is more than probability B on itself. Also inductive following does not depend on concrete contents of statements, but from their form [3].

VII. Associative thinking

A productive addition for logical thinking is an associative thinking, which realizes to some extent through language ability and imaginativeness. Associative thinking "break" the borderlines of exhausting resources. It makes our cognitive processes able to move forward and capable of infinite. Logical thinking (at least in the context of deductive thinking) contains a source to big extent further movement in itself. Are realized the potencies contained in set discourse. "Outside," coming just what is "inside". Here realizes the principle too - *ex nihilo nihil fit*. Coming out - it's a lot, but that's allt. There is a needed of push from outside. This push gives associative thinking.

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Development of Professional Competence of Coaches in Continuing Education

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Keywords: **continuing education, professional development, professional competence, sports coach.**

I. INTRODUCTION

The current situation in Latvian and the common European labor market requires learning and improving of professional qualification during the whole life span. Continuing education has its own specifics, which is aimed at the satisfaction of the professional, social and personal needs. The improvement of competence in all these directions has become the highest attainable goal of lifelong learning in the 21st century. Coach continuous competence improvement is affected by today's ever changing environment and new labor market requirements.

II. METHODOLOGY OF THE RESEARCH

In the research the following theoretical methods: the analysis of scientific literature are used The empirical methods are: qualitative analysis of the self-assessment of coach competences; data processing methods: qualitative interpretation of data, mathematical statistics.

Creating the model of coach professional competence development in continuing education, we employed the competence approach to professional activity as the foundation [1]. Simulating the full range of competence opportunities in coach qualification, didactic professional competences for qualitative execution of the functions of coach activity were structured. According to Duffy scientific insights in the development of coach competence, professional competence assessment criteria of the coach were established, which enabled the analysis of self-assessment of coach competence, which showed coach needs in the improvement of coach professional didactic competence in the framework of continuing education [2].

III. RESULTS

The self-assessment of coach competences was analyzed with the help of qualitative data analysis program NVivo 9. The obtained results concerning coach activities were coded according to the following criteria:

Level 1 (the level of independence and responsibility):

- are able to plan independently professional activity in unknown situations
- are able to organize independently professional activity in unfamiliar situations
- are able to conduct independently the training sessions, competitions and other sports-related activities in unfamiliar situations
- are able to assess independently their professional and their students' activities in unknown situations

Level 2 (the level of partial independence):

- are able to plan professional activity in predictable situations partly independently
- are able to organize professional activity in predictable situations partly independently
- are able to conduct the training sessions, competitions and other sports-related activities in predictable situations independently
- are able to assess their professional and their students' activities in predictable situations partly independently

Level 3 (the level of support)

- are able to plan professional activity with the help of other specialists
- are able to organize professional activity with the help of other specialists
- are able to conduct the training sessions, competitions and other sports-related activities with the help of other specialists
- are able to assess their professional and their students' activities with the help of other specialists

On the basis of professional competence assessment criteria and levels, were distinguished 5 groups of coaches, characterizing the expressions of professional activities in different learning situations (Table 1).

TABLE 1

The improvement of coach professional didactic competence in continuing education

Groups of coaches	***Existing professional didactic competences***	***Necessary improvement of professional didactic competences***
Coach *„independent planner, organizer, conductor, assessor"*	Can plan, organize, conduct, assess	Ability to develop Programs
Coach *„ independent planner, organizer, conductor"*	Can plan, develop Programs, organize, conduct	Ability to assess
Coach *„independent Program developer"*	Can develop Programs	Ability to plan, organize, assess, conduct
Coach *„ independent assessor"*	Can assess	Ability to plan, develop Programs, conduct, organize
Coach *„ independent planner"*	Can plan	Ability to organize, conduct, assess, develop Program

IV. CONCLUSIONS

The analysis of the obtained results leads to drawing the conclusions that professional activity expresses itself on different levels of competence, as demonstrated by professional competence evaluation criteria. Established coach groups show coach needs, characterized by the necessary improvement of didactic professional competence in the framework of continuing education.

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Dominant Motivation for Sports Activities of Studying Youths

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***Keywords* – motivation, sports activity, students, sport.**

I. Introduction

Nowadays the studying process in Latvia is characterized by a fairly broad range of information and intensification of intellectual activity. Although students give healthy lifestyle a fairly high importance in their individual value system, the prescribed amount of daily movement activities is often not achieved. Studying youth's involvement in sports classes is mainly to do with individual activity, because only a few of Latvian higher educational establishments include sports classes in their programs. RTU and LLU can be mentioned as positive examples – the first year at RTU includes sports classes, and first and second years at LLU contain them in the list of mandatory subjects.

The objective of this research is to evaluate the most significant factors which activate sports activity from students' perspective.

Research materials are based on literature analysis and surveying of 189 students on the most significant factors affecting sports activity motivation during studies.

II. Factors affecting motivation

Individual value system is the pillar of students' personality direction. Together with personality position, interests, unsatisfied needs, and most significant motives, it determines the particular student's choice of action and activity of pursuing the set goals. Motivation is viewed as a polymodal cluster that activates person's activity, actions, behaviours, attitudes, needs, and interests. Motivation forms under the influence of various factors, and its most characteristic manifestations are:

- personality's chosen direction of action,
- individual's effort and its intensity in purposeful action,
- persistence towards achieving a set goal in a certain period of time.

Social learning theory views motivation as a dynamic triad, where person's individual characteristics, behaviour, and effects of surrounding environment interact to produce a summary display in certain activity. Three motivation theory directions can be mentioned as the most significant in sports:

1. Need theories, with the view that people are activated by inner motives, which are directed at satisfying different personality's needs.
2. Goal setting and expectation theories, which hold a view that humans act rationally by evaluating desirable nearer and farther goals, the possibility of achieving them, degree of desirability, and individual appeal of results.
3. Fairness theories, which assume that people are mainly activated and motivated by external factors and that a reward proportional to the effort and subjectively evaluated as just will be received.

J. Cratty thinks that three motive groups are equally important in athletes' actions – physiological, psychological, and social motives. Besides an important characteristic of motivation is its dual – positively-denying structure. During positive motivation humans gain a stimulus at direct need fulfilment, while denying motivation hinders need fulfilment urges. Due to this, a fulfilment of some goal can only be at a cognitive or emotional level, without reaching a specific act of conduct [1]. So individually important goals will not always be fulfilled, because they can be affected by certain factors of the social environment, including upbringing, peers' views and attitudes, as well as action's predicted results.

III. Peculiarities of motivation in sports

In sports activity motivation research psychologists R. Vallerand and G. Losier analyze youth's unwillingness to get involved in regular sports classes[2]. They have deduced that the biggest negations against sports classes among youth are caused by lack of desired conditions for activities, and negative self-evaluation, which is caused by inability to achieve results satisfying one's personality. In the youth age group, when the self actualization is especially pronounced and there is a need to prove oneself, many understand the unpleasant reality that within their existing abilities they will only be able to achieve average results in the given sport. If the likelihood of achieving desired results decreases, it will most likely withhold the youth from participating in the given activity, unless other motivating factors are found.

Criteria of SMART theory suggest bringing forward such individualized activity goals, which would be specific, measurable, achievable, significant, and timely [3]. Effect of the motivating environment is important for the youth. Socially-cognitive approach, in its turn, accentuates importance of personality's knowledge and skills, emotional expectations, self-control skills and influence of the surrounding environment in creating new behavioural models .

IV. Suggestions

Overall youth appraise as significant for sports activities the following motivational factors: qualitative sports activity environment, individual goals and supportive social group, and public interest in creating an active lifestyle. It is advisable to take students' opinions into consideration while developing Sports policy guidelines for years 2013-2020, including introducing sports classes for first-year students of all higher educational establishments and improving sports environment infrastructure quality.

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Sports Injuries among Young People and Evaluation of Their Health Condition

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Key words **– injuries, young people, spor activities, giving of first aid, health level.**

I. INTRODUCTION

Injuries are significant problem which influences the quality of life of children and young people. Injuries are connected with lifestyle and physical activities. In the case of complications the determination of diagnosis and treatment of injuries can be long and complicated. Injuries which could be connected with wrong organization of training process could deter children from physical activities and sport (Krauksts, 2006). Overloud is a factor which can lead to injuries. The most often traumatized are ankle and knee (Adirim, Cheng, 2003). In many cases injuries can be prevented. In order to reduce injuries, it is important to clarify the characteristic injuries and their causes.

II. RESEARCH METHODS

The questionnaire of 17 – 19 years old young people was carried out in order to clarify the characteristic injuries of young people and the most common injuries of young people who are heavily involved in sport, the awareness of young people about injury prevention and their health level. 156 young people in Riga and different Latvia districts were questionnaire.

III. RESULTS OF INVESTIGATION

The results of investigation showed that the majority of young people (60%) regularly go into sports. A part of young people sometimes (27%) or rarely (9%) attend sport activities, but relatively small number of young people don't attend sport activities (4%). 19% of questionnaire young people regularly train into separate branches of sorts. The most popular branches of sports among young people are sport games (basketball, football and others). A part of young people go into cycling, field and track athletics and different kinds of wrestling. Young people who are heavily involved in sports more often get injuries in comparison with young people who don't go into sports outside of school. The most characteristic injuries of young people are bruises and joint sprains (Tab. 1).

TABLE I

THE MOST TYPICAL INJURIES OF YOUNG PEOPLE

(% FROM QUESTIONNAIRE YOUNG PEOPLE)

Type of injury	Yung people who don't train in separate branch of sports	Young people who train in separate branch of sports
Joint sprains	17	25
Joint dislocations	9	12
Bruises	29	26
Wounds	17	11
Fractures	3	4
Back injuries	2	3
Head injuries	5	7
Other types of injuries	18	12

Young people who train into separate branches of sports more often gain joint sprains, dislocations and head injuries but young people who don't train into separate branches of sports – wounds and different home injuries.

The majority of questionnaire young people consider that typical reasons of injuries are inattention, improper warm-up, failure of safety measures, improper use of equipment, unpredictable behavior of other people. The majority of young people who are heavily involved in sports admit that it is difficult to avoid from injuries during sport activities but it is necessary to pay special attention for prevention of injuries. The majority of young people consider that especially dangerous are such branches of sports as skateboarding, motocross, snowboarding. Certain branches of sports are associated with specific injuries.

The majority of questionnaire young people (67%) consider that it is necessary to pay more attention for acquiring skills of providing first aid. The majority of young people are not sure that in case of necessity they would be able to provide first aid but they would be willing, if necessary, try to do it.

The majority of questionnaire young people (71%) consider that their health level is good, part of young people consider that it is medium (26%) but only small part of young people (3%) consider that it is bad. The most characteristic health disturbances of young people are vision disorders, respiratory and digestive system disorders. Most often in recent years young people have suffered from respiratory diseases, acute infectious diseases, and gastrointestinal diseases. Some of young people have suffered from bone and muscle diseases and cardiovascular diseases.

IV. CONCLUSIONS

1. The majority of young people have positive attitude to sports, they regularly attend sport activities at school, some of the young people train in separate branches of sports.

2. Young people who are heavily involved in sports get injuries more often than those young people who don't train in separate branches of sports. The characteristic injuries are bruises and joint sprains.

3. Young people are able objectively assess the causes of injuries and admit that it is necessary to pay great attention to prevention of injuries however they consider that it is difficult to avoid from injuries intensively going into sports.

4. The majority of young people consider that their health level is good however some part of young people have minor or serious health disorders.

5. Most typical health problems of young people are vision disorders, respiratory and digestive system disorders. For some of young people health problems don't allow intensively go into sports.

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Urine Specific Gravity as a Measure of Hydration Level in Athletes' Body

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***Keywords* – body hydration, urine specific gravity, urine refractometer, football.**

I. Introduction

One universal method to determine the body hydration degree is not elaborated. The hydration degree of the body is in norm from the data of the American Sports Medicine Association if the urine specific gravity is below 1020 [1]. Using this characteristic of norm, 46 % of Chicago and Los Angeles fitness clubs visitors before training were in hypo hydrated body state. Athletes trained in different sports differ in their body mass composition, uptake of water and food or restriction of water and food uptake. Therefore the body hydration degree and loss of mineral salts before competitions, during competitions and after sports loads must differ in wide range in different athletes .

The aim of our investigation was to determine the urine specific gravity in football players at rest and its variations in dependence of diet and water uptake, as well as, the lean body mass.

II. Methods

Twenty male football players participated in the investigation voluntary. Their mean age was 23.6 ± 5.1 years, height - 183.7 ± 7.3 cm, the body mass - 79.3 ± 8.0 kg and the body mass index - 23.4 ± 1.4 kg/m^2. The body hydration degree at rest (before training) was estimated. The measurements should be performed approximately two hours after eating and within 30 minutes of voiding.

Every football player completed questionnaire concerning their daily eating and drinking habits three days before our measurements. This allowed us to estimate approximately amount of water, salt and proteins uptake in every athlete.

The body mass composition was measured by the bioelectrical impedance analysis method using the Body Composition Analyzer (Tanita, Japan). All athletes were weighted by the scales included in the apparatus. Body mass composition is estimated by measurement of the electrical resistance to a small, alternating current flowing between four electrodes: two electrodes are positioned below the feet of every athlete and two electrodes are hold in the hands. The duration of measurement was one minute. The obtained data were automatically processed by body mass composition formula taking into account the height, body mass, gender, age and body tissues electrical resistance of every athlete. The characteristics measured and calculated by the apparatus are: the body mass, lean body mass and fat content in the body. The error of measurement of the equipment was ± 4 %.

Every athlete collected mid – stream specimens of urine at rest. Urine specific gravity was measured by urine refractometer (Atago, USA).

The correlations between the urine specific gravity and lean body mass (muscles and skeleton), as well as, between the mean water, salts, protein daily uptake and urine specific gravity. are determined.

III. Results and discussion

The urine specific gravity exceeded the norm (1020) in 6 football players from 20 at rest. This confirms that approximately 1/3 part of athletes who participated in training were hypohydrated.

The highest urine specific gravity values were observed in athletes with greater weight of lean body mass. This can be explained by greater amount of the product of creatine phosphate metabolism – creatinine in the blood and urine in athletes with greater skeletal muscles mass. Greater concentration of creatinine in urine causes growth of the urine specific gravity and osmolarity. The concentration of metabolites in urine varies in different populations, for example, from the data of Jacobs et al. [2] the concentration of creatinine and albumins in urine is greater in males and Blacks than in females and Whites.

From our data the proteins and salts daily uptake positively correlated with the urine specific gravity. From the literature the amount of mineral salts in diet depends on the race and ethnical traditions in food preparation. For example, urine osmolarity in Germans is 860 mosm/kg, but in Polish people 392 mosm/kg [3].

These problems are not taken into account in the recommendations of the American Sports Medicine Association, and the body hydration degree is estimated as norm if their urine specific weight is below 1020. The more detailed investigations of different specialization athletes are necessary in future to elaborate the urine specific gravity norms in dependence on athletes' diet, lean body mass, age and gender.

IV. Conclusions

Therefore it is very important to continue investigations to determine norms of urine specific gravity in euhydrated body state for different specialization athletes and to elaborate the new method of body hydration degree determination, which will be not expensive and by using of portable equipment to do measurements in the field or sport hall conditions. This will allow us to recommend individual liquids and salts consumption program for every athlete.

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Comparative Analysis of Students' Anthropometric Characteristics

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Keywords **–anthropometric characteristics of students, physical activity of students, harmful habits, physical development of students.**

I. Introduction

Nowadays the length of active working life period increases. There is the interest about the ways of keeping the quality of life, high working capacities and potentiality of individual creative abilities [1]. The physical working capacities are based on the physical health, physical development level, physical activity and healthy lifestyle. The target of the Project is to evaluate the principle anthropometric characteristics, levels of students' physical activity.

II. Material and Methods

We have provided assessment of the principal anthropometric characteristics (height and the body mass) as well the anthropometric indices (Body mass index and height-weight coefficient).We have provided questionnaire for students from different high schools concerning physical activity. The questionnaire includes positions that allow us to collect information about sport's and physical activity during working day time and after it (Виленский, Ильинский, 1987). The questionnaire embraced all spectrums of week's physical activities. We have included the questions related to health problems (diseases (cardiovascular, respiratory, gastrointestinal) trauma and ect.) and duration of medical incapability (days per year). The data of questionnaire were evaluated according the scale (in points) and calculated. Those allow us to divided respondents into subgroups according the levels of physical activity (low, moderate, and good, high). Respondents were in aged from 19 years till 33years.

III. Results

Respondents from different high schools were divided into two groups. The first group included the students from Riga Teacher Training and Education Management Academy and National Defence Academy. Students` future speciality demanded the high level of physical activity and fitness. The second group the students from Medical faculty and Medical College were included. Their future speciality didn't require high physical fitness level. We have evaluated the BMI (Body mass index) levels. We didn't reveal overweight problem in respondents` groups. The numbers of students with tendency to overweight were equal the 1st group (13.1%) and the 2nd group (12.5%). We have noticed the number of individuals with low level of BMI in the 1st group– about 4.3% and in the 2nd group 10%.

The second group of respondents was included students who haven't any obligation to keep high level of physical activity (medical specialty). According the questionnaire results average physical activity level in the first group (58.6 points) – is about 70 % higher that the results of physical activity level in the second respondents groups (34,4 points).

Different levels of physical activity depended on administrative, organizing, economical and financial reasons [2,3]. The comparative analysis of physical activity in the four different students group revealed that the highest level of physical activity was in Cadets` group from National Defence Academy -72, 3±4, 8 points. The level of physical activity in the students` group from RTTEMA (47,1±5,6 points) was two times lower ,the level of physical activity for students from Medical faculty was 38,1±3,9, and the last place was taken by students from Medical College, the level of physical activity for them was 30,9 ±3,9points.

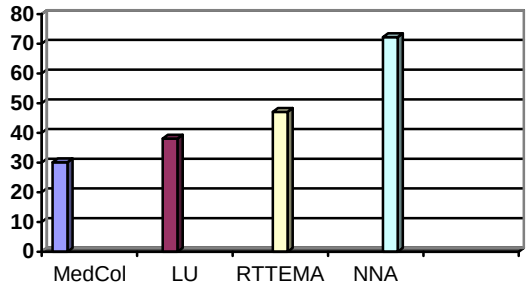

FIG.1 HIGH SCHOOLS STUDENTS` PHYSICAL ACTIVITY LEVEL IN POINTS

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Architecture and Urban Planning

Postmodern Discource of Post-Soviet Large Housing Districts: Modeling the Possibilities

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Keywords **– Large scale post-war residential districts, regeneration, globalization, postmodernism, restructuring large housing estates.**

I. Introduction

Studying the goals, the needs and the opportunities of restructurization of a large scale residential estates are very often confronted with the problem of an adequate assessment of the current situation.

It has become apparent and recognized that matters are fundamentally changed in the world. Global events are directly attributed to postmodernism – the dominant paradigm of thinking, with the trappings of modern society life.

This article gives an overview of some aspects of postmodern reality, directly or indirectly touching upon the large scale housing estates, and searched the grounds for such assumptions: post-Soviet society has changed, so the high-quality existence in the large scale housing estates became impossible without changing them essentially;

Soviet mass housing blocks are often over populated, but it does not mean the quality of these areas at all.

Current methods of renovation of the outdated and worn out living environs is just a waste of time and public finance.

II. Postmodernism and the Global Society of Large Scale Residential Districts

The mass construction of residential districts had become an economic inevitability of the socialist Soviet government provision of affordable housing. Impressive scale construction has been achieved. These areas are still the usual place of residence for most of the urban population (Fig. 1). However, this does not mean that these areas are suitable for today's society. Obviously, the large scale residential areas are a poverty environment. This is only tolerated, however, that a large part of society is still unable to afford cost of alternative residence.

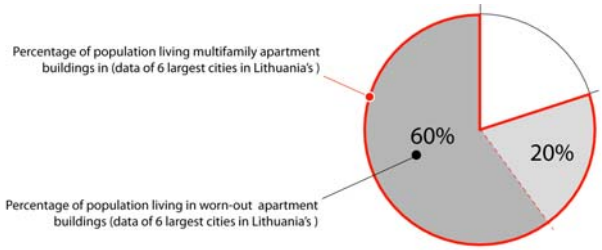

Fig. 1. 80% of Lithuania's population live in large urban apartment buildings. Three quarters of them are physically worn out.

The apparent ability to use the opportunities of globalization is characterized by social groups, which leaves the outdated residential areas. Not that other forms of habitat (suburban villa, new built residential housing, and so on) is better (a frequent case is just the opposite – that place is far removed from urban centers, complex communication, etc.) but the fact that the free market (with the actual government support) does not provide any possibility to transform the large scale residential areas to the desired place of residence. Ability to use modern means of communication and mobility allows absorbing the inconvenience experienced by living away from the city center of cultural and social infrastructure.

Real needs of the population and the changes of living conditions in reality are a challenge to create a new type of algorithm steps for modeling of large scale residential districts which would restructure the scenarios. Such a scenario can not be based solely on energy-saving ideas, because:

1. Saving energy resources have little to do with the creation of a comprehensive residence;
2. The economic potential of the population is hard to predict, so any claims that the massive construction of residential areas will remain attractive for long is questionable.

Society has changed, as the desired attributes of place of residence. Finally, although it is hard to imagine these desires will come true simply, but it is clear that modernization of several separate apartment buildings are not the way to go.

III. Experiment

Changes in the mass construction of large scale post-Soviet residential areas are inevitable. It is recognized that there is no easy way to restructure large scale housing estates in the Western Europe, where the mass construction of residential areas was not a mass phenomenon after all. Western European practice is subject to the various instruments (with varying degrees of intervention) to an outdated physical structure. Nevertheless, no one knows how to do that in post-Soviet countries. However, this does not mean that certain scenarios can not be created in certain situations modeled in Western Europe, partly by adapting to local conditions (Fig. 8).

Fig. 8. Possible layout of residential block after regeneration

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Sustainable City – a City without Crime

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***Keywords* – crime, urban structure, space syntax.**

I. Introduction

The concept of sustainable city involves the creation of a city without crime. Urban crime is closely related to urban structure. Human behavior in open public spaces can be described as to-movement and through-movement through the spaces. The intensity and character of movement, assessed by using the space syntax method, enabled us to identify the character of urban pattern. This stage of the research revealed that some public spaces were safer than others. The aim of the research is to identify how urban spatial pattern correlates and affects urban crime. The objective of the proposed research is formulated while having in mind alienation of society and bad criminogenic situation in many Lithuanian cities. Results of the proposed project will allow implementing sustainable urban development in Lithuania more effectively, to realize the concept of urban neighborhoods more successfully and identify the earlier urban mistakes.

II. Research Object and Methods

Klaipėda city was the research object. It is the third largest Lithuanian city which is situated on the coast of the Baltic sea. The city occupies the area of 110 km^2, and it has about 161 300 inhabitants. According to the statistical data, Klaipėda city remains one of the leaders of quantity of robberies, theft, public nuisance and murders in Lithuania. Taking into account the quantity of all the types of crime occurred in Klaipėda city during 2008-2010 it is the second high-crime Lithuanian city after Vilnius.

For the research of an affect of urban structure on crime *Space Syntax* method was applied (Hillier, 2007; Hillier & Hanson, 2003). Space Syntax is about identifying, representing, and measuring the social spatial relationships in our built environment. According to the method open to the public spaces (streets, squares, pedestrian paths and passings etc.) are presented as axial lines (see Figures 1 and 2). For the assessment of relations between various types of crimes and urban structure of Klaipėda correlation analysis was applied.

III. Results

At this stage of the research axial maps of Klaipėda city were prepared and analyzed: connectivity, control, global depth, fast choice, global integration, local integration R2 and local integration R3. Also the data on the quantity and location of various types of crimes was selected: destruction or damage of property, public nuisance, theft, and crime against a person, explosives, and other crimes. Then Kendall's tau_b and Spearman's rho correlation coefficients were calculated. Calculation results on Kendall's tau_b correlation coefficient values demonstrate that there is a weak relation between all the types of crimes, except explosives, and global integration. Also there is a weak negative relation between public nuisance and depth r_{tau_b}=-0.201 (p=0.000<α=0.05), other crimes and depth r_{tau_b}=-0.214 (p=0.000<α=0.05). The calculation results of Spearman's rho correlation coefficient reveal weak negative relations between all the types of crimes, except explosives, and depth. Also there are weak relations between all the types of crimes, except explosives, and global integration. According to Kendall's tau_b and Spearman's rho correlation coefficients, there are very weak relations between connectivity, control, fast choice, global integration, local integration R2, local integration R3, and all the analyzed types of crimes.

The prepared maps of global integration (Fig. 1) and global depth (Fig. 2) of Klaipėda city reveals potentially the most and the least dangerous open public spaces from the point of view of crime and urban structure. Hot colours (red, orange, yellow) mean very integrated spaces on the global integration map, as well as shallow spaces on the global depth map. Cold colours (blue and green etc) mean low integrated or disintegrated spaces on the global integration map, as well as deep spaces on the global depth map. The quantity of crimes are presented in the circles for some streets.

Fig. 1. Global integration of Klaipėda

Fig. 2. Global depth of Klaipėda

According to the research results all types of crimes depend on such spatial characteristics of urban structure as global integration and global depth. Therefore, for the further research of the urban safety through urban structure we should use the maps of global integration and global depth.

Correlation analysis revealed that the more integrated and the more shallow the open public spaces were the more crime in these spaces happened.

The most potentially high-crime Klaipėda city parts are the Old and New Towns, Lietuvininkai, Pušynas, Kretinga, Universitetas, Miškas, Mažasis kaimelis, Liepoja, Baltikalnė, Rumpiškė, Birutė, Vėtrungė and Kaunas districts, Šiaurės and Šilutės avenues as well as Liepojos, Mokyklos, Kauno and Dubysos streets.

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Is there a Baltic Case? Urban Sprawl of Major Cities in the Baltic States

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Keywords **– urban sprawl, suburban development, Baltic States.**

I. Introduction

After a century of modern urban planning debates on the negative consequences of extensive growth of our cities are increasing. However, cities continue to sprawl. Baltic cities are not the exception here.

The growth of major Baltic cities has been severely limited in the second half of the 20th century. Current growth of Baltic cities is highly affected by market forces and individual choices. Therefore their urban development inherits some features of western cities. One of them – more and more people are choosing to live in suburban areas and this results in diverse changes of peri-urban areas. These recent trends in urban development of Baltic cities require more attention and are described in this article.

II. Urban Sprawl: causes and consequences

It is generally accepted that main contributors to extensive urban development throughout the 20th century were variety of economic (land speculations, tax policy, mono-functional land use planning) and technological (development of transport infrastructure, mass usage of cars) factors. However, according to R. Bruegmann, the history of urban sprawl suggests two factors that seem to be most closely linked with sprawl: increasing affluence of citizens and political democratization [2]. This empowered people to take individual decisions on their place of residence, work, etc. These choices led to the formation of extensive urban development patterns that we observe today all around the world.

The negative consequences of contemporary urban sprawl are usually divided into two groups: economic and environmental. Economic consequences are generally linked with the transformation of functional structure of a city and the surrounding region, e.g. city can lose various activities which determine its economic viability (industry, commerce, etc.). The dispersion of urban structure also increases public expenditures. The most significant environmental problems caused by urban sprawl are associated with substantial land use changes in the peri-urban areas: diminishing agricultural activity, changing suburban landscape and its ecological and aesthetic structure. Urban sprawl is also blamed for the amount of pollution generated by longer commuting distances.

However, urban sprawl is a process of urban change that is not occurring only on the outskirts of the city. It affects the central city, suburban areas and distant exurbs. Overall, the urban expansion of cities is criticized for the inefficient use of energy and other resources [3].

III. The Baltic Case: some evidences from sprawling Baltic metropolises

Urban sprawl of major cities in the Baltic countries is mostly analyzed in the context of urban development trends in post-Soviet countries in Central and Easter Europe [3]. After political changes in 1990, the urban development of Baltic cities and towns have ceased the former course. Previously centrally planned Baltic cities, which inherited relatively compact urban structure, had to adapt to completely different political and economical situation. Land privatization, decentralization of governance and competition at the local and global level were essential features of this new reality. The further development of physical structure of Baltic cities was also affected by economic restructuring, negative demographic trends, traffic problems and, of course, the urban sprawl processes.

Currently the most visible trend in growth of major cities in the Baltic countries is fragmented development of peri-urban areas just outside the existing urban fabric. Usually these new developments are irrelative to essential topics of contemporary city development, such as transport infrastructure and public services, protection of agricultural and natural landscapes. Expansion of low-density residential areas into suburban locations is highly criticized by urban scholars due to the lack of a special aesthetic expression and environmental quality. In addition, extensive development of residential areas in the outskirts of Baltic cities is mostly driven by commercial interests and not based on any demographic presumptions [1].

The frequently mentioned factors responsible for excessive urban growth of Baltic cities are increased living standards, land restitution, the desire for home ownership, active real estate market and loan policies [1].

IV. Conclusions

The current extensive urban growth of major cities in the Baltic States is often discussed and analyzed as a legacy to urban development of the Western World cities. Due to globalization effect local urban differences are slowly disappearing and our cities and especially suburbs are becoming much alike.

However, urban sprawl processes of cities in the Central and Eastern Europe, and in the Baltic countries as well are slightly different than in the rest of Europe [3]. The development of Baltic cities in recent decades can not be studied apart from their historical evolution and current demographic tendencies. As a result, we must talk about "the Baltic Case" of urban sprawl and study it as an exclusive process of Baltic cities development, which is, possibly, acquiring a distinctive spatial character.

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Exploration on Flexibility in Urban Planning Formulation of China

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Keywords: **flexibility, uncertainty, planning and controlling method, urban planning.**

I. Introduction

The process of globalization causes comprehensive effects and changes in resources, environment, culture and other aspects. All these changes make the future full of uncertainty and the cities will face more uncertainty and irrationality. At present, China and other developing countries are in a period of rapid urbanization. Certainty and rigidity theory and method of urban planning can't adapt to the reality. Therefore, it's very important to recognize the uncertainty in the process of urban development and explore the adaptable and flexible theory and method to solve the dynamic problem of urban planning.

II. Concept of flexibility

The general meaning of flexibility is sometimes described as the ability to bend and the ability to change and adapt to different circumstances. It is described not only as a quality but also as the quality of an activity. The author defines the concept of flexibility in urbanism as the compatibility and adaptation of planning thought and planning system to the randomness market.

III. Necessity of flexibility in urbanism

The process of urban development is very comprehensive and contradictory. Uncertainty is the main reason to use flexibility in urbanism. It contains both external and internal factors [3]. External factors refer to the complexity and changes in the circumstances of urban development. Internal factors refer to planning activity itself that is the uncertainty because of the lack of information, different subjective wishes of urbanists, limitations of technology etc. Furthermore, the goal system of urban planning is a series of subjective prediction or wishes of urban development that belong to different parties. This requires planning formulation must be flexible to adapt to the constant changes.

IV. Direction of improving flexibility

A. Introduction of urban planning formulation system of China

The urban planning system of China is divided into two levels of the master plan and detailed plan. Master plan is the overall positioning and integrated deployment for urban development. Detailed plan can be divided into two types depending on the different missions, goals, and the depth requirements which named regulatory plan and site plan [4].

B. Improve and refine urban planning system

Master plan is the core of the urban planning formulation system. However, there are still some problems. The contents of master plan are complicate, and sometimes too specific and detailed. So it is recommended to refine and the urban planning formulation system furthermore. Nowadays, some cities of China have proposed the "concept planning", "strategic planning" and so on.

C. Explore new methodology

As mentioned before, it is full of uncertainty during the urban development. So the main task of planning is to find, evaluate and solve the problems of uncertainty. We should explore targeted approaches to enhance flexibility in different stages of urban planning.

D. Multi-target proposals

It contains two levels of meanings. The first one refers the development and distribution of multi-objective embodied in a program. The second one means making different programs according to different planning goals in order to provide a variety of options to multi-parties involved in.

V. Methods on flexibility at different planning levels

A. Master plan level

A development vision seems to be an appropriate instrument to steer the gradual development of city area especially for large areas, where there is not one commissioner, but a group of organizations involved in. It provides not only a literal plan, but also a handbook and guidelines for the area. Were a master-plan used to be a detailed overall design for an area, it now gets a different interpretation. There has been some innovative research on the specific formulation method at master plan level. For example, the forecast of urban population and urbanization is not a stationary monodrome but a range with amplitude and flexibility. The planning period should be flexible. It even does not require limited planning period but clearing the purpose of planning.

B. Detailed plan level

Regulatory planning is an important basis of urban planning administration and a means of achieving the goals of master plan. It guides site plan and architecture design. Here the author uses Wuhan city of China as the example. There are some good practices on how to improve flexibility in land use planning, transportation planning, controlling method and the planning form, and so on [8].

C. Layer approach

The layer-principle means some different approaches in different levels. To be able to deal with problems and opportunities that emerge, the ability and responsibility to deal with them should be organized at the level that is most appropriate and effective. In that way change can be addressed effectively (flexibility) and change doesn't become a problem.

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From Post-Soviet to Post-Capitalist City – Development of Riga over the Last 20 Years

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Keywords **– social segregation, egalitarian modernism, (post) colonial city, hybrid identity.**

II. Soviet City

World War II and its outcome along with political changes led to dramatic changes in the spatial and social structure of the city of Riga. The construction of the real *socialist city* began with the launch of the massive housing construction programme initiated by Khrushchev. Unlike in the *socialist* housing estates, in the central *capitalist* part of Riga only a few new buildings appeared. Without exception these buildings were built for the representatives of the privileged class [15]. Despite the ambitions of the Soviet system to create a classless society, *the socialist city* had certain qualities of the physical urban space leading to inequality. And a socialist model of central planning could not cope with the most typical problem of a *bourgeois* town, namely, social segregation [3].

III. Post-Soviet City

In 1991, the Republic of Latvia regained its independence and put an end to the 50-year-long Soviet occupation. And city of Riga once again had to become a capital city of an independent state. Less than two years after the restoration of the proclaimed independent state in 1991, the work on the Riga City Development Plan for 1995–2005 began. It was elaborated at the time when the process of denationalization was in full swing, the number of population was decreasing, types of ownership and laws changed, and there was a quest for an appropriate structure of city administration [15].

IV. Post-Capitalist City

For the most part, a socialist city was an industrial city, and Riga like other dynamic cities evolved from a traditional industrial city into a post-industrial agglomeration, which triggered off inevitable structural changes. At first the aim was to restore the urban and cultural scenery of Riga as it was in the pre-socialist era. But the beginning of the new millennium can be described as the time of the *global* narrative, especially, the period from 2004 when Latvia joined the European Union and NATO. Intensive construction of public, office and residential buildings and industrial complexes continued until the 2008 global financial crisis that struck Latvia particularly hard. As the issue of mortgage loans stopped, the real estate bubble burst and the *global* narrative lapsed.

As regards the urban development of Riga over the past 20 years, when it was changing from a post-socialist city into a post-capitalist city, its *socialist* and *capitalist* nature should be evaluated critically. Similarly, the Soviet central planning model could not establish an egalitarian *socialist* city and avert the most typical problem of a *bourgeois* city, i.e. social segregation.

The post-socialist city cannot become a *capitalist city* and provide the most typical characteristic feature of a *bourgeois city*, i.e. accumulation of local capital. Instead the urban and public structure is exposed to unrestricted arbitrariness of the external global financial capitalism which makes it possible to designate it as a (post) colonial city [13]. Over the last 20 years, moving from an industrial economy to a (more unstable) service economy, the city could not establish preconditions for the emergence of a strong middle class. Therefore, it seems that the post-industrial, creative, neo-liberal model of a city can still be useful and applicable to Western European cities, while it would not work in the city located on the outskirts/periphery of the European Union.

A model of democratic governance and the lack of policy vision could not restrict the liberal Freedom and neo-liberal urban development based on the dogma of sacred private property, and protect its citizens from the chaos caused by the global financial capitalism.

Over the last 90 years, there have been several attempts to transform Riga by means of a homogeneous narrative. Today these narratives do not work anymore, and Riga has to find a new post-Soviet and (post) colonial narrative.

The spatial and social structure of Riga is unique and provides good preconditions for successful development in the conditions of modern capitalism. Yet at the same time, the reasons why the city of Riga cannot realize its immense potential derive from its inability to recognize its distinctive hybrid identity, and therefore in future refrain from repeated attempts to adopt imitative models of development and policy, which disregard the high potential of the hybrid solutions of this city.

The aim of this Report is to review and analyse these questions by highlighting possible causal relationships of different aspects.

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Go, Show, Know: Architectural Excursion as a Tool

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***Keywords* – modernist heritage, Soviet residential districts, modernisation, community involvement, architectural excursions.**

I. Introduction

Similarly to the rest part of the former USSR, Vilnius did not escape the rise of large-scale housing construction observed in the 60's either. The new socialist city having emerged in the suburbs of Vilnius over 35 years still has the major share in the housing fund that shall be re-thought and re-activated in the twenty-first century. The stuck and technocratic modernisation program [1] contains neither clear policy nor criteria or extensive research how to deal with still unprivileged modern urban and architectural heritage that undergoes changes and irreversibly loses its previous shape during the processes of modernisation. The growing public interest in the modernist heritage and increasing research on the subject have also involved the gray brother of Modernism – the residential or so-called "sleeping" districts – prompting to ask whether the former socialist city is truly unable to meet the today's needs (particularly, in the context of the mass housing phenomena of the 21st c.). Why the urban and architectural heritage of residential districts is not regarded appropriately? What are the ways to initiate the environmental improvement by the very residents? "Architecture is necessary to strengthen the understanding of society as well as to raise the awareness of key habitat conditions and their outlook" [2], and public tours are one of the most acceptable tools to achieve this – both for professional experts (knowledge of status quo in scale 1:1 – the real basis for further research and for the start of the re-thought modernisation) and wider audience, especially residents of the districts (for their perception and appreciation of local identity, provocation to take the initiative).

II. Experimental excursion around socialist experiment

From the 60's to 90's, the north-western suburbs of Vilnius were occupied by the new socialist city arranging nine new districts (Lazdynai, Karoliniškės, Viršuliškės, Šeškinė, Justiniškės, Pašilaičiai, Baltupiai, Fabijoniškės, Pilaitė) along 12 km long Kosmonautų Avenue (Cosmonauts' Avenue). Since the very beginning, construction of residential districts in Vilnius has caused controversy: they were both built in the spirit of slogans "Faster, Cheaper, Better!", "An Apartment for Each Family!" and highly appreciated all-Union wide for excellent planning (Žirmūnai located in the north-eastern part of the city was awarded the USSR State Prize in 1968, whereas Lazdynai was granted the Lenin Prize in 1974). Some pieces of architecture found in the aforesaid districts were also awarded a range of various state prizes. A few years later, however, an avalanche of intense criticism followed attacking monotony, similarity, anonymity of districts. Today, these two blocks of opinions are still sharp: on the one hand, Soviet residential districts are associated with mono- functional, unsafe, bleak environment settled by those who have no other choice; on the other hand, the districts represent an unexplored territory of Vilnius or the former/current place of residence remembered with nostalgia. The two approaches were vividly illustrated by the response of the public and guides invited to the first excursions around Vilnius "sleeping" districts – that was a kind of experimentation, who and why will be interested to take a tour around the socialist experiment.

III. Research in scale 1:1

The first tours around the socialist Vilnius containing the aforementioned nine residential districts were organised in 2011 under the title "A Perfect Micro-Region: Do-It-Yourself". The idea of the tours was born upon the discussion what angle of the housing topic would attract both professionals and the general public. All the districts are quite similar by composition thereof: 3-4 microrayons, groups of modular apartment blocks arranged around the public spaces, commercial/service centre, school, nursery-kindergarten, tower blocks, etc. Some of the aforesaid components are standard, whereas others are considered unique pieces of architecture the most exciting cases whereof were visited during the excursions. One of the targets was to complement the personal memories/stories by historical facts and comments of the architects having designed the districts, thereby encouraging the very participants of the tours to re-think the concepts of a "perfect/imperfect" district. Excursions were guided by the architects of the districts, municipal representatives, researchers of the modern heritage of the city, philosophers exploring the themes of the city, artists and leaders of private cultural initiatives.

IV. Excursion as provocation

Most participants of the tours are the people who live or used to live in Soviet residential districts. In addition to their own personal stories, they were interested in the history of their district development in terms of more objective assessment. Each district was designed referring to an individual urban and architectural idea more or less reflected by the realisations but containing no clear perception today. Another aspect of personal stories is related to the "do-it-yourself" initiative in public spaces wide ranging in scale and function – from gardens and micro-sculpture parks to the cultural community centre "BeePart". Being the latest one-man-initiative in Pilaitė, "BeePart" asks directly whether such a cultural centre in the district is able to increase the added value of the district [3]? Initiators of the excursions re-ask: do the tours around the Soviet residential districts help the residents to re-appreciate their environment? If they do, maybe it is one of the impulses to take the initiative and declare definitely what is the perfect neighbourhood and what is missing? These issues are the codes for further research.

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Contemporary Art in Public Space in the Context of Urban Planning

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***Keywords* – urban landscape, art in the public space, urban planning.**

I. Introduction

This study is viewed in the context of contemporary art in public space as a tool in urban planning. Thereby the aim of the research is to explore into what levels of spatial planning art should be included in public space and what significance there is.

II. Art in public space

Art in public space has broadened the boundaries of the use, forms, and types of expression [1]. In this paper art in public space is viewed outside the museum exhibition halls or interior. Consequently, the understanding of contemporary art in the public space varies depending on the change of the notion of spatial and temporal conception that determines the types of artworks used in a broad range and variety. Public art influences the spatial plans, neighborhoods, etc. Likewise, art is affected by public regulations [2].

III. Public space

Public space is affected according to the urban planning documents. Public space becomes overloaded by various actions, artefacts, information signs and other signs, thus the question of the role of contemporary artworks is brought up. Public space has been viewed in the context of the notion of a place that has a significant role in this study, focusing particularly on the place-making concept. The place concept and other aspects emerge, such as contextuality, the sense of place and others.

IV. The planning context

In order to find it out, the understanding of contemporary artworks in the urban planning principles for landscape architecture has been investigated. In the planning context, the framework of policy and the planning levels are identified and analyzed to determine in what ways contemporary art enters public space. Thus, the conflict between the top-down and the bottom-up approaches has emerged. Accordingly, both approaches have advantages and disadvantages. In the investigation the curatorial approach has been developed, which is essential not only in the art domain, but also in landscape planning. Thus, the curatorial landscape concept is offered combining strategic planning levels with the local place level.

V. Conclusions

The art in public space and public space itself is changing and transforming with the time by expanding the boundaries. The subject provides a field of research for urban planners.

Analyses allow concluding that curatorial landscape approach may be one of the ways how to manage the artscape and creative approaches.

VI. Acknowledgements

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Local and Global Tendencies of the World Expo Architecture. The Case of Lithuanian Pavilion in Expo 2012 Yeosu, Korea

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Keywords **– global and local tendencies, World Expo, exhibition, pavilion, architecture.**

I. Introduction

This paper brings together my interests in the World Expo architecture, in a narrative of space which it forms, and national identity, in this case, a content of this narrative. I would like to present a case study of Lithuanian pavilion design process. At the beginning I would describe some local and global tendencies of World Expo Architecture, which I found observing the history. In the end I would present some principles which I used in Lithuanian pavilion design.

Now, when this paper is written, the Lithuanian pavilion is already built. In the International Exhibition "Expo 2012" in the South Korean city of Yeosu, Lithuania appears as the country of amber. Now thinking about goals which I expected to achieve and the complex of tools – tactile actions, the use of symbols, lighting, etc. I will give it as a conclusion, but the World Expo in Korea is still going on and complete assessment of value of Lithuanian pavilion will be a background material for the next paper.

II. The World Expo

World's Expo is not an invention of our days. It dates back to the times when large markets were regularly held in cities. These events thus provided a space for exchanging and evaluating ideas and for demonstrating and comparing skills. Through these events a highly beneficial atmosphere of expedience developed between people of different nations and cultures. Tradespeople traveled to the cities in particular from all over World. The commercial transactions of long ago thus paved the way for the world expo of today, which play an educational role and promoting progress [1]. The first "universal and international" exhibition took place in 1851 in London. Paris took over and organized brilliant exhibitions in 1867, 1878, 1889 and 1900. Soon other large centers were also eager to welcome craftsmen and manufacturers from all over the world, and among the most successful international exhibitions were those held in Vienna, Amsterdam, Brussels, Barcelona, St. Louis, Turin and Philadelphia. Although most of the expo architecture were the temporary buildings, but some of them there actually be genuinely iconic, which made a huge impact to the history of architecture. To recall a few: the Crystal Palace built for the Great Exhibition of the Works of Industry of All Nations, 1851; the Eiffel Tower, built for the Exposition Universelle in Paris, 1886 and the legendary Barcelona Pavilion by Mies van der Rohe at the International Exhibition 1929 [2]. One of the most significant and global tendencies of world's expo architecture is to entertain.

World expo's architecture evolved over time. As people had more and more entertainment options, world expositions have continued to find new ways to provide information and inspiration in new ways [3].

But I believe that world expositions are changing and will continue to change with the times. There will always be new ways to inspire, new ways to enlighten and new ways to entertain. And one of these ways could be described as a local tendency: to find something in history and national identity and to show it in a new light.

III. The Lithuanian Pavilion

According to tendencies mentioned above, the primary task of the Lithuanian pavilion was stated: to find something which corresponds the theme of the expo (The Living Ocean and Coast) and has roots in Lithuanian context (culture, history, folklore, etc.) And this thing is amber, it is mentioned in a lot of Lithuanian legends and the main fields of amber are in a former territory of Lithuania. The idea which won national context was to show amber in a new way – to create a feeling of looking at the world from inside of amber. The inside of pavilion is covered with amber imitation coating, shining monochromatic yellow light. The inside space has an unusual ambiance, as people and objects appear in black and yellow and light comes from the bottom, so there are almost no shadows, thus creating a special feeling (Fig. 1).

Fig. 1. Visualization of Lithuanian Pavilion.

The pavilion stands out with its amber image among other participants, who had chosen marine colors. To bring in more flamboyancy and escape uniformity, it was decided to match yellow and black colors. The entire Lithuanian pavilion looks like a big amber. There are three openings in the pavilion; they could provide glimpses of Vilnius, the Curonian Spit, Trakai, the Hill of Crosses, and other notable sights. There is a possibility to get hands on the history of amber with different samples containing all sorts of relics trapped inside. The upper floor houses a specialized presentation on Lithuania, film days and photography exhibitions.

The facade of the pavilion features a piece of amber with an inclusion, and the entrance is decorated with stylized aged tree figures, reminiscent of Juodkrantė treasures. Different events and publications reflect the theme of the exhibition.

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A Relationship between Architectural Research and Practice

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Keywords **– architecture, research, practice, mediators, institutions, culture.**

I. Nature and Importance of Architectural Research

Architectural research covers a variety of areas. Each of them requires a different approach determined by traditions of a certain discipline, namely, environmental science determines perception of materials and the environment, social sciences affect their application and use, history of administration defines management while humanities define history and theory, and principles of specific spatial organisation shape the design which are studied and applied in practice both by architects, landscape architects and urban planners in different areas, i.e. designing buildings and gardens, housing estates and districts. Therefore, architecture cannot be treated as a separate branch itself.

However, research in architecture focuses on one specific theme – the environment that people create and build for themselves. Only research in architecture implies combining the techniques of several areas, which are usually separated and treated separately, in a survey of one particular theme. Architectural research differs from the rest of the studies in its need to combine several branches, and it implies both strength – since it presents a promising alternative to a severely criticised distinction between the so-called hard and the so-called soft forms of accumulation of knowledge, and weakness as well – since architectural research often fails to meet the requirements set to one particular discipline because in a peculiar way it highlights the interaction between two or more disciplines where one of them may be perceived as less developed.

Architectural research is important to both society and architects. As regards society, first of all, research promotes interaction between technical studies and formation process of the space, secondly, it encompasses the results of environmental improvement and tests the quality, which is not normally done by professionals, thirdly, it provides a critical view on the existing environment and the ongoing process and activity as they have been created and have originated, and, fourthly, it develops an idea that architectural designs are given the role of the media, comparable to such creative industries as cinema and literature. As regards the profession of architects, the research gives architecture an ability to compete with other professions and groups of society. A knowledge-based society requires any profession, whose task is to shape the human-created environment, to be based on research. In the knowledge-based economy, professions dealing with architecture and spatial planning should adopt a different nature, i.e. replace the so-called uniformity with knowledge and professionalism based on other types of research. Architects as well as landscape architects and planners should have an equally good command of both research and design tools.

A strong professional public organisation is the best mediator between architectural research and practice. The research carried out in architecture has a specific role in architect's profession determined by the forms of professional activities and the way they are taught at schools. Thus, the profession can affect the research and the research can affect the professional practice in a variety of ways. Professional and other publications, providing a concise overview of research results, are a significant form binding research and professional practice and helping professionals access these results. Conferences, seminars and exhibitions are important forms of mediation, too.

II. Mediators between Architectural Research and Practice

After the end of the Cold War, Central and Eastern European countries did not radically change the culture system inherited from the communist regime characterised by elephantine and slow institutions. As a result of the subsequent rapid social, economic and political changes, many of them lost any direction of development or took a commercial course in order to survive in conditions of reduced state funding. At the same time the outburst of cultural initiatives took place resulting in small organisations, festivals, centres, venues, laboratories, studios and galleries which made a tremendous contribution to diversification of cultural scenery.

Riga School of Architecture and the society "Latvian Architects Association" are the institutions the cooperation examples of which are used to describe the issues addressed in the article. Riga School of Architecture with its long-lasting traditions is a basis for the formation of the unique architecture of Latvia and particularly Riga. It was established in 1869 as the Department of Architecture at Riga Polytechnic Institute, evolving over the time, at the beginning of the century, it became the centre of academic education in architecture of Latvia and partly also entire Baltic region. The Faculty of Architecture and Urban Planning of Riga Technical University is the only institution of higher education in Latvia producing specialists in spatial planning, architecture, restoration of cultural monuments, interior design and landscape architecture.

The Latvian Architects Association is a professional public organisation established in 1924 which has 472 members (12 April 2012) – professional architects. After the restoration of the Republic of Latvia, as a result of structural reforms, it has found a good way how to ensure continuation and development of traditions. The society owns and manages buildings in Riga, at Torņa iela 11/15 which are used as a venue for a variety of architectural and cultural events.

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Identification of Visual Influence Zones of Wind Farms in Lithuania

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Keywords **–wind turbines, wind farms, the influence of wind farms on environment, zones of visual impact.**

Landscape constantly changes because of human activity and this alternation is not always positive. Landscape loses its identity, variety, and scenic beauty – the main values of landscape.

Objects of alternative energy have miscellaneous impact on visual environment. Of all the alternative energy facilities, wind turbines are notable for their visual parameters. The height of tower of wind turbines which are currently under construction is 80-120 m, and the total height is 120-160 m. Thus wind turbines become dominant vertical elements in the landscape. Wind turbines can be seen from up to 20-25 km. under ideal weather conditions. When locating such objects in landscape it is very important to assess their visual impact on the objects of cultural heritage, recreational zones, protected areas and other visually sensitive objects, and when constructing wind turbines a big attention has to be paid to the visual impact assessment. Wind turbine often visually influences several landscape visual types. Visual impact of wind farms is even more significant. Therefore, in order to assess the visual impact properly, it is necessary to determine the area of the landscape which is under visual impact, i.e. it is important to determine the size of visual influence zone of wind turbine/farm.

Visual impact of wind farms is analysed in the paper. The main aim of the paper is to describe the factors of wind farms visibility, and, after comparison of theoretical sizes of visual influence zones and degrees of visual significance with the results of empirical research, to establish possible ways of elaboration of methodology of visual impact assessment establishing visual influence zones.

Visual influence of the wind farms localised in the regions of Kretinga, Silute and Taurage were analysed. There are only single wind turbines constructed in other regions.

Five wind farms are operating in the region of Kretinga. Overall number of operating wind turbines is 57 and 1 is under construction.

In 2010 wind farm from 6 wind turbines was constructed in Silute region. Two low-power (200 kW) wind turbines also operate in this region. Currently in Ciuteliai village wind farm from 17 wind turbines (39100 kW capacity) is under construction.

22 wind turbines operate in Taurage region Griezpelke village constructed in 2009-2011. In 2008 two used small wind turbines were constructed in Meldikvirsiai village.

One of the most important aspects influencing visual impact of wind turbines is the viewing distance. The significance of visual impact of wind turbines and their farms is directly proportional to the distance from them: the further we are from them the weaker visual impact is, though it also strongly depends on the characteristics of landscape. The peculiar characteristics of landscape natural and anthropogenic components change the sizes of visual influence zones and character of wind turbines visual impact.

The empirical research is based on the hypothetical degrees of the visual influence of wind turbines. Viewing points were selected in the most visually sensitive areas: urban areas, areas of cultural heritage, visual corridors of roads, and areas of protected landscape.

The main results of the research were established factors of negative visual impact of wind farms, sizes of zones of visual influence and character of visual impact in different zones of visual influence.

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Adaptable Landscapes in Housing Renovation: a Tool for Activating Local Territorial Communities

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***Keywords* – urban planning, architecture, landscape, housing renovation, community involvement.**

I. Introduction

Based on the used theoretical principles and the existing practices of community involvement into planning the article explores the ways of improving urban landscapes of residential territories especially in a process of housing renovation. The main interest areas of local residents as better living space and the surrounding areas are essential and landscape is seen in this context as an important consolidating element. The article gives a set of recommendations on the ways of improving the methods and practices of complex urban renovation with the underline of community-based landscape development plans.

II. Recent Research on Public Involvement in Housing Renovation

The problem of renovating the existing housing areas is widely discussed by researchers of different countries. The aspects of involvement of local communities [1], the urbanism as a system of landscape [2], the need for balanced mobility and soft recreation [3], social affordability, energy efficiency of housing blocks are underlined as the most important ones. The review of recent research clearly notes that involving public into the planning processes is a perfect, well experienced and reliable tool to achieve more socially acceptable results for residential and the other areas of a city.

III. Legal Framework and Practice

The legal framework for regulating public involvement in Lithuania is adequate and up-to date compared to modern national tradition across many European countries. It gives an action space in the planning process for all the main stakeholders. Still the short practice of its application results in poor experience and status of the emerging civil society in general. The increasing number of participants in public discussions for various planning projects indicates that stakeholder groups are gaining more experience very fast.

The community interest for ecological and healthy environment with good options for recreation is especially sensitive in residential areas as a major indicator of quality of life. These trends are analysed in the cases of Vilnius city.

Fig. 2. The renovation project for the housing block Architektų str. in Vilnius.

IV. Policy Measures for Landscape Improvement

The list of policy measures on Landscape that has been adopted by the Ministry of environment of Lithuania presents the basic strategies for changing natural and cultural landscapes. On the level of municipality plans more detailed solutions are provided for achieving more integral and compact urban tissue and more liveable cities. On this level the basic solutions for residential areas are generated to be implemented in the last phase of planning – technical design.

V. Identification and Layout of Community Interests

The intake area that could identify a community is different depending on a scope of planning and its margins need clearer identification for the overall success of the project. In spite of territorial and structural differences the basic groups of interests that citizens have in residential areas as Lazdynai and several others in Vilnius City could be identified and structured in several basic groups starting from smaller territorial scale and going to the big scale planning projects.

VI. The Way Towards Better Landscape in Renovation

On the level of a project programme involvement of local communities is inevitable as an absolute majority of residents in Lithuania are the owners of apartments. On the other hand this additional social energy could and should provide architects with additional knowledge and inspiration to create individual, socially conscious and architecturally valuable solutions for renovating recently dull and disliked blocks and turning them into modern multifunctional urban structures.

VII. Conclusions

Public involvement in residential areas should be treated in research and professional practice as an important generator of quality solutions to improve functionality and aesthetics of the space. It should be organised minding the interest areas of resident's groups. Empowerment of local territorial communities should be extremely fruitful in this process. Improvement of spatial organisation of existing landscapes should be executed by close citizen's involvement that could provide the professionals with the ground information for sustainable and viable solutions.

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Sustainable City – a City without Crime

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***Keywords* – crime, urban structure, space syntax.**

I. Introduction

The concept of sustainable city involves the creation of a city without crime. Urban crime is closely related to urban structure. Human behavior in open public spaces can be described as to-movement and through-movement through the spaces. The intensity and character of movement, assessed by using the space syntax method, enabled us to identify the character of urban pattern. This stage of the research revealed that some public spaces were safer than others. The aim of the research is to identify how urban spatial pattern correlates and affects urban crime. The objective of the proposed research is formulated while having in mind alienation of society and bad criminogenic situation in many Lithuanian cities. Results of the proposed project will allow implementing sustainable urban development in Lithuania more effectively, to realize the concept of urban neighborhoods more successfully and identify the earlier urban mistakes.

II. Research Object and Methods

Klaipėda city was the research object. It is the third largest Lithuanian city which is situated on the coast of the Baltic sea. The city occupies the area of 110 km^2, and it has about 161 300 inhabitants. According to the statistical data, Klaipėda city remains one of the leaders of quantity of robberies, theft, public nuisance and murders in Lithuania. Taking into account the quantity of all the types of crime occurred in Klaipėda city during 2008-2010 it is the second high-crime Lithuanian city after Vilnius.

For the research of an affect of urban structure on crime *Space Syntax* method was applied (Hillier, 2007; Hillier & Hanson, 2003). Space Syntax is about identifying, representing, and measuring the social spatial relationships in our built environment. According to the method open to the public spaces (streets, squares, pedestrian paths and passings etc.) are presented as axial lines (see Figures 1 and 2). For the assessment of relations between various types of crimes and urban structure of Klaipėda correlation analysis was applied.

III. Results

At this stage of the research axial maps of Klaipėda city were prepared and analyzed: connectivity, control, global depth, fast choice, global integration, local integration R2 and local integration R3. Also the data on the quantity and location of various types of crimes was selected: destruction or damage of property, public nuisance, theft, and crime against a person, explosives, and other crimes. Then Kendall's tau_b and Spearman's rho correlation coefficients were calculated. Calculation results on Kendall's tau_b correlation coefficient values demonstrate that there is a weak relation between all the types of crimes, except explosives, and global integration. Also there is a weak negative relation between public nuisance and depth r_{tau_b}=-0.201 (p=0.000<α=0.05), other crimes and depth r_{tau_b}=-0.214 (p=0.000<α=0.05). The calculation results of Spearman's rho correlation coefficient reveal weak negative relations between all the types of crimes, except explosives, and depth. Also there are weak relations between all the types of crimes, except explosives, and global integration. According to Kendall's tau_b and Spearman's rho correlation coefficients, there are very weak relations between connectivity, control, fast choice, global integration, local integration R2, local integration R3, and all the analyzed types of crimes.

The prepared maps of global integration (Fig. 1) and global depth (Fig. 2) of Klaipėda city reveals potentially the most and the least dangerous open public spaces from the point of view of crime and urban structure. Hot colours (red, orange, yellow) mean very integrated spaces on the global integration map, as well as shallow spaces on the global depth map. Cold colours (blue and green etc) mean low integrated or disintegrated spaces on the global integration map, as well as deep spaces on the global depth map. The quantity of crimes are presented in the circles for some streets.

Fig. 1. Global integration of Klaipėda

Fig. 2. Global depth of Klaipėda

According to the research results all types of crimes depend on such spatial characteristics of urban structure as global integration and global depth. Therefore, for the further research of the urban safety through urban structure we should use the maps of global integration and global depth.

Correlation analysis revealed that the more integrated and the more shallow the open public spaces were the more crime in these spaces happened.

The most potentially high-crime Klaipėda city parts are the Old and New Towns, Lietuvininkai, Pušynas, Kretinga, Universitetas, Miškas, Mažasis kaimelis, Liepoja, Baltikalnė, Rumpiškė, Birutė, Vėtrungė and Kaunas districts, Šiaurės and Šilutės avenues as well as Liepojos, Mokyklos, Kauno and Dubysos streets.

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The Impact of Urban Planning on the Development of Territorial Land Resources (Experience in Lithuania)

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Keywords **– territorial land resources, territorial planning, land use, master plans.**

I. Introduction

In Lithuania the spatial development of territorial land resources mostly is determined by the territorial planning process. Territorial planning processes according to its level (state, region and municipality) and it is done by preparing master plans, special plans and detailed plans. The spatial structure of towns and country is organized by the legal system – there are special legal statements that allow building and other construction without a certain complexity planning. This situation in the conditions of private land ownership causes very contrary situation of planning process. There are cases when territorial planning quality decreases in favor of private property owners rights. So the rights of land private owners and public interest challenge each other, but to achieve the right solution is very difficult.

II. Situation Of Urban Planning In Lithuania

The urban development on the conditions of market economics faces with new challenges to compare with planned economics. After the Soviet period new market conditions at first had taken priority for quick economical effect that often was not corresponding with high quality of spatial structure.

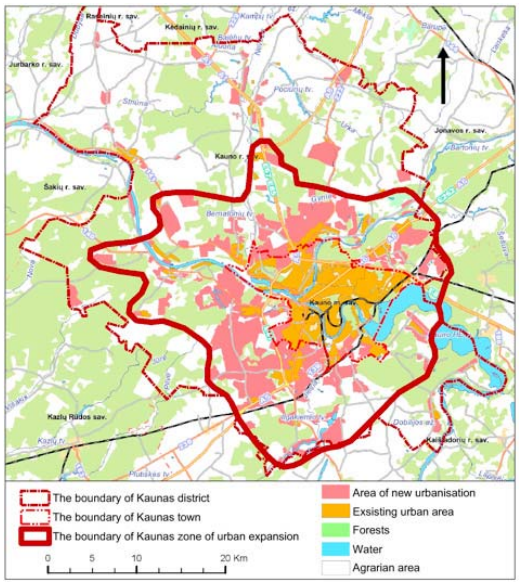

Fig. 1. Urban development in Kaunas district in period of 2004-2012 year

The period when market economics was introduced in territorial planning should have shown new tendencies of urban development. At first it caused a new migration from densely settled city parts to extensively urbanized suburbs. Corresponding to such tendencies, new master and special plans where done to make more possibilities for really accident investments. So planning procedure started to serve for non planning urban processes.

The newly created private land property caused new compositions of the plans of quarters, new groups of parcels for the building. Lots of territories planned by individual land owners seemed to be created more for the present commercial needs as opposed to the future welfare. Lots of territories were scattered far away from the compact urban places in a chaotic way form urban sprawl, which causes the problems of transport, climate change, social infrastructure etc.

Appearing chaotic urban structures stand out by extensiveness, landscape fragmentation, lack of open and public spaces. They leads to monotony, loss of identity and attractiveness.

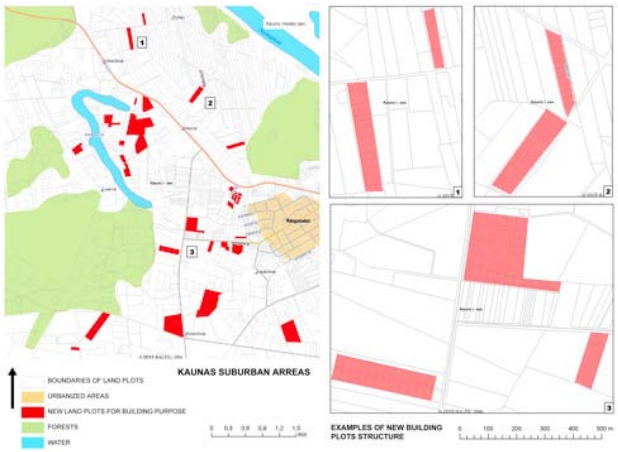

Fig. 2. The structure of new building plots for dwelling houses

Such urban and landscape formation do not correspond with the objectives of sustainable development that is adopted in National strategy of sustainable development, in Territorial planning law and other legal documents.

III. The Directions For Improvement Of Territorial Planning System

Many countries seeking to achieve rational land use are faced by lots of problems connected with the procedural processes of territorial planning. In order to realize urban proposals many of countries have to solve problems like land readjustment, land expropriation and other.

Nowadays the countries with rapidly growing economy are solving spatial and urban planning problems (Germany, Finland, Sweden, Japan, Turkey and others). Meanwhile there is an absence of attention to these problems in the post- Soviet countries that have left the planned economics conditions.

Present situation in Lithuania shows a very problematic territorial planning process that mainly causes the loss of territorial resources and not very rational upcoming of new urban structures. In order to manage such process there is a need for new rules in order to plan the urban areas that could regulate the interest of private citizens and society.

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Spatial Regeneration of the Cultural and Historical Heritage of Farmsteads in Latvia

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Keywords **– cultural and historical heritage, landscape transformation processes, spatial planning.**

A farmstead is an essential element of the rural cultural landscape in Latvia and the future generations should preserve ensembles with the historic structure. (1). For this purpose, it would be necessary to carry out an in-depth research of Zemgale farmsteads.

Four political and economic development phases within 90 years have brought major changes or transformation processes to the Latvian rural landscape.

It is most noticeable in manor ensemble and farmstead sites. Each of the country's stages of the economic management has given its own architectural and compositional changes in the rural landscape.

- The agricultural land reform (1922):
- Buildings of the post-war year (50s-80s of the 20th century) collectivization:
- Development of planning and detailed plans of rural municipal areas alongside with creating new mansion building areas (1990-2005).
- The administrative-territorial reform (2005-2010), drastically changing the structure of the rural municipal administration which brings up emptying of the rural populated areas and the flow of the population to cities. The existing infrastructure is abandoned to vandalism.

Fig.1 The picturesque old farmstead is hidden behind the warehouses (2012.).

The modern administrative-territorial reform in rural areas has contributed to the development of a large-scale industrial management method which enters the territory of the farmstead, bringing in a new dimension of buildings - industrial buildings, warehouses, machinery parking space, covered areas, etc. This is due to the cultivation of cereal, potatoes, rapeseed grain processing, biogas plant and greenhouse complex construction. Farmers usually select to locate production buildings adjacent to the existing residential zone that most commonly in the fertile Zemgale is the cultural and historical heritage with the construction period from 80s-90s of the19th and 20s-30s of the 20th century. For instance, on the right bank of the River *Svitene,* the farmstead is built as a new farm in the 20s of the 20th century (splitting the manor of *Biļļi* land) with a residential building, cattle-shed, granary, barns surrounded by windbreak plantations and an apple orchard. From 2005, when the farmer increased potato cultivation there were two metallic hangars built, the location and scale of which in the mainstream view lines cover both the historical buildings and tree plantings in the landscape space.

The mosaic type architectonic form-type nature within one farm is readable 1 km further for *Gaideļ-Šauvas* home which was built around 1930. During the collectivization period (50s of the 20th century), near it a large cattle-shed is located which is hidden behind the tree crowns so that it is not noticeable in the view lines from the road. Adjacent to it there is a new residential building with outbuildings (1985) which is architecturally well fitted into the historic nature of the building. The cattle-shed of the old farmstead is reconstructed as a church at the same time creating a beautiful memorial garden for the soldiers killed during the war in the battles near Lielupe in the summer of 1944. The church's outer wall whitewash and the cross sign is visible approximately 1.5 km from the highway to Pilsrundale. 75 years ago the same building served as a cattle-shed and in the distant view lines it was supplemented by a herd.

Fig.2 The architectural expressiveness of the farmstead is hidden by trees (2012).

In transforming the rural landscape space functionally and searching a compositionally unified cultural and historical environment, there was a multi-dimensional cultural-landscape space created. In particular, it must be evaluated in analyzing the main view lines from roads as a set up of protection zones around the historical buildings of farmsteads is impossible. This is due to the nature of the agricultural activity and landed property boundaries. The need of preservation, protection and development of the cultural heritage should be highlighted for all levels of the programming documents, making a separate planning for landscape spaces. The farmstead, as a tourist attraction where it is not viewed as not only the historical-landscape value but also as a new management tool, is an important task to achieve in overcoming the weak points of the administrative territorial reform.

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Think BETA - Systems for Participation in Urban Development

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***Keywords* – Participation, Urban Development, Digital Media.**

I. Introduction

"ThinkBETA Evolution of Smart Cities" is an international think tank funded by the German Federal Ministry of Education with the RTU as partner. Think Beta is about R&D and the design of future technical and cultural infrastructure for the urban development of Smart Cities and the optimization of municipal services, participation infrastructure and environments for intercultural and diversity management optimization. The technical objective is to research and develop mobile-stationary, multi-media environment as infrastructure for smart cities and their participative development. Challenges are the requirements of a future technical and cultural (mass player) infrastructure. Existing technical approaches from eGovernance, urban planning, LBS, to the user-affected eCulture, eCreativity are integrated to develop and provide optimized mobile-stationary digital systems for urban development, planning and participation. Previous software approaches did not take into account existing expertise, e.g. in the sectors of civic participation: integration of decentralized design or the social balance in architecture were not adequately developed or focused on a single discipline perspective. Which is to be counteracted through the interdisciplinary configuration of the think-tank and its experimental approach via urban art and design. Similarly, technical and organizational issues of participatory urban planning with different approaches for different user groups are considered in the actual systems of Betaville and concepts for future ICT-systems.

II. Application Scenario

Betaville is an actual project for the development of a platform that fosters online collaboration and participation of community groups in urban development by providing mobile-AR, multi-touch-table and 3D-online tools and methods. It provides a development, communication and decision making environment for local initiatives and project groups. Betaville supports the complete development process from analysis of citizens' needs, specifying early-stage ideas and fostering discussions through ongoing engagement of communities in project development and consensus formation:

In Alphaville, a fictitious city, an old factory has been torn down. The vacant area is to be revived in the near future and the city hall constitutes a planning board–the official process has started. In order to take into consideration its citizens' demands for a livable city on the one hand as well as potential interests of authorities and technical restrictions on the other, the public administration is interested in the active participation of other parties in the decision and development process. Therefore, it creates a new project within Betaville and configures the available real estate in the virtual system.

Bob likes to actively take part in the planning process about his vicinity. As he is interested in a mixed use of the area, he uses Betaville's functionality to incorporate 3D models of a town houses settlement as well as a small shopping mall with space for different shops. Alice gets to see Bob's proposal on Betaville and adds a 3D bounding box that serves as a request for a kindergarten that she finds essential for a vivid quarter. Later, other members of the community may create new proposals and replace her placeholder with sophisticated 3D models of kindergartens. After releasing her ideas, her friend Carol also wants to participate in the redevelopment of the area. Equipped with her mobile device, Carol inspects the area and uses Betaville's mobile client for 3D on-site-visualizations of the different planning proposals on her mobile screen. With these authentic impressions in mind she realizes the long distance from the housing area to the kindergarten and changes the proposal directly on her mobile by repositioning the kindergarten. Back at home she realizes a lack of green space and substitutes the shopping mall in Bob's design by a small park. In order to integrate as many citizens as possible in the process, Alphaville additionally allocates interactive urban screens in the vivid city centre for communicating the current status of the development process. At multi-touch tables (MTT) small groups can meet and collaborate in real life, discuss alternative proposals, create and manipulate new ideas and visualize them on the attached urban screen.

III. Conclusion

Within Betaville, members of the community, local authorities, or even potential investors have the chance to refine and extend the development branches created by Bob, Alice, and Carol by changing existing proposals or creating new ones from scratch. Furthermore, every member of the community has the chance to participate in the decision making process that will converge on a small set of favored solutions. Currently, Betaville experiments with different strategies to perform this task. Nevertheless, participation in the urban environment covers many categories of interest, such as city (re-)development, urban art, preserving cultural heritage, urban resting places, etc. Within the partners of ThinkBETA several projects ideas in these fields are already carried out successfully. The question is how to come to a generalized framework to generate participation in the new urban project design. This will be discussed at the same time at the Riga Technical University 53rd International Scientific Conference, the BMW Guggenheim Lab Berlin, the Municipal Art Society of New York City and the Goethe Institute Montreal. We invite the conference participants at the RTU to take part in the discussion and become partner in our future interdisciplinary projects. We have currently finalized prototype systems that are accessible through: http://betaville.hs-bremen.de, http://bxmc.poly.edu/betaville http://betaville.net/ , http://www.m2c-bremen.de

Meta-Functional Typology of the Forts of Kaunas Fortress

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***Keywords* – military architecture, utilization, meta-function, space syntax, Kaunas Fortress**

I. Introduction

Military architecture could be seen as a unique phenomenon that represents the architectural and urban features not met in civil architecture. As the unique objects, former fortifications can help to assure the key features of the preferred urban environment: legibility, complexity, coherence, mysteriousness. Despite the huge architectural-urban potential the full-fledged integration of the modern fortifications into contemporary cityscape is not an easy task because of the above mentioned unique architectural features of the objects. The research presented in the article aims to make this task easier by offering a meta-functional typology of the forts of Kaunas fortress.

II. METHODOLOGY

Cityscape in the article is seen as a complex spatial – social phenomenon. Space syntax methodology was chosen as the most appropriate one for the identification of the code or architectural genotype of the investigated objects. Investigation was conducted in two stages: evaluation of the locations of Kaunas forts; identification of the genotype or meta-functional type of the inner structure of the forts. Names for the meta-functional types of the forts are selected according to the types of the contemporary architectural objects with similar structures.

III. Original Typology of the Forts

Locations of the forts of Kaunas fortress are analyzed in the following maps: global depth, global integration (Fig. 2), local integration, fast choice. According to the locations the meta-functional possibilities of all 9 forts are identified, e.g.: more complex and integrated activities for the forts located in shallow zones, more specialized functions for the forts located in deep zones; higher integration into city's everyday life for the forts located at the axes with high integration values; function of neighborhood catalyst for the forts located in the centers of local integration, etc.

Fig. 2. Global integration map of Kaunas and locations of Forts (black color indicates the five percent of the most integrating axes).

While analyzing the inner structure of convex spaces of the forts the following features were identified: depth, integrity or fragmentation, characteristics of the structure from the point of view of "serial vision" and perceived "here and there" relations. The three big meta-functional groups of the forts were identified: inside-out type of the forts where complex of amphitheatric theaters, representative squares and "galleries" are connected only by the interior spaces (e.g. Fort No 1, Fig. 5); complex of the autonomous exterior spaces (representative squares, amphitheatric arenas, galleries, etc.) with the buildings (e.g. Fort No 6, Fig. 10) and big number of alternative connections; underground labyrinth-gallery with the isolated islands of exterior spaces (e.g. Fort No 9, Fig. 13).

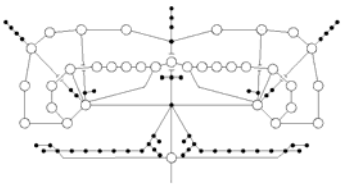

Fig. 5. Structure of the convex spaces of the Fort No 1. Black circles represent the interior convex spaces.

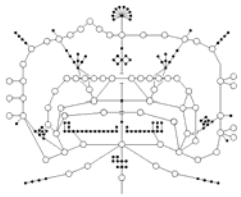

Fig. 10. Structure of the convex spaces of the Fort No 6. Black circles represent the interior convex spaces.

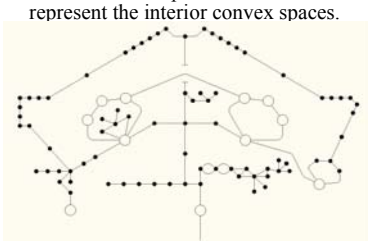

Fig. 13. Structure of the convex spaces of the Fort No 9. Black circles represent the interior convex spaces.

IV. Alterations of the Meta-Functional Types of the Forts

During exploitation of the forts after WW1 big number of changes was made there. Even if the above mentioned changes do not look very significant from the architectural point of view, the conducted analysis revealed the significant alterations of the genotype of the objects, e.g.: significantly decreases depth of the Fort No 1 and destruction of the open "galleries" when infantry rampart was destroyed; transformation of "representative squares" into "market squares" when entrances were created instead of the windows of the barracks in the Forts No 1 and 5; role of the interior spaces as the only transit spaces was weakened by the creation of additional open connection in the Fort No 3, etc.

V. CONCLUSIONS

Meta-functional types of the Forts of Kaunas Fortress are identified according to the location and inner structure of the objects. Three groups of the types were identified. The presented typology could be used as a background for architectural interpretation and utilization scenarios of the forts. Some changes or destructions in the forts made significant alterations of the code of the object.

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Implementing the Bioclimatic Design in the Sustainable Architectural Practice

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***Keywords* – sustainability, architectural practice, bioclimatic design.**

I. Introduction

One of the first ecologically justified architectural design concepts referred to the bioclimatic design, of which principles were published in 1963. Nonetheless, both bioclimatic design and sustainability ideas have been implemented in architectural practice very slowly and this is still a very topical issue. This paper summarizes the reasons that contributed to or hindered the application of the bioclimatic design methodology in the architectural design practice.

II. The Topicality of Ecological Ideas in the Modern Architectural Practice

After an ignorant attitude of architecture towards the natural environment in the first half of the 20th century the environmental movement expanded its role in the middle of the 20th century. A number of important environment-related publications were issued in the 50th and 60th, including also the first book on the bioclimatic design methodology. In early 70th the world oil crisis became a determinant incentive for the Western countries and building designers to start reduction of the building energy consumption. The requirements to the energy performance of buildings in the national laws and regulations have been raised, but, nevertheless, integration of the ecological idea in the architectural practice failed. Saving of energy and application of the bioclimatic design principles in designing were perceived as a technical supplement rather than the design philosophy per se. The environmental sustainability issues gained more attention after the Brundtland Report in the 1984 UN Conference, but only in the beginning of the 21st century the integration of the sustainable development ideas in the architectural design practice became more intense.

III. Bioclimatic Design Theory and Practice

Since issue of the first book dedicated to the bioclimatic design the bioclimatic design methods have been improved and developed based mainly on the comfort zone identification by applying psychometric charts (Olgyay 1963, Givoni 1969, Szokolay 1986 et.al.). There were attempts to develop more convenient methods for application in the architectural practice (Mahoney 1971). The bioclimatic design was mainly perceived as a linear process: climate analysis – defining of human comfort zone – finding technological solutions – architectural design. Such linear view of design process did not meet the diversified nature of a creative process. This was one of the factors, which narrowed the possibility of application of the said methods in the architectural practice on a larger scale. Integration of bioclimatic estimation in the computer-aided design environment referred to one of the solutions to this problem.

IV. Bioclimatic Factors in the Computer-Aided Design Environment

The history of building microclimate simulation software dates back to the mid-70th of the 20th century with a simplified estimation of building thermo-technical parameters. More active development of software as a practical design aid began about the mid-90th, but such software mainly existed as extra tools to the customary range of design methods. The situation began to change rapidly about 2008 - 2011, when the architectural industry began switching from CAD – type drawing software to BIM parametric design software. Currently, the major software developers are actively engaged in inclusion of the user-friendly building microclimate simulation options into the working environment familiar to architects. Similarly, free solutions are available as well. Both digital technologies and ecological principles of construction are sufficiently developed and they do not hinder any more reorientation of the design practice to the sustainability principles-based thinking. Currently the main topicality lies in the ability of architects to upgrade their knowledge and skills so that to be able to use more efficiently the bioclimatic design theory in combination with practical modelling methods and available building technologies.

V. The Bioclimatic Design and Sustainability Principles in the Architect's Knowledge System

Pursuant to the bioclimatic design theory an important role in the architect's knowledge system belongs to understanding of climatology, biology and thermal physics. Today it also involves computer skills. Integration of the principles of eco-friendly thinking in the design process and education programmes goes slowly. The reason lies in the specificity of architect's thinking rather than in the shortage of specialists in the said field or lack of educational programmes. When learning or teaching the bioclimatic design separately from the customary design practice, the sustainable design principles are being perceived only as a supplement to the existing design practice. The architects, first of all, should evaluate all of methodological aspects present in their practice in the sustainability context, and should make relevant adjustments in all existing work aspects, since the main problem lies in the rearrangement of present way of thinking rather than in the acquisition of new design methodology. Also in the education system the integration of bioclimatic design principles in the existing courses attains the largest effect than just development of a separate ecological discipline.

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Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
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Assessment and Planning Tools for Design of Seasonscapes

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***Keywords* – seasonality, seasonal calendar, seasonscape, assessment and planning tools.**

I. Introduction

In Nordic countries of Europe and northern cities of Canada and the United States of America the significance of climate specific urban planning and design is actualised. The United Nations Habitat Agenda emphasize the aspect for quality of life for the sustainable human settlements in an urbanizing world by developing societies to be in harmony with nature. [1]

Exterior space of human settlements is spatially open to atmospheric impermanence irrespective of their scale and density. Exterior space or landscape is in constant flux due to the alternating diurnal, weather and seasonal rhythms and the variety and character of landscape materials like air, water, soil, flora, fauna and man-made artificial materials. Human life in exterior space is constantly influenced by seasonal character. The seasonal character of landscape is a component of regional landscape identity. Since today we live in the '24 hour 365 days' model the proposition of this research is to search an approach for design in coherence with seasonal impermanence.

II. Seasons calendar

In order to analyse course of the landscape year, it is first necessary to revise archetype of seasons. In this paper I did investigation on legitimacy of paradigm - a year as a set of four seasons. The division of year in seasons have been analysed by comparing phenologic seasons with Gregorian division of calendar in months and old-Latvian seasonal division. The closest to real landscape calendar is the one compiled based on phenological methodology. Due to subjectivity encoded in human perception the landscape seasons perceived differs by individuals. This is considerable aspect for planning and design of seasons.

The division of year in specific seasons is human construct, historically developed classification and as such could be rewritten to assess real seasons for definite landscapes and to meet specific landscape planning and design objectives.

The investigation resulted in several arguments for assessment, planning and design of seasons' expression in landscape. Number of seasons and length varies depending on classification objective – solar and lunar cycle or event. Seasons like nature itself are a process – succession of phenological qualities. Seasons could be measured in varying timescale – months, days or even hours (for instance ice going in the river). Seasonal landscape is multi-layered (for instance winter means all – frost, wet slush or landscape covered in white snow). Seasonal calendar has also got cultural layers set by festivities and traditions. [2, 3] Seasonal calendar has close relation to symbols and symbolism of the nature. There is attribution of seasons to identity of cities – for instance winter cities, flood cities, London as rain city, examples in Latvia are wind city Liepāja and blossom of bird cherries in Sigulda.

For the holistic approach to landscape there should be coherent view on landscape seasonal year set from two sides – contextual, preconditioned by the nature and complemental, formed by landscape use, planning, design and decoration.

III. Assessment and planning tools

The aim of the tools is to evaluate diversity of seasons' expressions in landscape and answer whether landscape satisfies aesthetic, identity, authenticity and functionality goals, opportunities and constrains raised by seasons'.

A. Calendar approach

The paper proposes calendar approach for measurement of seasons in landscape. The approbation is done on two case studies of Tetele, Ozolnieki municipality and Strēlnieku Street, Rīga city, Latvia. The cases are selected for their differing landscape character and scales of urbanisation.

B. Seasons' schedule

The method for seasonal analysis of architectonic elements is proposed on case study of river landscape. This is conceptual research done on case of the river Lielupe analysing existing architectonic elements identified and appended with seasonally adjusted or conceptually possible with objective of encompassing wider spectrum of elements. The case of river landscape is selected due to its variety of natural landscape elements and artificially created architectural elements. The method developed can be used as systematizing and control tool to analyse use and seasonal coverage of existing and planned architectonic elements according to set seasonal objectives.

C. Seasonality grades

To measure factor of seasonality in definite landscape the grade is proposed – to make up an inventory of landscape elements and range them from season-specific to non-seasonal. This measurement could be done both for existing landscapes and during design process.

These three tools supports alternative to create region specific seasonscapes instead of production of prototypic landscapes.

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Urban Allotment Gardens in Riga – Challenge for Landscape Succession in Future Development

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***Keywords* – allotment garden, landscape succession, land use plan, sustainable development, urban wellbeing.**

I. Introduction

As stated in the European Thematic Strategy on the Urban Environment, four out of five European citizens live in urban areas [1]. Their quality of life is directly influenced by the condition of the urban environment. Cities mostly are facing similar problems – poor air quality, high level of traffic and ambient noise, derelict land and urban sprawl. This causes a series of negations – dependence on private cars, increase in one-person households and demographic downturn. The local authorities keep the instruments to improve the inner health of the city, and it depends how effectively they use them. One of the means providing alternative to urban lifestyle within urban living conditions promoting efficient diversity is urban allotment gardening.

II. Demand for Nature and Urban Sprawl

Studies show that people, living in cities, often become tired of the too urbanized environment and suffer from insufficient presence of the natural space. Many of them, as soon as the level of their income allows, find the escape from the intense urban life into a single-family house somewhere in the outskirts of the city. On the one hand it provides them with the desired presence of nature while on the other hand promotes expansion of the suburb villages and makes negative impact on the health of the city environment – increase of daily migration, traffic and air pollution and impoverishment of the city resources in general.

Although, the economic downturn has limited the rapid expansion of new suburb housing developments, being very typical at the period of economic uplift, the current stabilization predicts that the interest in the expansion of the single-family dwellings in the nearest outskirts of the city may renew in foreseeable future if no alternatives are offered.

III. Allotment Gardening – Risks and Challenges

Allotment gardening as integrated approach combining high urban density with the benefits of presence of natural environment in the cities can provide sustainability of urban development, i.e., appropriate land-use planning can enhance the level of satisfaction of people with the living conditions and thus help to reduce urban sprawl and save the surrounding natural biodiversity. Allotment gardens in Latvian towns and cities started appearing already in the early XX century, played significant role in the food supply during the period of WWII and spread out rapidly during the following three decades since were supported by the state policy and major enterprises formed garden areas for their employees.

Allotment gardening provides the opportunity for an active, healthy lifestyle which is socially inclusive and reflects the ideals of well-being. It provides not only exercise and relaxation, but also is the place to make and meet friends along with gathering the harvest of fruit and vegetables [2]. Allotment gardens preserve the urban ecosystem, support ecological diversity and provide some food. The demand for allotment gardens is increasing in densely populated European cities and interest in gardening and allotments has risen dramatically over the last decade [2] as more and more people appreciate the social, environmental and health benefits to be gained from tending to a garden in their an allotment plot.

Besides the mentioned, allotment gardens have also important social benefits. Typically beneficiaries of allotment gardens are older people, low income or socially disadvantaged families, youth and minority ethnic groups. Diverse social composition promotes stability and safety of those areas. Thus, allotment gardens face manifold challenges according their use, impact and position in urban development today.

IV. Alternatives in Riga Development Plan

Many allotment garden areas have survived till now. At present, due to increasing land value in the cities, the local authorities often prefer looking forwards to more profitable land uses – housing, commercial, educational, etc., and do not support keeping the existing allotment garden areas.

In Riga development documents, for example, the existing allotment garden areas are mostly regarded to brownfields what is mainly argued by poor maintenance quality of the areas, high level of illegally erected temporary buildings for holding of the gardening equipment and bad-looking urban landscape in general. In most cases the Development plan anticipates to change the land use type in these areas [3]. It will lead to significant reduction of allotment gardens in perspective, and they will be completely removed from the central locations in the city. Implementation of the planned stances will change the landscape succession and considerably reduce the amount of green areas in the city.

V. Conclusions

Spatial distribution over urban territories, spatial impacts and transformations of the allotments with respect to their urban context and morphology are important identifiers of the urban space. Advanced urban design development plans that incorporate urban agriculture as one of the elements of the city are the recommended ways of sustainable development. A possible route would be to integrate the allotment gardens in the greenery system of the city, as well as to increase public accessibility and usability of the areas.

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Fractal Architecture

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Keywords: **new detail, self-similarity, complexity, perception, attention.**

I. INTRODUCTION

Contemporary architecture is recently re-defining the meaning and a role of a detail and ornamentation. Changes in thought and thus artistic practice that started at the turn of 20th century provoked a profound discussion upon human perceptive abilities and the role of attention. That once even lead to a manifest that regarded detail as a crime. However, residues of puristic modernism are very often regarded as overwhelming. New architecture, seemingly, seeks a form that has a simple but somehow elaborated structure: defined but not obvious. This is what fractals are.

II. THE ROLE OF A DETAIL IN THE PAST

Most of the buildings from previous centuries would be very hard to classify without a layer of an ornament which used to serve as a decoration of few straight and simple planes: walls, ceilings and floors. Thus, a value of architectural detail in defining an identity of an artistic style was predominant. Virtually, *by style people meant ornamentation*. Not only were those details subordinate to an existing aestethical values, but also carried a load of re-interpretations of a symbolism and affiliations particular to a period.

Huge revolt in the intellectual and artistic life, that took place in nineteenth century, *"against traditional systems in thought, in politics, and in economics, gave rise to attack upon many beliefs and institutions that had hitherto been regarded as unassailable"* [1]

As a result, new stylistic manifestos occurred. In 1908 Adolf Loos presented his essay *Ornament and Crime*, where he repudiated an added ornament in architecture. Was this an aim against detailed elaboration of a composition of a building? In authors opinion, it was rather against covering it with reliefs that refers to obsolete cultural and social context.

Anyhow, modernism left us with numerous buildings, which are, in common recognition, better received from a distance, or even more so - on an artistic black-and-white photo. The clarity and simplicity of a structure are very often regarded as overwhelming. Laymen tend to regard as beautiful rather a gothic cathedral or a baroque palace than a La Tourette Abbey or La Cité Radieuse in Marseilles.

III. IDIOSYNCRACY OF CONTEMPORARY PERCEPTION

Author thinks that human possesses a natural (primordial) inclination towards complexity and details. That is contrasted with an acquired (derivative) intellectual need for synthesis and reduction. It can be a result of a nature of visual environment, as well as a idiosyncracy of human mind's activity.

Since contemporary notion of attention was defined as *"a primary, although fragile tool to impose a coherent and explicit forms of the scattered contents of consciousness*" [3], after being first regarded as a simple method of memorising information, nature of cultural creation has changed significantly. They are based on strong, though often transient emotions that enable inhibition of environmental stimuli and focus attention on the desired object. Although, it is only natural that *attention is diverted from one thing and moved to another (...)If we wish to attract it to the subject, we must constantly seek something new in it, especially if other powerful sensations try to tear it away and distract".*

Modernised architecture is subject to same rigorous rules. It needs to be distinctive and eminent. Nevertheless, it should be elaborated and complex, to fulfill a requirement of being aesthetically long-lasting. Since "*buildings are heavy, expensive, and more or less permanent*" [10], moreover, they are a part of many people's day-by-day perceptive environments, responsibility of an architect to compose wisely their structures is relatively high. In order to make them more likely to be well-perceived, there is a huge potential in a quest for defined complexity. Not only in determined algorithm but as well in stochastic. It is highly expected to find those rules in a natural environment.

IV. NATURE OF ENVIRONMENT

Nature usually does not have the simple figures in its structure. Classical (Euclidean) geometry does not have tools to describe a form of the world around. *„We've got nothing to describe this with: clouds are not made with straight edges, trees are not circles, they are not triangles, they are something very very different, indeed, but there is a continual kind of a pattern that I can see as I look at the edge of the rising cumulus cloud".*It is to say that those patterns are more similar to fractal geometry which was first described this way in 1980s by a french mathematician Benoit Mandelbrot.

V. CONCLUSIONS

Contemporary architecture is conducted by a need for self-justification. There is no singular model of proportion, symbolism or pattern that can serve as a module for composition. However that polymorphy of patterns (notions), as Derrida proposed, is a consequence of deconstruction made within an existing structure of patterns given as a common belief, it is now architect's interpretation or even independent construct, that is a base for a composition.

That self-justification, a primary rule of a composition of a building, can be very simple. Nevertheless, there is a very high potential when the rule generates a complex structure that is self-similar and somehow infinite. All of those characteristics are immanent for fractals, which are not only another shapes in classical geometry, but are distinguished phenomena that open one's mind to nonlinear (chaotic, but not random) complexity and a new abstract modules for compositions.

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Banská Štiavnica – Educational Space for the Preservation of Cultural Heritage

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***Keywords* – Education of cultural heritage, Banská Štiavnica.**

I. Introduction

Historical mining town Banská Štiavnica is one of the three historical towns in Slovakia entered on the List of World cultural heritage. The town is famous not only for its historical, architectural, natural and technical values but from the 18th century, similar to European centers of education, science and technology, with Mining academy, the first university of its kind in the world.

This fact has influenced Faculty of Architecture SUT in Bratislava to established in 1986 one of its departments in historical building near the town hall. In fact this building itself has become a training place for more as 400 students, which took part on its restoration.

Research and educational center of Faculty of Architecture SUT in Banská Štiavnica (RE Center) has been opened in the year 2000 and from this date it is a place of experimental research and educational activities, same as place of workshops, summer schools and conferences of national and international character.

II. Project „Creation and utilization of progressive training methods for the preservation and conservation of architectural heritage“

In the year 2000 has the RE Center obtained financial support from the Open Society Foundation for the project „Creation and utilization of progressive training methods for the preservation and conservation of architectural heritage."
In frame of this project has Faculty of Architecture in Bratislava (Department of History and Theory of Architecture and Monument Preservation) organized training activities for various subjects of bachelor's degree courses of architecture as well as for the M.Arch.

Course of Architectural Restoration (for the 3rd bachelor's study year) is one of them, realized by lectures and exercises. Training is focused on preparing work of the conservation (inventarisation, measuring, documentation, analyses, researches etc.) same as on the architectural restoration methodology, concept and creation, with important role of the work in terrain.

In frame of this project a part of the students could realize the terrain work in specific conditions of Banská Štiavnica – on the background of its architectural, historical and technical values.
The training has consisted of two parts:

- The first one concerned in documentation, recognizing and interpretation of cultural and historical values of architectural heritage in terrain
- The second one focused on the training of crafts utilized in historical architecture

Tabling of craft training to the study program of architects has followed two main goals:

- To enable the architects (creators of conservation concept) the knowledge of original and historical materials, techniques and technologies as best way of authenticity conservation
- Creation of private contact and relation to architectural heritage and craft work of their ancestors

The students have trained following crafts:

- Forging
- Working up of the stone
- Realization of traditional plasters
- Carpentering

Forging
Training was realized in original smith's workshop, with explanation of the technology and some examples of the steel's work up

Working up of the stone
It focused on short examples of basic tools and methods of surface adjustment.

Realization of traditional plasters
Training consisted of theoretical part (technologies, materials and tools) as well as practical exercises of:

- Preparation of various kind of plaster mixture on the base of lime
- Realization of wall plasters

Carpentering
Training consisted of preparing works:

- Work up of the natural wood
- Preparing and applying of the tools

The next step was exercise of traditional carpenters' connections and creation of the truss construction model.

The training was finished by discussion with the students applying the same questionnaire as to the students training in Bratislava, in order to compare their experiences, knowledge and opinions.

On the bases of this experience we have put this training in the regular education of architectural conservation on the study program of Architecture.

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How Rural Becomes *Urban*: Rural Manor Residencies in the Urban Context. Lithuanian Case

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Keywords **– built heritage, heritage management, manor residence, urban sprawl, revitalization.**

INTRODUCTION

The research deals with two supposed antagonisms: urban and rural, the cities and the manors, and concentrates on a particular case of Lithuania while analyzing in a wider context of Europe. Its aim was to demonstrate the preservation challenges of the manor residencies in the rural-urban interface in Lithuania in a wider context of literature. In order to accomplish this, we have analyzed the literature, historical and contemporary maps, and performed several photographical surveys in the territory of Kaunas.

II. PRESENT SITUATION, MANAGEMENT PECULIARITIES AND CHALLENGES

The research had demonstrated that the interface of rural and urban territories cause different threats for affected manor residencies: unfavorable shifts in ecological situation, the loss of original functions and valuable architectural and landscape features, and the disregard of historical property limits. We have distinguished four specific issues that should be addressed in management of Lithuanian manor residencies under urban pressure:

1. Historical peculiarities of the Central and Eastern European manor residencies. The Central and Eastern European manors from one point of view were similar to the extra-urban residencies of the noble and royal families of Western Europe, which were connected with the urban settlements and even have influenced their development, and at the same time the majority of them are identified as the antipodes to the cities by the historians [17, *27–32*]. These manors were preeminently oriented towards the agricultural production [18, *147*], which was mainly exported to the Western Europe. In this respect manors even hindered the development of cities and urban culture in this region. These historical urban-rural antagonisms make the issue of urban-rural continuum even more complex.

2. Peculiarities of urban expansion. Analyses of urban expansion patterns of Lithuanian urban settlements demonstrate rapid shifts from rather compact development to low-density urban sprawl [20, *66*]. J. Bucas [3] described the character of development of Lithuanian landscape as "emergent": the radical changes in land management and landscapes were caused by the radical political shifts and reforms. The change in urbanization patterns in Lithuania also can be characterized in this way. D. Bardauskiene and M. Pakalnis [2] underlined the specific character of the urban growth and expansion in Lithuania of the communist and post communist periods. They noted that Lithuania had inherited compact cities and landscape diversity after 1990 but contemporary situation is quite different: "migration of citizens from cities to the suburbs is induced by the open market and "ad hoc" territory planning", "after regaining the independence the main driving force of the growth became a private housing sector", cities are surrounded by chaotic urban structures (urban sprawl) and "poor landscapes". Current character of urbanization in Lithuania can be described as the chaotic spot expansion of the compact settlements. Consequently, the residencies of former manors are being increasingly absorbed into the urban fabric without any special considerations.

3. The experience and consequences of the Soviet regimes. The policy of the Soviet regimes had caused many specific social and heritage preservation problems in the countries that made a part of the communist bloc. These are the lost cultural continuity, the alienation of the society to form its heritage, lost territorial and spatial integrity of the heritage properties due to nationalization and adaptation to various new purposes etc. These problems have become even more complex in the context of the dynamic rural-urban interface.

Undervalued built heritage objects often are absorbed into the urban environment without any respect to their historic property limits or valuable architectural and landscape features. The problems of preservation of historic property limits are much more complicated in the post-communist countries. The properties of large rural ensembles, nationalized by the Soviet regime, during the process of privatization were subdivided into the smaller lots owned by different owners. The subdivision of the properties and the multiplicity of owners with different intentions and social problems usually become an obstacle for rehabilitation of the ensembles even in their authentic setting. In the urbanized zones, where the pressure for new development is much stronger, it becomes even more difficult to retain the historic rural property.

4. Potential for innovations.

We consider that the complex situation of Lithuanian manor residencies under pressure of rapid urban expansion presents not only these preservation challenges, but also the particular possibilities for adaptive re-use and rehabilitation. The presumptions are made, that they can influence the development and quality of urban places in multiple ways. For example, manor residencies can become centers of newly planned urban areas, can be adapted to the recreational needs, and become the "green islands" in the city. This demonstrates the need on further research on the integration of these residencies into urban development.

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Xenia Hotels Project, 1950-1967.

Policies on tourism, typological organization and standards in tourism accommodation in Greece

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***Keywords* – Xenia Hotels, Tourism, Politics, Accommodation, Modernism, Greek National Tourism Organization.**

I.Introduction

A.The 'Era of Reconstruction'

In the early 50s, Greece started its reconstruction after World War II and a following civil war.

B.Post-War Modern Greek Architecture

In a country ruined by wars, Architects and Engineers had the mission to rebuild it. Modern Architecture had been established in Greece since the interwar period, especially in public buildings and public works programs (schools, hospitals etc.).

C.Greek National Tourism Organization

The Greek National Tourism Organization (G.N.T.O.) was founded in 1950, when tourism became a basic axis of the national economy, and started the Xenia Project; the one and only attempt of the Greek State to create accommodation infrastructure for the development of Tourism.

Under the dictatorship of 1967, the 'Era of Reconstruction' ended and the official tourism policy changed, giving priority to mass-tourism.

II.Xenia Hotels Project, 1950-1967

A.Policies on Tourism

We will refer to some of the main programs planned by the GNTO. Most of them were completed, while others were revised or even abandoned.

By analyzing the Policies on Tourism we can conclude that the types of buildings and the locations of the infrastructures of the Xenia Project were defined by the policies on the development of tourism.

B.The types of buildings

The buildings of the project (more than 70 all over the country), prominent examples of Post-War Modern Greek Architecture, set the standards of accommodation for International Tourism, in a time that high standard facilities for tourists did not exist and there was no interest for private investment in tourism.

The project includes different types of buildings (hotels, motels, hostels, pavilions etc.) in privileged places - beautiful and/or historical sites.

C.General characteristics of the Xenia Hotels architecture

The architect of each Xenia Hotel would select the location where it should be built, in a privileged site, providing beautiful view, proper orientation and accessibility.

The main general architectural characteristics of the Xenia Hotels are the following: environmental integration (natural, urban and cultural environment), proper orientation (usually south or east), a functional program of the floor plans, simplicity in forms and authenticity of the material and techniques, a low budget construction, separation of public and private functions, relationship between inner and outer space, grid, typological organization and standards of the construction.

The materials selected were usually a combination of modern materials and materials used in local traditional architecture.

Beyond these common characteristics, each building is unique.

Fig. 8: Ph. Vokos, Xenia in Spetses.
(Source: Benaki Museum Photographic Archives)

III.Conclusion - Present Situation

The Xenia Project was a special Greek State program which set the standards for Greek tourist accommodation. GNTO had to lead the private Greek investors towards international high standards.

Those constructions were made to offer hospitality to high class international tourists, who brought valuable foreign exchange to a poor developing country.

On the other hand, those buildings with their infrastructures became very popular to the local society, hosting festivals, weddings, conferences etc. till nowadays.

Mass tourism, a new luxury life model and bad managment led the Xenia Poject to decline. Most of the hotels are abandoned. A few years ago, the Association of Greek Architects started an 'aggressive' effort to save some of the most important projects.

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New Architecture as an Infill in Historical Context

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Keywords **– historical context, urban infill, interpretation, strategies of implementation, metaphoric imitation/ analogical composition**

The relationship between new architecture and its historical context is determined from the values assigned to the meaning of its cultural heritage architecture and consequently its modern interpretation. Thus, "The design of a new work of architecture not only comes physically close to the existing one, entering into visual and spatial rapport with it, but also produces a genuine interpretation of the historical material with which it has to contend, so that this material is the object of a true interpretation which explicitly or implicitly accompanies the new intervention in its overall significance" [1]

Our aim is to present strategies involved in cases where new architecture is implemented into a historical urban fabric as an infill. Our focus will be on how the architects have interpreted the relationship between the new architecture and the cultural heritage context in cases where the new building is inserted into the continuous streetscape, aligned along the street façade with the historical presentences. The interventions are perceived as "surfaces" and not as spatial volumes. Cases where the new meets the old such as in additions, alterations, rehabilitations and refurbishments will not be examined. The buildings presented will be approached from the point of view of the viewer and the emphasis will be on the strategies applied, which are revealed from the comments of the architects themselves.

The problems of the interrelation between new and old architecture in the urban fabric are crucial in all cities which are physically a combination of a traditional part of corridor streets, grid organization of the roads, squares, green public spaces organized linearly or as large voids, and buildings articulated in a line with a preferential façade. The buildings in this case are perceived mainly as planes and not as volumes, as it is the case of free standing public buildings. Nevertheless, in the modern part of our cities the buildings are free standing volumes, multisided and isolated from their neighbours. Thus when working in the dense urban historical fabric we have to consider the close proximity of the adjacent architecture. Our intervention will be a part of a whole considered as a unity.

Issues involved in the implementations are the notions: place/context, identity, interpretation, metaphoric imitation/ analogical composition. The place/context is approached as a resultant of its various identities (cultural, economic, social, historical, physical, functional and the identity of the built environment). The interpretation of the architecture in a historical place is the revealing of its principles and underling rules. Any act of intervening based on the interpretation of the existing is related in a way to the notion of imitation. The imitation should be regarded as metaphoric according to Quatremère de Quincy [2] and close to analogical composition in the way Ignasi de Solà Morales approaches it.

The Modern Movement distanced itself from tradition and history. The pioneer architects of the '20s considered architectural artifacts as isolated objects bearing no concern for the adjacent buildings and their context. As Theo van Doesburg stressed in his 24 Points of the New Architecture in 1925, "In contrast to frontalism, which has its origin in a rigid, static way of life, the new architecture offers the plastic richness of an all-sided development in space and time". The analysis of infill projects from Gerit Rietvelt, Jacobus Johannes Pieter Oud, Le Corbusier and Adolf Loos shows that their architecture contrasted strongly with their neighbours and rarely had references to them.

At the beginning of '60s we witnessed a shift from the relativist view of history of modernism to a normative view. Consequently, the past was regarded as a heritage which was considered, in its heterogeneity, as a base for the new interventions. As Bernardo Secchi pointed out "The theme is no longer that of the construction *ex novo* of the modern city [3]. The spaces within which we will live the coming decades are largely already built. The future must provide a sense and a design by continuously modifying the city, the territory and the existing materials [3]. In that period with the urban theory of Colin Rowe named contextualism and the development of typological approach to design a shift occurred towards the issues concerning the interpretation of the architectural cultural heritage and its complex relationship with the urban frame.

Within this framework, architects developed a critical approach through the analysis and interpretation of the existing built environment. The new architecture as an infill in a row of old buildings is regarded as a layer added to the existing fabric. A question that arises is whether there is a single approach or a multiplicity of approaches of infilling new architecture in a historical environment. It is argued that there is no single answer to the above issue. Any intervention in pre-existing environment can be approached "case by case", as a specific solution to specific problem.

The strategies applied are a matter of interpretation of the historical context and the values we attribute to its meaning. An analysis of various infill projects reveals three basic approaches. The first one can be referred to as *referential*, the second one *differential* and the third one *contrasting*. In *referential* strategy the new develops a language in analogy to the old with immediate references to its principles. In *differential* the new has a different architectural language from the old but is conceived as an abstract continuation of its pattern of development and in *contrasting* the new architecture contrasts strongly with the existing context

In the historical perspective there is a shift of strategies applied in the beginning of the 20th century until today, from the *contrasting* approaches to the *referential* as well as *differential* and back to *contrasting* in our days, however in a different manner it was originally introduced.

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Challenges of Designing New Urban Quality in Historical Environment (Based on Final Projects of BA Students of the Department of Urban Design, FA, VGTU)

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Keywords **– historical environment, urban open space, designing new urban quality, urban design, regeneration of historical parts of town.**

I. Introduction

The problem of inadequate use of town space afflicts most urban centers today. An increased dependence on the automobile, the attitude of architects of the Modern Movement toward open space, abandonment of industrial, military or transportation sites in the inner core of the town - it is not a compete list of factors that have contributed to the loss of space in our cities [1]. Urban structures with lost spatial quality are not only in peripheral parts of towns, but also in historical cores [2].

Derelict territories of the historical part of a town, converted industrial zones or "wilderness" of large-scale construction of residential areas are selected for final projects of BA students of the Department of Urban Design, FA, VGTU. This article is focused on projects drawn up for historical parts of a town. Methodology, tasks, solutions argumentation and methods of designing new urban quality in BA student's' final projects are reviewed.

II. Methodology of final projects of BA students of the Department of Urban Design, FA, VGTU

Creating a new urban quality in historical environment, without prejudice to the existing harmony is a complex and challenging task. Its solution requires methodological consistency. In order to achieve a good result the following design stages are in place: study of features of existing urban structure, determination of urban-architectural concept underlying territory formation (Fig. 2), detailed design.

Fig. 2. Concept of regenerating territory of historical part of Panevėžys, Lithuania (student E. Gumauskaite, tutor D. Dijokienė).

III. Tasks and methods of regeneration of historic environment in final projects of BA students

The urban structure of a town has always changed, is still changing, and will be changing in the future – the change is the engine of its existence. Each generation makes an effort to preserve in the town what it considers valuable and modifications which seem to need a change. A person with Western European mentality is more inclined to express, establish and immortalise himself/herself rather than preserve heritage of others.

Students in their projects seek to maintain contact with the historical environment as well as aim to preserve the valuable features of the urban pattern and to integrate them into the newly developed built-up. New urban quality in historical environment is designed by formation of plan, built-up and volume-spatial composition. Sometimes solutions are successful, sometimes – less so. One Lithuanian architect, researcher of the old town's composition, has once said "Success of synthesis of the old and new architecture depends solely on the mastery of the creator" [3].

IV. Conclusions

Architects, urban planners and urban designers represent the segment of the society that is most capable of changing the town's face. Success of their work depends also on perception of the special value of historical environment and ability to establish balance between "old and new". The idea that the town's past must be preserved for the sake of its future is not novel but still highly relevant today. Visual aspect of historical environment is among the key factors establishing individual and communal identity. Therefore projects of historical environment renovation should be assessed from the perspective of revitalising the cultural memory and strengthening the urban community.

The synthesis of historical environment and modern society should maintain a subtle balance between realisation, fostering, and utilisation of the valuable features of the inherited urban structure, as well as attainment of new quality and development.

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Trends of Sustainable Residential Architecture

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***Keywords* – sustainability, sustainable residential architecture, sustainable housing.**

I. Introduction

Aim of this article was to create a model of understanding of sustainable residential architecture based on six prevailing trends, such as: ***social, ecological, technological, economic, esthetic*** and ***organic***. During the research main features of sustainable housing were formulated, like: *contextually, esthetical expression cost effectiveness, environmental friendliness, psychological acceptability* and *technological innovativity.* Each direction can be described by major or minor features detected during visual and technical observation of the data in each sustainable residential project. Depending on selected housing trend practicing architects can forecast the outcome of particular project and prevent possible problems which may occur in the future.

II. Methodology of Research

In order to understand the subject of sustainable residential architecture and to construct the scientifical framework of architectural trends the methodology of the research was formulated. The whole research consists of several steps:

1) Analysis of juridical documents and literature - trends and features of sustainable residential architecture were formulated;
2) On site research of built residential examples both in Lithuania and abroad (including realized projects during Scottish Housing Expo 2010);
3) In order to estimate the expression of sustainable residential features in every trend of sustainable housing a special assessment scheme was created;
4) Furthermore the predominant project setting was investigated (***city areas***, ***small town areas*** and ***rural areas;***
5) Moreover such features as: *visual quality, relationship between the building and its setting* and *environmental impact of each realized sustainable residential building* were analyzed.
6) Analysis and systematization of gathered data and identification of conceptual trends of sustainable residential architecture was performed.
7) Gathered information was generalized and summed up in final conclusion;

V. Research of Sustainable Housing

A. Research of features of sustainable homes

Based on observation of juridical documents and technical data of each project, main six features of sustainable houses were identified, such as: *contextually, aesthetical expression, cost effectiveness, environmental friendliness, psychological acceptability* and *technological innovativity.* In residential buildings these features are expressed differently, because they depend on architectural idea, specific requirements and site settings. Each feature consists of specific subcategories and is formulated according to world famous LEED-home rating system.

B. *Research of predominant site setting*

The aim is to estimate the most suitable site setting for each sustainable housing trend. Estimations are made based on actual setting of each studied object. There were distinguished three main possible settings: **city areas** (their downtown areas, natural environment and suburban sites*),* **suburban or small town areas** and **rural areas.** [2]

C. *Research of visual quality*

The purpose of this assessment is to estimate visual quality of each sustainable housing trend based on overall impression. During the assessment type and level of relationship between the architectural composition of the building and its environment is measured.

D. Research of relationship between the building and its setting

Visual impact of each sustainable housing trend on its surrounding environment was estimated. It was important to estimate the relationship between aesthetical expression of each sustainable home and its particular environment (urban or natural). The research was based on V. Jurkštas proposed building estimation scheme. According to it, each object's ability to blend with surrounding environment depends on its overall architectural composition. [3]

E. Research of environmental impact

The purpose of this estimation was to evaluate environmental impact of each sustainable housing trend. Environmental impact is evaluated according to the usage of renewable resource. There were estimated three levels of environmental impact of sustainable homes: *negative, neutral* and *positive*

VI. Results of Sustainable Housing Research

Based on architectural idea, project requirements and surrounding environment in certain trends some features may become dominant and some minor. It was important to distinguish the level of expression of each feature in every trend in order to better understand this complex stream of architecture. Also the predominant project setting for each trend was formulated and such problems were analyzed: *visual quality, relationship between the building and its setting* and *environmental impact of each project*.

VII. Conclusion

2. The research showed that there are six trends of sustainable residential houses. Each of it can be described by major or minor features, such as: *contextually, esthetical expression, cost effectiveness, environmental friendliness, psychological acceptability* and *technological innovativity.* In residential buildings these features are expressed differently, because they depend on architectural idea, specific requirements and site settings.

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Architectural Tendencies of Recent Infill Buildings in Kaunas Historic Centre

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***Keywords* – new architecture in a historic environment, infill buildings, contextuality, Kaunas historic centre, Lithuanian architecture in the Independence period.**

I. Introduction

The paper deals with the problem of the contextual relationship between architecture of modern buildings and their historic setting. The problem is analyzed concentrating on the case of second largest Lithuanian city Kaunas, which historic centre is covered by two protected bordering areas of the Old Town and the Historic part of the city. The author aims to define architectural tendencies, contextuality and impact on the surroundings of recent infill buildings built in the Kaunas historic centre since the regaining of Independence of Lithuanian state in 1990. The architectural character and the contextuality of infill buildings are discussed according to the recommendations of that time; the dynamics of evolution is revealed by division into three characteristic periods.

II. Legal background and recommendations

The protected areas in Kaunas historic centre are Kaunas Old Town (revised in 1996); and Historic part of the city (set in 1999). The differences in establishing the legal basis for protected urban sites emerged as the documents for protection and development of an urban heritage site had been elaborated only for the historic centre of Vilnius - UNESCO World Heritage site. As the Soviet regeneration projects became out of relevance, the protection and development of the historic centre of Kaunas had no objective legal documents, projects or guidelines till recent years. The process of the design of new buildings in protected areas was relying on the professional qualification and know-how of architects and local officials, responsible for the approval of a project, rather than based on regulated purposeful course.

Without elaborated purposeful local legal background the regulation for the protection and development of urban heritage in the documents by international organizations might be treated as the basis for the design of architecture in protected areas and their positions – as criteria for its evaluation. During the period discussed the evolution of the principles of urban heritage conservation developed towards territorial spread and heterogeneous multi-layering. Intangible cultural heritage and the spirit of place were incorporated as autonomous parts of cultural heritage. The context to be reflected broadened up to a multi-layered place of unique traditional, social and cultural characteristics; the recommendations for new architectural interventions beside morphological and structural means of harmonization were calling for reflection of spirit of place, intrinsic integration, pointing out the need for architectural quality.

III. Period 1990-1999

The regaining of Lithuanian Independence was followed by a deep economic decline that resulted in a low amount of buildings built in Kaunas historic centre. Emotional rise and deep concern to cultural heritage in society and Post-modern movement determined specific architectural tendencies of the infill buildings of the period. The architecture of the buildings of that time is rather similar in its contextual approach and tolerant relationship to the context. Infill buildings were integrated into the surroundings in a harmonious and careful way, avoiding any declarative attitude or intense impact on the context even in the historic part of the city before legal restraints were set there. The architectural expression was low; architectural language was based on the transformation of historic elements in a Post-modern way, the relationship to the surroundings was passive.

IV. Period 2000-2005

The XXI century started with the building boom that took place in the historic centre of Kaunas (except the Old Town) as well as all over the Lithuanian cities. Despite the establishment of the legal protection of Historic part of the city in 1999 the newly built buildings there followed the main architectural stream – minimalistic boxes of glass or concrete without harmonizing division, small-scale elements or elaborated details that might help to contextualize the infill architecture. Innovative and expressive buildings out of characteristic scale make an active but controversial impact on their historic surroundings due to cosmopolite design ignoring local features. The mainstream of infill buildings was oriented towards different direction than international recommendations were calling. The tendency of previous period was continued only in a few buildings inserted into the context respectfully adapting the main compositional scheme of historic buildings in a modernized way.

V. Period 2006-2012

The architecture of the buildings from the third period is mostly heterogenous. The architecture of a part of buildings, mainly built in the Old Town, searches and reinterprets the characteristic local features in a more or less innovative ways, although the relationship to the context and architectural quality differs. The other part consists of pieces of contemporary architecture with a certain attention to the scale and compositional scheme of local buildings for a better integration. Anyway, the largest harm to the historic part of Kaunas is also done during this period by buildings ignoring any respect for an existing urban situation and contemporary recommendations. The huge commercial centre “Akropolis” built on a bank of river totally changed the urban structure and scale of the historic part of Kaunas.

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Construction Science

Construction Science

Concerning Concrete E-Modulus

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***Keywords* – Concrete, E-modulus, measuring procedure.**

I. INTRODUCTION

Usually performed tests to determine concrete modulus of elasticity in codes are with a procedure using standard concrete cylinders (height 300mm and diameter 150mm). The cylinders are compressed and the strain development is measured on it sides. However it has to be noted that there is a friction between the steel loading platens and concrete cylinder, which hinders the cylinder top and bottom to expand. This leads to bending out of the cylinder sides. At mid height of cylinder are used gauges for vertical strain measurements. The measured compressive strain is reduced by the tensile bending strain and the total compressive strain becomes less as if there was no friction and bending. The E-modulus becomes too big.

II. ELASTICITY MODULUS OF CONCRETE

The elasticity modulus base in concrete codes goes back to the tests done by M. Roš at EMPA in Zürich in 1937, figure 1. The scatter of results is mainly due to different types of gravel.

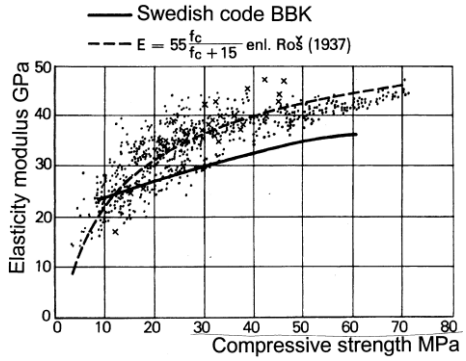

Fig. 1. Tests by M. Roš at EMPA in Zürich in 1937.

In tests [1] it was concluded that friction between cylinder ends and steel loading platens will deform the cylinders according to figure 2, left cylinder. Using double Teflon plates between the concrete and loading steel platens the failure picture is changed according to, figure 2 and 3.

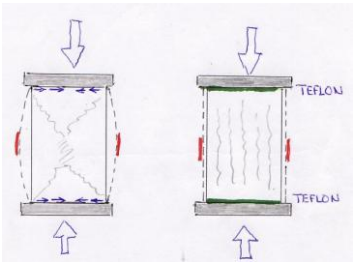

Figure 2. Friction caused bending gives tensile strain, which reduces the compressive strain, left cylinder. Without friction failure cracks become vertical, no bending, right cylinder.

III EFFECT OF TEFLON LAYERS ON E-MODULUS

The modulus for five concrete strengths was determined on concrete cylinders with double Teflon friction removing layers on loaded ends in [1]. The obtained measured modulus E_{1test} is compared with that in CEB-FIP Model Code 1990, [2], E_{1c}, determined without Teflon layers at 28 days, in Figure 7.

Fig. 3. Cylinder failures. Left picture with friction and right with double Teflon layers removing friction.

$$E_{1c} = E_{co} [f_{cm} / f_{cmo}]^{1/3}; \quad (1)$$

where $E_{co} = 2.15 \times 10^4$ MPa;

f_{cm} is mean 28 days compressive strength in MPa;

$f_{cmo} = 10$ MPa;

The tensile bending strain reduction of compressive strain is more for weaker concretes and results in too high code modulus of elasticity due to tensile strength being greater part of the compressive strength, Figure 7.

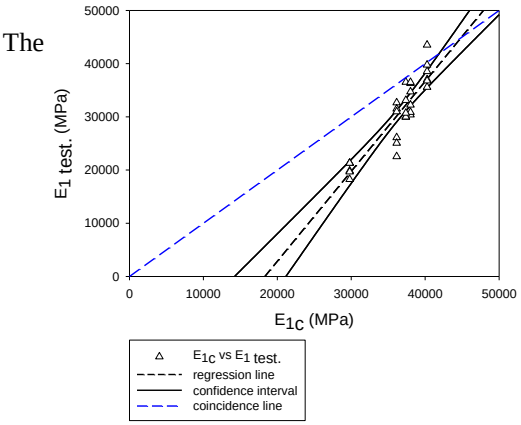

Fig. 7. Comparison between E_{1test} and E_{1c} calculated according to CEB/FIP MC90, [3] and [5].

IV CONCLUSIONS

The concrete modulus of elasticity in codes especially for weaker concretes is too big, because its evaluation is done with strains reduced with tensile bending strains obtained from cylinder tests according standard procedures. Code writers should take these observations in account. In practice delivered concrete strength is normally exceeding design compressive strength for reason to avoid delivered concrete with too low compressive strength. The modulus of elasticity in design is based on concrete 28 day strength, but concrete becoming older increases its strength and also modulus

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Assessment of the 2007 - 2013 National Road Traffic Safety Programme in Latvia

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Keywords **– road traffic safety, accidents, traffic safety improvement programme.**

I. Introduction

Since Latvia entered the European Union the nature of traffic has changed very rapidly. In 2008 automobilisation level reached 412 cars per 1000 inhabitants. Traffic flow is now denser, but development of road network was not so quick. Road traffic safety programme is one the most important national documents setting the main goals in road traffic safety work. First National Road Traffic Safety Programme in Latvia was adopted by the Cabinet of Ministers in 2000. The following article analyzes the results of Programme implementation within time period of 2007 – 2010 and gives detailed look on the most effective measures in Latvian circumstances.

II. Evaluation of Road Traffic

The number and mileage of vehicles in good technical condition increased until 2008 as shows summary of vehicle statistics in Latvia (2011). Since 2008 both the number of vehicles in good technical condition and their total mileage has decreased. Despite this fact the number of vehicles in good technical condition has increased 1.3 times and their total mileage – for 1.15 times since 2004. In accordance with Latvian State Roads Yearbook 2010 around **50%** of paved roads, 38**%** of gravel roads and **57%** of bridges were in poor and very poor technical condition**.** The road quality in the first four years of the „Road Traffic Safety Programme 2007 - 2013" has not improved, in fact the quality of paved roads has even decreased (41% of paved roads were in poor and very poor condition in 2007).

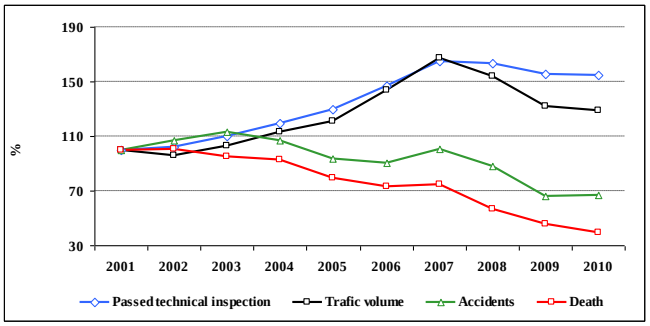

Fig. 1. Road traffic indices in Latvia (2000 = 100%)

III. Evaluation of Road Traffic Safety Level

In the recent ten years the mileage of vehicles has increased for **1.3 times**, the number of vehicles in good technical condition – for **1.5 times**. Development of road and street infrastructure has fallen behind the increase of traffic volumes and road condition continues to deteriorate. Despite this fact the improvement of traffic safety level may be observed in the last few years [see Figure 1] – the number of killed has decreased for **2.6 times** and the number of road accidents with killed/injured has decreased for **1.5 times.** As the task to increase traffic monitoring and control level set in the programme is being implemented, the number of road traffic accidents caused by drivers under the influence of alcohol in the recent years has decreased for 4.1 times from 947 accidents in 1995 to 232 in 2010 and the number of killed in such accidents has decreased for 9.2 times from 203 persons in 1995 to 22 persons in 2010. This is achieved with appropriate legislation, campaigns and intensive police enforcement. Despite wide advertisement campaigns and police enforcement the number of registered drivers under the influence of alcohol still is relatively high:

- every 13th accident involved drivers under the influence of alcohol (except moped riders and cyclists);
- every 10th killed person is registered in accidents involving drivers under the influence of alcohol (except moped riders and cyclists);
- every 12th injured person is registered in accidents involving drivers under the influence of alcohol (except moped riders and cyclists).

IV. Evaluation of the Implementation of Road Traffic Safety Programme 2007 – 2013

In accordance with the target of Road Traffic Safety Programme the number of killed in 2010 should not exceed 280 persons. 218 persons were killed in 2010, i.e. for 22.1% less that the set target for 2010. The target set by the EU – to reduce the number of killed for two times – was achieved already in 2009.

Cost-benefit analysis (CBA) evaluated the results of financing of implementation of safety measures of the Programme.

TABLE 3

Effectiveness Of Implementation Of The Programme

Total benefits, million LVL	213.55
Total additional expenses for road traffic safety, million LVL	42.32
CBR = benefits per expenses	5.05

As the CBR is higher than 3, the effectiveness of the National Road Traffic Safety Programme is good. In addition to that road traffic safety situation significantly improved after the introduction of penalty point system. The cost benefit ratio of introducing the penalty point system is excellent, as well as, the results of the campaigns combined with intensive enforcement against drinking and driving.

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Identification of Dynamic Model of Bolted Joint of Structural Elements

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Keywords **– bolted joints, identification, dissipative and elastic characteristics, phase trajectory.**

I. Introduction

The structural systems involve large number of elements that are connected through the bolts and pins. Joints and fasteners are used to transfer loads from one structural element to another. Structural joints are regarded as major source of non-linear phenomena. The complex behaviour of connecting elements plays an important role in the dynamic characteristics, such as natural frequencies, mode shapes, and non-linear response characteristics to external excitations. The stresses and slip in the vicinity of contact regions determine the static strength, cyclic plasticity, frictional damping, and vibration levels associated with the structure. The need for developing methods for developing models of structures with joints has been discussed in papers [2, 3,5]. Among the many factors affecting bolted joints and fasteners are friction and hardness [7]. Each factor will vary from bolt to bolt and joint to joint because of manufacturing or usage tolerances.

The relevant methods of identification of joints dynamic parameters, as a rule, are based on treatment of frequency response function. Yoshimura [6] carried out a series of experimental investigations to measure dynamic characteristics and quantitative values of the stiffness and damping of a bolted joint. Estimated modal parameters have been used in several studies to identify joint structural parameters. Yuan and Wu [7] and Kim et al. [4] used a condensed finite elements model and incomplete mode shapes to identify joint stiffness and damping properties. These methods require accurate modal parameters, which are difficult to evaluate especially in cases of closely coupled or heavily damped modes.

II. Phase Trajectories Mappings in Expanded Phase Sapce

Dynamic behaviour of mechanical systems is usually presented as oscillating processes in various graphic forms such as time processes, the Lissajous patterns and hodograph. Such patterns of presentations enable to determine the type of a process and to perform numerical estimations of its characteristics, but do not disclose any properties of the governing system. Unlike them classic phase trajectories have the row of advantages.

A phase space in classic mechanics is represented as a multidimensional space. The number of measured values for a phase space is equal to the doubled number of degrees of freedom of the system being investigated [1]. The state of the system is presented as a point in the phase space, and any change in the system state in time is depicted as the displacement of the point along a line called a phase trajectory. The image on phase plane $(y,\dot{y})$ is a more vivid presentation because it depicts inharmonious oscillations particularly well. Each phase trajectory represents only one definite clearly defined motion. A disadvantage of phase trajectories $(y,\dot{y})$ consists in the fact that they do not provide for the immediate presentation of oscillating process in time. However, this drawback is compensated by a significant advantage. The geometric presentation of a single phase trajectory or a set of trajectories allows coming to important conclusions about the oscillation characteristics. It is, foremost, true with the oscillations, which are described with nonlinear differential equations.

As is has been shown by several authors [8], the expansion of a phase space by taking into account the phase planes $(y,\ddot{y})$ and $(\dot{y},\ddot{y})$ substantially promotes the efficiency in analyzing a dynamic system behaviour. Hereby, we pass on to a three-dimensional phase space confined with three co-ordinate axes, i.e. displacement, velocity and acceleration. An interest taken into accelerations in dynamic systems is conditioned by the fact that these accelerations are more sensitive to high-frequency components in oscillating processes. Phase plane $(y,\ddot{y})$ is of a particular interest in the analysis of dynamic system behaviour, because it allows a more evident interpretation of power relations in the dynamic system under investigation. Namely, the area confined by curve $\ddot{y}(y)$ and axis $(0\,\ddot{y})$ is equal to work, and the anticlockwise motion around its contour corresponds to the energy spent by the system for one cycle of oscillating. Another important characteristic of phase trajectories on plane $(y,\ddot{y})$ is the fact that dependence $\ddot{y}(y)$ for autonomous non-conservative systems is a mirror symmetric image in relation to axis $(0\,\ddot{y})$ to the graph of changes in elastic force characteristic.

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Micro-crack Initiation and Propagation in Fiber Reinforced Polymer Composites

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Keywords **– polymer composites, fiber/matrix interface, fracture mechanics, fatigue.**

I. Introduction

Predicting micro-damage initiation and evolution is one of the key challenges for safe design of fiber reinforced polymer composites. Micro-scale damage such as, for example, single fiber break may be unnoticeable and negligible during the initial service life of composite, however, with many loading and unloading cycles this initially micro-scale damage may propagate forming macroscopic scale cracks that can significantly reduce the service lifetime or even lead to unforeseen catastrophic failure of the composite structure.

The objective of this study was to develop methodology for prediction of micro-crack propagation in fiber reinforced polymer composites. Fracture mechanics concepts of strain energy release rate are applied for crack growth analysis. Analytical modelling combined with numerical FEM calculations is used to obtain the values of energy release rate. Parametric analysis is performed to evaluate the significance of the applied load and various material properties on the micro-crack growth rate. Calculation results are implemented into power law relation, to predict the crack growth in fatigue loading.

II. Materials and Methods

In order to analyze debond crack growth along fiber/matrix interface; fracture mechanics concepts can be applied. Energy release rate G_{II} related to Mode II crack growth is used as a parameter for debond growth analysis. For unidirectional (UD) polymer composites subjected to tensile loads only Mode II crack propagation is relevant because the Poisson's ratio of the matrix is larger than for the fibers. In addition, thermal expansion coefficient of matrix is also larger than for the fibers meaning that due to cooling down from manufacturing to room temperature the radial stresses on the fiber/matrix interface will be compressive. Both of the abovementioned obstacles eliminate the Mode I (opening).

In UD long fiber composites with fibers of circular cross-section, debond growth initiated from a single fiber break can be approximately considered as a problem with axial symmetry. Concentric cylinder assembly (CCA) model introduced by Hashin [1,2] can be applied in analytical calculations as in [3].

The UD composite may be represented by a CCA model consisting of three phases – broken and partially debonded fiber cylinder in the middle, a matrix cylinder and an "effective composite" cylinder, which represents the surrounding undamaged composite.

When considering debond crack growth in a UD composite, two different crack growth conditions have to be separated:

1) if debond cracks are long and the tip of the debond crack is far away from the fiber break where it initiated from, and the oppositely propagating debond crack is also sufficiently far away, the crack will propagate in a self-similar manner since there is no interaction. The energy release rate for self-similar (long and non-interactive) debond cracks is therefore a constant value independent on the crack length;

2) if debond cracks are short, the stresses at the tip of debond cracks interact with stresses at the tip of fiber crack. Thus debond crack growth related energy release rate is magnified and is larger than in the self-similar region.

Power law expression was applied to describe the debond growth along fiber/matrix interface as a function of applied number of load cycles in tension-tension fatigue.

Fatigue experiments were performed in this study on fragmented single glass fiber/epoxy composites and the debond length was measured as a function of the number of cycles.

III. Results

Fig.1 shows that the overall agreement between experimental data and simulations for samples A, B and C is acceptable. It has to be stressed that modelling data for samples A and B are self-predictive, while modelling data for sample C were obtained using constants from sample A.

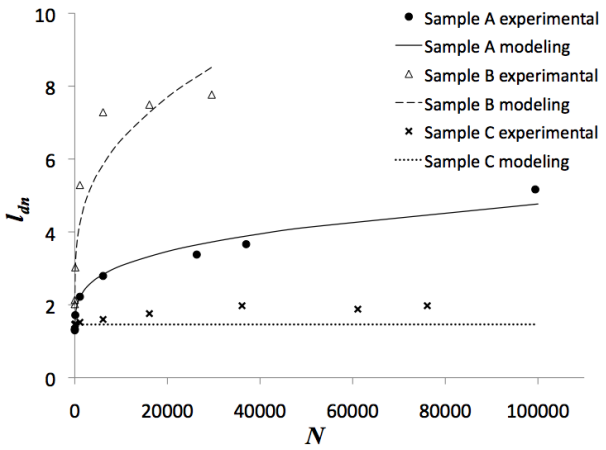

Fig.1. Average normalized debond length l_{dn} as a function of applied load cycles N. Experimental and modeling results.

IV. Conclusions

Using the quantified debond length versus number of cycles data it was shown that the power law with respect to the strain energy release rate change is applicable for debond growth characterization in tension-tension fatigue. Simulations showed that the obtained parameters give acceptable predictions for cases, when the debond grows and when it does not grow.

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Of the Behavior of Web-Flange Junctions of GRP Pultruded Profiles

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Keywords **- Pultruded GRP Profiles, Web-Flange Junctions, Experimental Investigation, FEM**

I. Introduction

Fibre-reinforced polymer (FRP) composites represent a class of advanced materials whose use has spread from the aeronautical, mechanical and naval industry to civil infrastructure due to their high strength-to-weight ratio, low maintenance cost and high corrosion resistance.

As the interest in using PFRP profiles in construction applications continues to increase, it is critical and essential to understand their short- and long-term mechanical behavior. Several recent and relevant studies have been conducted and focused on the performance of PFRP frame structures. The results of these studies have highlighted the major problems associated with the structural deficiency of unidirectional PFRP profiles, especially at the web-flange junctions (WFJ) that lack fibre continuity. This lack of fibre continuity may lead to progressive degradation in both axial and rotational stiffnesses and strength of these junctions, affecting both the buckling, post-buckling and the overall short- and long-term structural integrity of the PFRP profiles.

The authors are developing a research program whose main aim is to evaluate the strength and stiffness characteristics of open-web PFRP profiles. In particular, both the axial and rotational stiffness of WFJ of I- profiles and c- profiles are investigated through in-depth experimental program in order to develop P-5 and M-0 relations that are necessary for accurate analytical predictions of both the local and global responses of PFRP frame structures. In fact, their failure mechanism has yet to be fully understood and they often involve failure of the web-flange junctions. Moreover, P-5 and M-0 relations are also essential for establishing optimum and reliable design limit-states of such structures.

In particular, this work presents the results obtained from the first series of pull-out experimental tests on GFRP pultruded I-profiles conducted in the Materials and Structural Testing Laboratory of the Department of Civil Engineering (DICIV) of the University of Salerno.

II. Experimental Setup

In the pullout tests, WFJ from different profiles were subjected to a uniform pull load applied on the bottom flange of the profiles. Specifically, two different test setups were considered: in the first, the pull force was eccentrically applied at the end-point of the specimens while, in the second, the pull force was applied at their mid-point

For all the specimens, the pull axial load was performed using a calibrated *Shenck Hydropuls* servo-hydraulic testing machine equipped with two thick steel angles in order to provide fixity to the upper flange and web of the profiles.

In all the tests, a force-controlled loading protocol was adopted and both the incremental applied load as well as the associated relative web/flange displacement was continuously recorded via a calibrated data acquisition system *(System 5100 Vishay MM)*. Data obtained during the test were subsequently elaborated using the *StrainSmart* software.

Two sizes of commercially-produced structural pultruded I-profiles *(Fiberline Composites)*, i.e., 160 (H) x 80 (B) x 8 *(Tf=T_w)* mm and 200 (H) x 100 (B) x 10 mm *(T=T_w)*, denoted as *I 1 6 0* and *1 200*, respectively, were chosen for this investigation.

The nominal values of the main mechanical properties of the pultruded profiles were supplied by the manufactures and verified by the authors through traction tests.

III. Results

A total of 15 specimens were cut transversely from the I- profiles and loaded in tension at a constant rate of about 0.001 N/s until failure. In particular, they were divided into four groups according to the profile size *(I 1 6 0* and *I 200)* and location of the pull force *(End-Point* and *Mid-Point)*.

Typical load versus displacement curves, obtained from tests on *I 200 EP* specimens, are shown in Fig.1. In particular, for the *I 200 EP2* specimen the displacement increased linearly with increasing load up to an axial displacement of 0.6363 mm, corresponding to a load level of 5.0063 kN. After this load level failure occur.

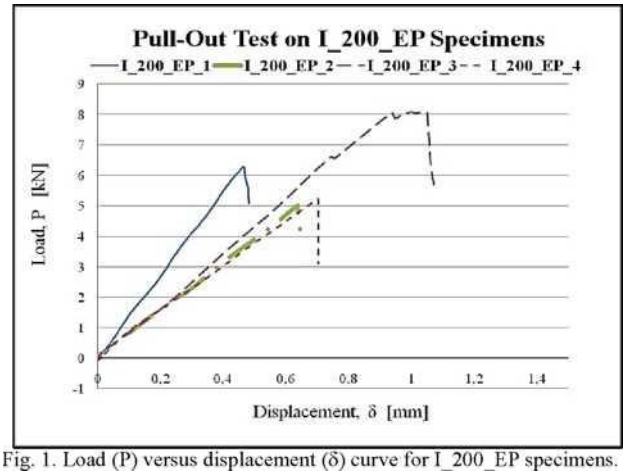

Fig. 1. Load (P) versus displacement (δ) curve for I_200_EP specimens.

IV. Conclusions

The results gathered from this preliminary pilot research study provide important information on one major structural deficiency and limitations related to the inherent weakness of the web-flange junctions of the majority of commercially- produced, off-the-shelf unidirectional pultruded composites.

The results of this research will provide structural engineers with essential design data to assist to secure optimum design as well as to achieve maximum benefits of PFRP materials.

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Dynamic Loading and Response of Observation Towers

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Keywords **– Dynamic response, observation tower, walking induced loads.**

I. Introduction

The excessive vibrations of some observation towers in Latvia highlights the lack of the understanding and inadequate design information of the building codes, regarding the slender tower dynamic response to human induced loads. Research demonstrates that in areas with a low seismicity and relatively low wind loads the human induced dynamic loads are determinative to a slender and light-weight observation tower design and mostly due to checking the serviceability criteria.

II. Theoretical and Experimental Background

A. Loading from Human Movement on Stairs

Human walking induces dynamic and time varying forces. These forces have components of vertical, lateral and longitudinal directions. The lateral forces are the consequence of the sideway oscillation of the gravity centre of human body while stepping alternatively with the right and left foot forwards [1]. The lateral force walking frequency is found to be a half of the vertical and longitudinal one [2].

The acceleration of the person's center of gravity (COG) in vertical, lateral and longitudinal directions during stair ascent and descent were measured to obtain individual continuous walking force time histories. Based on these histories there was established the mean one and further analytically approximated.

B. Calculations and Measurements of the Tower Vibration

Slender sightseeing towers are line-like structures. The response of the system with viscous damping to induced harmonic excitation can be written in the form of well-known linear non-homogenous differential equation:

$$M\ddot{x} + C\dot{x} + Kx = F_{\max} \sin(pt + \delta), \qquad (1)$$

where M, C and K are mass, damping and stiffness of the system correspondingly, but $F_{\max} \sin(pt + \delta)$ is harmonic excitation. To take into account human movement initiated excitation, the lateral and longitudinal human walking force in the time domain is represented as a sum of Fourier harmonic components and equation (1) updated with human induced lateral or longitudinal walking forces are:

$$M\ddot{x} + C\dot{x} + Kx = \sum_{i-1}^{m} G\alpha^i \sin(p_i t + \delta^i), \qquad (2)$$

where G is a static weight of the subject's bodies (N), i – order number of the walking harmonic, m – the total number of contributing harmonics, α^i – the Fourier coefficient of the i^{th} harmonic often referred as dynamic loading factor (DLF), p_i – i^{th} harmonic angular frequency (rad/s), δ^i – the phase shift of the i^{th} harmonics.

Research analyses experimentally measured response of the tower's structure to the excitation caused by human movement upstairs and downstairs. During the experiment there have been measured and recorded the vibration accelerations of the top platform of several observation towers.

III. Results

Dynamic loading factors and corresponding phase shifts for the first five harmonics of continuous walking force history in case of the stair ascend and descend are presented. The imperfectness of individual footfall forcing functions and differences between continuous walking force histories among individuals were taken into account. During the stair ascend at 2Hz the averaged vertical reaction force peak amplitude is 1.6 times of body weight, during descent - 1.8 times of body weight. During ascent the longitudinal reaction force peak amplitude was 0.28 times of body weight and during descent 0.23 times of body weight. During ascent the lateral reaction force peak amplitude was 0.28 times of body weight and during descent 0.24 times of body weight.

It was experimentally identified that human movement up and down the stair significantly amplifies the observation tower's vibrations (Fig. 1)

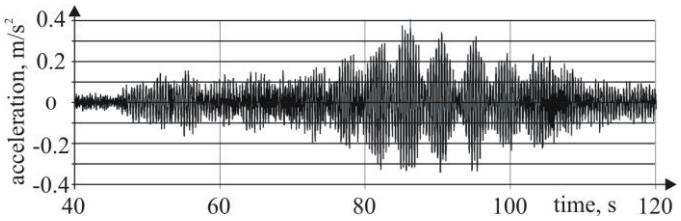

Fig. 1. Observation tower in Krustpils response to 2 person stair ascending

IV. Conclusions

The obtained analytical mean functions of human walking force histories during the stair ascent and descend may be used in numerical and analytical assessments of structure's dynamic response. The obtained parameters of the vertical force are within agreement of other researchers' work.

It was experimentally established that typical observation towers are susceptible to remarkable human induced vibrations.

V. Acknowledgements

This work has been supported by the European Social Fund within the project "Support for the implementation of doctoral studies at Riga Technical University".

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Analysis of Dynamic Parameters of Timber and Steel Observation Towers

Liga Gaile *(Riga Technical University)*

***Keywords* – Damping, Frequency, Human-induced loads, Observation tower.**

I. Introduction

Observation towers located in the countryside are designed to allow viewers an unobstructed view of the landscape and their design is mostly driven by economic aspects. With generally flat terrain, Latvia has a numerous observation towers mostly located in Latgale and Kurzeme regions. The structural design of all of them is mostly based on the previous experience. It is because of lack of understanding how these structures dynamically perform under human induced loads [1].

II. Methods and Materials

The purpose of this research is to identify the performance of most of the light weight observation towers open for public in Latvia. It analyzes their structure, condition, dynamic parameters (fundamental and natural frequencies, damping, frequency, which amplitude amplifies due to towers visitors' movement) as well it analyzes the loading scenarios to identify the critical ones based on the experimentally obtained data.

A. Experimental Program

During the experiment there have been measured and recorded the vibration accelerations of the observation towers. The accelerometers where located on the upper platform of the tower. The accelerations were measured under the following conditions: very mild wind and no visitors on the tower, two visitors moving upstairs and afterwards downstairs, two visitors moving along the upper platform in transverse direction and in circular direction. Additionally, there were measured the geometry of the structure and the weather conditions during the experiments.

B. Observation Tower Description

Locations of experimentally measured observation towers are presented in Fig. 1.

Fig. 1. Location of observation towers in Latvia.

The heights of the observation tower are in the range of 19m to 36m, a plan dimension of main lateral load resisting system varies from 1,5m to 9,5m. 70% of inspected towers are a traditional timber structure design towers with non-uniform cross section. Others are made of steel where in most cases the plan dimension over the height does not change. The slope of stairs is in the range of 30^0 to 70^0 but most of the observation towers' slop of stairs is around 45^0.

III. Results

Although the most of observation towers are less than ten years old their technical condition widely varies. Only those timber towers that has less than five years are in good condition. Most of the damages are located in the main column areas (Fig.2), whereas the steel towers columns' splice seems to be affected by the tower's vibrations (Fig.3).

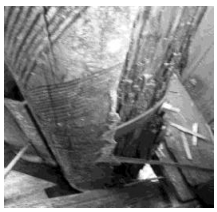

Fig. 2. Typical damage for timber structure

Fig. 3. Typical damage for steel structure

A. Dynamic Parameters and Dynamic Response

The critical range of the structure's frequencies *f* when it is prone to human-induced vibrations [3]:

$$0.666 \pm 0.147\,Hz \le f \le 3.300 \pm 0.147\,Hz \qquad (1).$$

All inspected observation towers in Latvia are in this critical range. The measured noticeable acceleration amplifications from human movement confirm that all lightweight observation towers should be designed considering human-induced dynamic loading. Timber observation towers' fundamental mode damping varies from 6% to 10% but steel towers' – 2,5% to 4,6%.

IV. Conclusions

Timber observation towers have very short service life but they perform better under human induced loads due to higher damping ratio than steel structure towers. Steel towers are very prone to human induced vibrations and there is a necessity to develop suitable damping devices. It has been observed that tower responded to human induced loads not necessarily with lowest frequency but with frequency that has lower damping ratio and still relatively close to the typical pacing frequency.

V. Acknowledgements

This work has been supported by the European Social Fund within the project "Support for the implementation of doctoral studies at Riga Technical University".

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Numerical Analysis of Concrete Structures under Blast Loads

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Keywords **– dynamics, numerical simulation, blast loads.**

I. INTRODUCTION

The aim of the paper is to present an effective approach for robustness oriented analysis of structures subjected to extreme loads due to explosions or impacts. The main problems concerning the fundamental aspects of the analysis are defined and discussed in details.

To verify the proposed material model for concrete the simple numerical tests were performed and compared with results of experimental tests published in literature. Since this comparison shows the sufficient consistency between the experimental and numerical results, more complex validation analyses were undertaken in order to check the proposed approach in simulation of the real-life situations..

II. DESCRIPTION OF THE PROBLEM

A realistic evaluation of the structural response due to blast load is a task of timely and growing importance in many engineering situations, no longer confined to classified areas of defence technology.

In order to obtain reliable results from numerical analysis, the rate - dependent plastic - damage constitutive model for concrete has been applied, based on considerations presented by Faria and Oliver [3]. The main goal of the choice of material model was to obtain the relatively simple algorithm, reliable and easy to implement into commercial finite element computer code. The model has its own point of departure on the continuum damage mechanics [6,7], which is a very powerful and consistent theory that is based on the thermodynamics of irreversible processes. Nonlinear mechanisms of degradation of concrete under tensile or compressive loading conditions are characterized by two independent scalar internal damage variables. This option deals with tensile and compressive concrete behavior in a unified fashion, where the same material model is adopted for any load combinations. Rate dependency, a very important factor in the analysis of blast loaded structures, has been accounted for as an almost natural extension to the plastic-damage model, introducing a viscous regularization of the evolution laws for the damage variables..

III. NUMERICAL ANALYSIS OF EXPERIMENTAL TESTS

The assumed material model has been implemented into the computer code Abaqus/Explicit as a user subroutine. In order to verify the assumed material model numerical simulation of the experimental test performed by Schenker [8] has been carried out. In this experiment, the permanent damages developed in a thick plate by a far-field explosion of large PETN charge (980 kg) were examined. For such simple geometry, consisting of the relatively rigid flat surface loaded by a contact explosion, [4] empirical formula was introduced. This approach is only applicable for rather simple geometry structures, where the effects of blast wave reflection and their consequent interaction are not so significant [1,5].

The main goal of this study was to investigate the behaviour of selected structural elements subjected to extreme loads. Among many factors influencing the analysis, one of the most important is the material modeling. Although there is great variety of material models for concrete and steel available in literature, the choice of the material formulation is difficult. The decision should take into account the physical nature of the modeled phenomenon, static or dynamic behaviour, possible rate of deformation, etc. For this reason, the relatively simple, scalar damage model has been chosen, modified, and implemented.

Figure 1 shows the final distribution of tensile damages for a concrete element subjected to a far-field explosion, calculated in the framework of this study.

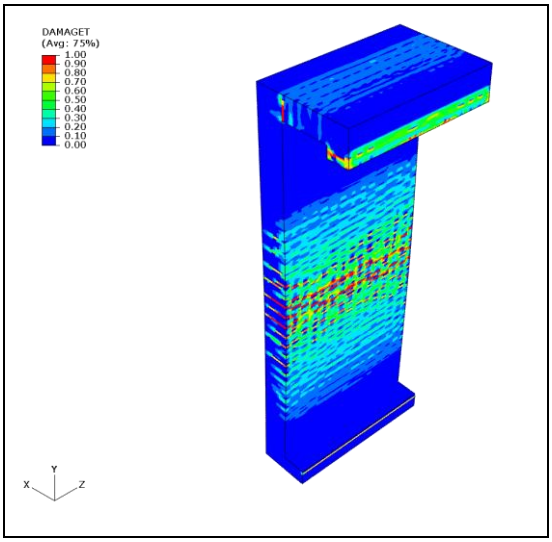

Fig. 1. Distribution of tensile damage.

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Characterization and Analysis of Time Dependent Behavior of Bio-based Composites Made out of Highly Non-Linear Constituents

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Keywords **– Bio-based composites, regenerated cellulose fibers, time dependent behaviour.**

I. Introduction

Currently there is compelling motivation from industries and society for development of materials from renewable resources. Fairly recently a number of bio-based thermosetting resins and high quality natural fibers (e.g. flax) became available which promoted development of entirely bio-based high performance composites for structural applications. However, there are still weaknesses related to the natural fibers that have to be considered, such as limited fiber length, sensitivity to moisture, temperature, etc. However probably major drawback of these fibers is variability of their properties. Therefore, another type of reinforcement with high cellulose content and of natural origin has attracted attention - regenerated cellulose fibers (RCF). RCF are continuous and it is easy to arrange them into fabrics with stable orientation and geometry. On the other hand, RCF are highly non-linear. The performance of bio-based resins is also of similar kind and, therefore performance of the composite with such constituents is non-linear with presence of very significant vicsco-elastic/plastic component.

The main objective of this investigation is to predict mechanical behaviour of these composites and their constituents by generalizing existing models to capture their time-dependent behaviour. In order to identify and quantify parameters needed for the modelling, extensive damage tolerance tests as well as creep experiments are carried out.

II. Materials and Methods

In this study as reinforcement for composites regenerated cellulose fibers “Cordenka 700 Super 3” was used. EpoBioX were used as bio-based resin. EpoBioX is epoxidised pine oil based resin (Amroy, Finland). As a curing agent Ca35Tg hardener with mixing ratio 100:27 was used. EpoBioX resin is approximately 75% bio-based.

Composites were manufactured as follows: Fiber roving was winded on steel plates using a filament winding machine (2 layers for unidirectional composites (UD)). Afterwards fiber performs were impregnated using vacuum infusion with resin heated to 50ºC. Composites were cured for 2h at 80ºC. The final composite laminates were with fiber volume fractions 67%.

Tensile tests of composites were performed on Instron 3366 machine equipped with 10 kN load cell, pneumatic grips and extensometer with gauge length of 50mm (Instron 2630-111). Tensile creep tests were performed using a creep rig with dead weights. Creep load is applied in steps and in every step stress is applied instantly and kept constant for time certain interval. The duration of strain recovery interval was at least 8 times longer than the loading interval. Creep strains (measured using extensometer) were recorded during the loading and also during the following interval of strain recovery after load removal. Creep tests used for determination of time and load dependence of viscoplastic strains were carried out in multiple steps over shorter time intervals of 10, 20, 30 and 60 min.

III. Results

It is important to be able to predict long term behavior of materials under investigation. One of the most general approaches is thermodynamically consistent theory for nonlinear viscoelastic and nonlinear viscoplastic materials developed by Schapery [1,2]. The constitutive equation was further modified to account for microdamage in [3]. The final form of the material model (for one-dimensional case) is:

$$\varepsilon = d\left(\sigma_{\max}\right)\left[\varepsilon_0 + g_1 \int_0^t \Delta S\left(\psi - \psi'\right)\frac{d\left(g_2\sigma\right)}{d\tau}\,d\tau + \varepsilon_{pl}\left(t,\sigma\right)\right] \quad (1)$$

Several step creep tests for Cordenka/EpoBioX composites are presented in Fig. 1. It can be seen that viscoplastic and viscoelastic strains at 160 MPa stress increases twice as much as at lower stress levels with 20MPa stress increase.

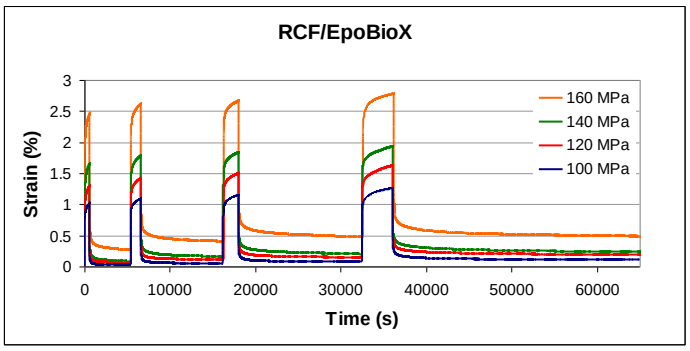

Fig.1. Several step creep tests results for Cordenka/EpoBioX composites

IV. Summary

It was shown from creep tests that composites from regenerated cellulose fibers are highly nonlinear with high amount of viscoelastic, viscoplastic strains. The results accumulated in this investigation facilitate understanding of behavior of composites with highly non-linear fibers. It will promote development of these materials as well as help in validation of models for prediction of performance of such composites. This knowledge will be further used to design materials with new compositions (and properties) tailored according to the particular applications.

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A simplified Approach to Assess Indoor Radon Activity Concentrations Based upon On-site Experimental Evaluations of Radon Exhalation from Building Materials

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Keywords **– Radon exhalation from building materials, Indoor Radon concentrations, human exposure to Radon, Indoor Air Quality.**

I. Introduction

The current legislations effective in different European countries about the assessment and the monitoring of population and workers' exposure to natural radioactivity, mainly associated to Radon inside workplaces and residential dwellings, require basically a mere verification that the average activity concentrations, measured over a period of one year, turn out be lower than some determined values, fixed according to the recommendations provided by International Organizations, like the ICRP, the UNSCEAR, the EURATOM and the WHO.

However, it is widely agreed by the scientific community that a more appropriate evaluation of the physical agents contaminating Indoor environments and, therefore, spoiling Indoor Air Quality, must not be limited only to some few integrated measurements but it should be able to identify and evaluate the different Radon sources (soil, domestic water and gas supplies, building materials (BM)) contributing to the entry and accumulation of indoor Radon. In such a way it should also provide, afterwards, sounding elements to design and plan the most convenient operations of mitigation on existing buildings and develop a more efficient design approach for new buildings.

II. The Model

In order to evaluate the maximum values of indoor Radon concentration to which occupants would be exposed and then to identify a correct technique of mitigation which would ensure the respect of default limits imposed by law, we have developed a simplified steady-state procedure SIREM© (Salerno Indoor Radon Exhalation Model) for predicting Indoor Radon activity concentrations based on a dynamic analytic model for the entry and accumulation of Indoor Radon, developed with the STELLA II SOFTWARE environment [3]. The complete model [1] is made of a number of physical sectors, equal in number to the possible Radon sources (soil, building material, water, gas supply) and interacting among each other through a system of coupled first-order differential equations. To solve this model, in principle, it would be necessary to measure all the different emissions from all the possible Radon sources and, moreover, the several soil parameters and the detailed geometric characteristics of the confined space under investigation should be known with accuracy.

III. Materials and Methods

The particularity of our procedure is a newly developed approach, based exclusively on on-site experimental measurements with only one instrument, the Radon detector RAD7, capable to perform alpha-spectrometry for Radon's alpha-emitting short-lifetime progeny, in soil-gas, in the air and from exhalation by building materials. This simplifies a lot the complexity of the analytic model and enables the operator to clearly distinguish and easily evaluate the different contribution by each source to the Radon entry and accumulation inside a confined space. Relevant features about this experimental approach are the precisions of the measurement and the fast instrumental response.

IV. Case study and first results

To verify its validity we have applied our procedure to a single-family detached house, chosen as a test-house, the test-house is located in Baronissi, in the province of Salerno, Southern Italy. The building material used for the construction is concrete. The dwelling conditions (absence of cracks, holes etc.) turn out to be generally very good and the test-house is very well isolated from the underneath soil. Measurements have been performed for Indoor Radon, Radon soil-gas, outdoor Radon and Radon exhalation by BM, using the Radon monitor RAD7 and emission chambers for BM by *Durridge Co*. (details in [3]). A measurement protocol [2] based on a continuous monitoring (of about 2 hours) of Radon and Thorium emission by BM have been applied.

The first and preliminary results [3], showing a very good agreement between the predicted values and the measured ones within the experimental errors, suggest that the main source of Radon entry and indoor accumulation is provided by the building materials. From them it can be inferred that our approach, based on accurate on-site experimental measurements of the emission by the building materials, turns out to be very convenient compared with other models described in literature, which rely on a larger number of parameters, which are sometimes difficult to evaluate directly or to measure in a easy manner.

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Heat Engineering Measurements of Renovated Building Envelopes

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Keywords **– heat transfer, U-value, renovated building.**

I. INTRODUCTION

The paper is devoted to the analysis of heat transfer processes of renovated building envelopes. The paper gives theoretical calculation of the actual U-value, as well as based on practical measurements of cavity walls after thermal insulation.

II. THEORETICAL BASIS

In the European Union, former USS Republics and the Baltic states there are held various researches, technological and practical activities dedicated onto the decision of the heat engineering problem of walling and materials. Many different experiments that give grounds for theoretical and practical basis of various heat engineering issues are made.

To continue a practical evaluation of heat engineering problems of renovated building envelopes we would like to present a research compare theoretical and practical approaches. Investigated building envelope in figure 1 consist of outside silicate brick cladding, cavity space insulated with Ecowool, wood frame construction fill in with slag and inside mortar finishing.

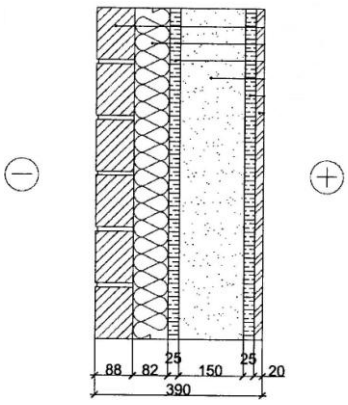

Fig. 1. Building envelope after renovation.

Experimental measurements were held during one year, but in paper we present a data only for winter time, because of the importance of the figures received.

III. THE RESULTS OF EXPERIMENTS

Air humidity and temperature measurements were taken by HOBO loggers. Heat flow and wall temperature data were collected with device ALMEMO 8590-9 equipped by sensors FTA 15P, T 190-2 and FQA 118. The uncertainties in all measurements were stated according with devices passports as 0.1%.

In figure 3 all data that was measured during experiment from 18 to 26 of February is presented. There is inside and outside air temperature, wall surface temperature, heat flow, outside air humidity and wind strength. All data collected was carefully evaluated to find out any relationship between each of the effects.

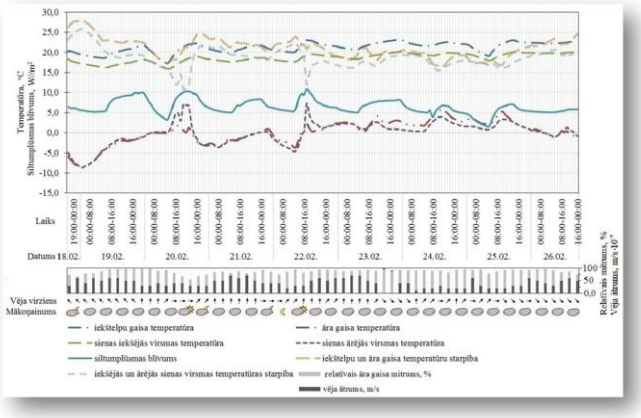

Fig. 3. Heat flow, temperature and weather condition.

In figure 4 results in period from 18 to 26 of February are shown, where U_{sm} is the coefficient of thermal conductivity (U value) calculated according with Latvian Building code, U_{xpg} – U value measured by outside air temperature, U_{xps} - U value measured by outside wall surface temperature, U_{xpsg} - U value measured by outside air and outside wall surface temperature.

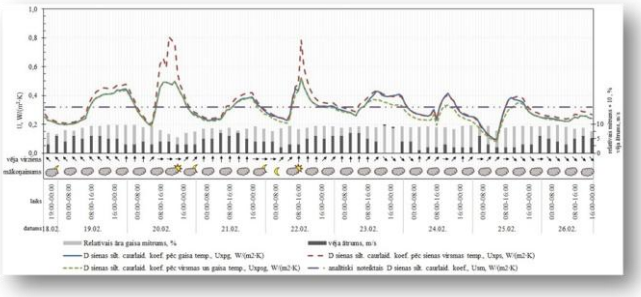

Fig. 4. Coefficient of thermal conductivity.

All calculations and measurements were done according to Latvian Building code or European recommendations.

IV. CONCLUSIONS

According with different methodology there is calculated four coefficient of thermal conductivity values – U_{sm}=0,318 (W/m^2*K), U_{xpg}=0,307 (W/m^2*K), U_{xps}=0,333 (W/m^2*K), U_{xpsg}=0,292 (W/m^2*K). All values are calculated on winter time period from 18 to 26 of February. We believe that better results could be received if experimental thermal conductivity values measured by outside wall surface temperatures were used. It means that sun activity should be evaluated in non-stationary heat engineering calculations.

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Performance of Mortar Made with Waste Fine Aggregate and Ceramic Fume

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Keywords **– mortar, fine aggregate, ceramic waste, cement, composite.**

I. Introduction

In many areas, the growing difficulty in obtaining natural coarse aggregates for the production of cement composites led cement composite manufacturers to a search for feasible alternatives [1]. The first way to solve this problem is to create cement composites based entirely on fine aggregates. The second way to solve the problem is to use construction and demolition waste as aggregate. The most ecologically efficient and sustainable solution would be combining both approaches and creating a cement composite based on two types of aggregate: fine and demolition waste. This article presents the results of an experimental programme where the technological viability of creating fine aggregate cement composite based entirely on waste fine aggregate of natural and demolition origin was examined.

II. Harnessed materials, mixing and curing procedures

The amount of construction and demolition waste produced only in 15 European countries is about 180 million tonnes per year with an increasing trend [1]. Fine fractions of ceramic waste aggregate obtained during crushing ceramic debris is still not harnessed. The production of one tonne of cement generates around 1 tonne of CO_2, which means that global cement production accounts for about 7% of the total carbon emissions [2]. Therefore, the replacement of cement in concrete by ceramic waste powder represent a tremendous saving of energy and has important environmental benefits. For the purposes of the research programme a ceramic fume obtained as a by-product during manufacturing of coarse "post demolition" aggregate was used. This fume was used to partially replace binder in mortar mixtures. Waste post-glacial sand of hydroclassification origin was employed as an aggregate.

Standard mortar mix used to test compressive strength of cement was harnessed as a preliminary mix. The proportions of materials for one cubic meter of the standard mortar mix are as follows: cement=512kg, water=256kg, sand=1534kg. These proportions were modified by admixture of 1% of highly effective superlasticizer. There were cast 9 prism specimens (40mm·40mm·160mm) out of each batch. The first step of curing was to keep the specimens in their moulds covered with polyethylene sheets for 24h. The specimens were then removed from their moulds and cured by storing them in a water tank (Temp: +21^{o}C).

III. Research programme

The programme of experiments was divided into two main stages. The objective of the first stage was to determine the workability of fresh mortars and density of hardened mortars. The second stage was to conduct compressive (f_c) and flexural (f_f) strength tests. Compressive test was conducted on surface of 40mm·40mm=1600mm^2. Flexural test was conducted on freely supported prisms (span 100mm) and loaded in the middle by single force. Three groups of mortars were tested characterized by w/c ratio equal to 0.50, 0.55 and 0.60 respectively. In each group of mortars the amount of cement which was exchanged by ceramic fume varied from 10 to 50% (by volume).

IV. Results and discussion

All achieved results were presented with the help of bubble charts. The entities displayed on a bubble chart can be compared in terms of their size as well as their relative positions with respect to each numeric axis. Compressive strength is presented in Fig.3 (f.v.) which consists of three different charts corresponding to varied w/c ratio of tested mortars. The compressive strength varied from 27.9MPa for cement mortar to 7.4MPa for mortar with 50% of cement replaced by CF. In case of w/c = 0.55 the relation was much more flat and the compressive strength varied from 24.4 MPa for cement mortar to 9MPa for the maximum volume of replaced cement (50%). In case of w/c = 0.60 the compressive strength varied from 16.7 MPa for cement mortar to 7.3 MPa for the maximum volume of replaced cement (50%). For the maximum volume of replaced cement (50%) the compressive strength for all analysed w/c ratios is similar and varies from 7 to 9 MPa.

Flexural strength is presented in Fig.4 (f.v.) which consists of three different charts corresponding to varied w/c ratio of tested mortars. The flexural strength varied from 6.2MPa for cement mortar to 2.9MPa for mortar with 50% of cement replaced by CF. In case of w/c = 0.50 the relation was much more flat. In case of w/c = 0.60 the flexural strength varied from 5.6 MPa for cement mortar to 2.7MPa for the maximum volume of replaced cement (50%). For the maximum volume of replaced cement (50%) the flexural strength for all analysed w/c ratios varied from 2.7 to 3.4MPa.

Taking into account possible practical applications of discussed mortars it should be stated that mortars with w/c equal to 0.60 are the best. They are characterized by overall lowest compressive strengths but at the same time the ceramic fume cement replacement had the smallest impact on compressive strength. Even 30% replacement of cement did not significantly lower the overall compressive strength of such mortars. One of the main issues associated with replacing cement by ceramic fume is the homogeneity of mechanical properties (R^2 = 0.667 for w/c = 0.60) of casted mortars and mechanical properties itself. The achieved results of mechanical properties prove that mortars based on waste natural aggregate and modified by ceramic fume as partial cement replacement can be used to cast elements characterized by less demanding mechanical characteristics.

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High Efficiency Concrete Containing Micro and Nano-sized Particles

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***Keywords* – high efficiency concrete, ultra high performance concrete (UHPC), pozzolanic admixture, nano silica, Sol-gel method**

I. Introduction

Technology of high efficiency concrete provides for use of ultra-fine micro and nano-sized admixtures which considerably improve properties of fresh and hardened concrete. In the frame of this study the concept of high efficiency concrete provides for two basic directions:

1. Creating ecologically effective concrete mixes with low cement content (<330 kg/m^3) for conventional application (mass concrete etc).
2. Creating concrete having high compressive strength (>100MPa) and high performance characteristics allowing producing thin light-weight bearing elements. (HPC –High Performance Concrete, UHPC –Ultra High Performance Concrete).

The basic principles for obtaining high performance properties are low water/cement ratio and dense micro structural packing achieved by using special pozzolanic admixtures which chemically react with calcium hydroxide and form calcium silicate-hydrate. Silica fume is the most popular commercially available pozzolanic micro filler based on silicium dioxide. Pyrogenic silica having nano-sized particles (<100 nm), has been elaborated recently.

The aim of this study was to estimate the possibilities to use locally available micro and nano fillers having pozzolanic action and to evaluate use of alternative nano silica synthesized by Sol-gel method.

II. Materials and Methods

The initial stage of research was intended to compile locally available micro and nano fillers, to create their database and to test particle properties, such as grading (particle size distribution), specific surface (BET method), reactivity (active SiO_2/R_2O_3 content), SEM microscopy etc.

The effect of admixtures was estimated by testing specially prepared fine-graded samples based on cement, quartz sand and different micro (nano) fillers. Concrete compressive strength, water absorption and mineralogical composition (by X-Ray method) were tested. The first experimental phase included replacing 15% cement by different micro fillers (water/cement ratio 0.43). The second experimental phase included replacing 1% silica fume by special nano silica synthesised by Sol-gel method (water/cement ratio 0.19). Sol-gel method implies settling of SiO_2 from TEOS solution, drying 80°C/24h, calcination (burning at 400-1000°C) for 2 hour and grinding to destroy agglomerates. SEM microscopy recorded that silica fume and pyrogenic nanosilica had rounded particles, Sol-gel nano silica had very porous nano-sized structure (like sponge)

The properties of some used nano and micro fillers are summarised below.

	Particle size, μm	Specific surf., m^2/g	Active SiO_2/R_2O_3, %
Cement I 42.5N (CEM)	2-50	0.50	
Dolomite powder (D)	5-60		
Calc. devon clay (M15)	0.54	2.20	0.89 / 7,92
Calc. kaoline (K15)	0.52	1.65	1,10 / 32,76
Silica fume (SF)	<0.5	7.92	
Nanosilica pyrogenic	0.184	22.03	
Nanosilica Sol-Gel	0.099- 0.60	7.2-52.4	

III. Results

The effect of different micro-fillers on compressive strength is shown in Fig. 1. The best results (high compressive strength and low water uptake) was demonstrated by mixes based on silica fume (SF) and calcinated kaoline (K15). X-Ray analysis indicates minerals such as portlandite, hatrunite (CEM, D) and larnite (K15, M15 and SF). Low content of portlandite in compositions SF and K15 can be interpreted by pozzolanic reactions.

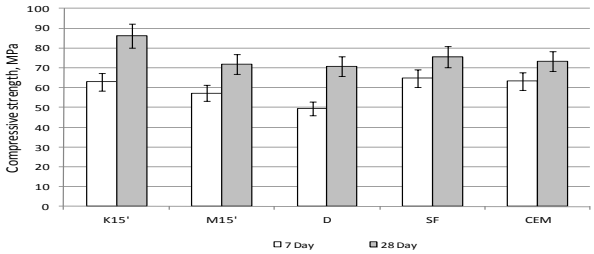

Fig. 1. Compressive strength results

Comparing the effects of different nano fillers, it must be said that compressive strength results differed only by some percent (3-5 %) for all compositions and X-Ray analysis did not indicate any significant difference in mineralogical composition for 3 mixes containing standard nanosilica (NS1), non-calcined nanosilica (NS2) and calcined nanosilica in 500°C (NS3). Minerals hatrurite, larnite and portlandite were found in all cases. Low values of water absorption results (0.22-0.40 %), indicates about very dense material structure.

IV. Conclusions

The main factors such as pozzolanic reactivity, particle grading and morphology determine the effectiveness of micro and nano fillers. The most effective fillers in this case are silica fume and calcinated kaoline clay. This particular research has shown insignificant effect, if replacing traditional silica fume by different type nano-particles (dosage 1%).

Nevertheless, Sol-gel nano silica may have some benefits compared to conventional silica because controlling the parameters of sol-gel process allows producing the particles of definite sizes and sol-gel process does not require very high temperatures compared to traditional nano silica.

Acknowledgement

The financial support of the ERAF project Nr. 2010/0286/ 2DP/2.1.1.1.0/10/APIA/VIAA/033 „High efficiency nano concretes" is acknowledged

Mechanical Properties of Cement Paste with Glass Cullet

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Keywords **– glass cullet, fluorescent waste glass, concrete, mechanical properties.**

I. Introduction

Glass cullet is a solid waste material, which represents an environmental problem all over the world. Not all waste glass can be recycled into new glass because of impurities, prohibitive transportation costs or mixed colour waste streams and therefore it is stored in landfills. Governments and waste producers are as a result turning to new technologies to solve this problem. As it was mentioned by Meyer in 2001[1], crushed waste glass which is amorphous and with high silica content, with it subangular particle shape and a smooth, flat surface texture used as a form of construction material was rapidly becoming one of the most favoured options because of the large quantity consumed, relatively low quality requirements, widespread construction sites, and the potential benefits achievable. Nowadays, waste glass ground into small size particles up to nanoparticles[2] with modern technological means limited the potential risk of alkali-silica reaction in concrete and therefore increased potential application of it in the concrete. A size effect was observed by many researchers when partial cement in concrete was replaced with glass powder. Shayan[3] concluded that the use of ground waste glass as a high volume cement replacement in concrete seemed feasible if the particle size of the glass can be reduced sufficiently. It has been found that the pozzolanic reaction between the glass powder and cement paste enhances the properties of concrete. With different fineness the glass powder show different effects on the properties and pore structure of Portland cement hydrates. The finer the glass powder, the higher the strength of glass powder blended cement. The same trend has been demonstrated by Shayan and Xu[3]. In their study, a smaller glass particle size led to higher reactivity with lime, higher compressive strength in concrete and lower expansion.

II. Materials and Methods

An experimental study was carried out to investigate the effects on the mechanical properties of concrete with finely ground waste glass as Portland cement partial substitution at levels of 30%. Glass cullet (clear, amber, emerald green bottle glass), borosilicate DRL and lead LB fluorescent lamp glass chippings were ground within 60 minutes in laboratory planetary ball mill Retsch PM400 (with rotation speed 300 min-1) into powder with Blaine specific surface of 371m^2/kg, 481m^2/kg, 303m^2/kg, 458m^2/kg, 475m^2/kg accordingly. Ordinary Portland cement CEM I 42.5N from "Kunda Nordic" (Estonia) was applied as binding agent. Cement conformed to standard EVS EN 197-1:2002 "Cement – Part 1: Composition, specifications and conformity criteria for common cements". A total of 8 different cement paste mixes were prepared: Cem2 – reference mix, DRL60 – mix with DRL glass, LB60 – mix with LB glass, DRLs60 – DRL glass ground in water environment [2], DL60 – DRL(15%) and LB(15%) glass mix, C60 – mix with clear glass, A60 – mix with amber glass, E60 – mix with emerald green glass. Portland cement substitution was at level of 30% with waste glass powder in 6 mixes and waste glass suspension in 1 mix. Specimens were cast in 40x40x160 mm steel moulds. The moulds were cleaned and lightly coated with form oil before the casting procedure. Concrete was compacted on a vibrating table. After that the specimens were covered with polyethylene pellicle and left to set for 24 hours. Then they were removed from moulds and cured in water (with temperature +20±2°C) for 28 days.

III. Results

The results for compressive strength are shown in Fig.1.

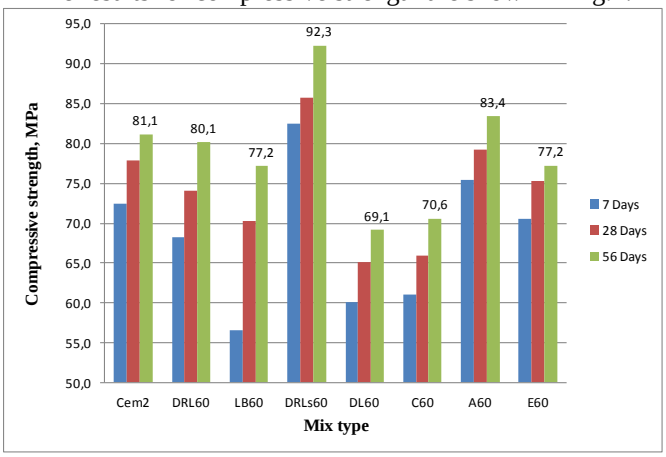

Fig.1. Influence of waste glass content and curing time on the concrete compressive strength

IV. Conclusions

In present study Portland substitution with ground DRL fluorescent waste glass suspension and amber glass cullet powder at level of 30% showed the best results at the age of 7days, what is very important for structural elements, with 82 and 75Mpa accordingly compressive strength values in comparison to reference mix.

V. Acknowledgement

The financial support of the ERAF project Nr. 2010/02 86/2DP/2.1.1.1.0/10/APIA/VIAA/033 „High efficiency nano concretes" is acknowledged.

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Composition of Porous Geopolymers Made of Aluminium Recycling Waste

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***Keywords* – Geopolymer binder, Porous material, Secondary raw materials.**

I. Introduction

Due to several advantages zero-Portland cement based binders called geopolymers starts to play an important role in the society of scientists and engineers. Scientists and "green thinking" engineers have focused their attention on developing of non-limestone based cement, which does not require the use of fossil fuel to heat large kilns. Geopolymer concrete cements (GPC) are inorganic polymer composites, which are prospective concretes with the potential to form a substantial element of an environmentally sustainable construction by replacing/supplementing the conventional concretes [1]. Natural minerals and waste materials have been investigated as sources of geopolymers in recent years [2].

This case study investigates the application of the process waste or non-metallic product (NMP) generated from aluminium dross processing. Wastes from aluminium scrap recycling industry and calcined metakaolin as well as glass waste was used as basic raw materials for production of geopolymer binder in this research.

II. Materials and Methods

In the current study, the basic raw materials of geopolymer binder were metakaolinite (MK), non-metallic product (NMP) received from aluminium scrap recycling industry and lead silicate glass waste. Alkali activation of raw material composition was done by water glass modification with an addition of sodium hydroxide to increase alkali solution concentration.

Two mixture designs were created. Mixture A7.5 contained 7.5% NaOH and second composition A10 contained 10% of NaOH flakes from total mass of alkali solution.

Geopolymer mixture was cast in 40x40x160mm prismatic moulds and the curing conditions were kept constant at the temperature regime: 80°C for 24h. Mineralogical composition of specimens was determined by X-Ray diffractometer. The samples were examined by using scanning electron microscope

III. Results

During hardening process, material pore structure was developed. Due to the chemical reactions and gas evaporation, highly porous material was obtained (Figure 1). The pore volume and density could be controlled by alkali concentration in the solution. Mixture A10 provide density in a range from 460-510 kg/m^3 while samples with mixture composition A7.5 provide density from 580 to 600 kg/m^3. Mechanical and physical properties are given in table 1. Due to higher open porosity samples with mixture composition A10 provided higher water absorption – 67-70% and samples made from mixture A7.5 had water absorption 47-48%.

The flexural strength was in range from 0.08-0.12MPa for both compositions A7.5 and A10. Compressive strength of hardened samples was 1.1-1.4MPa for samples A10 and 1.8-2.3MPa for samples A7.5 (table 1).

TABLE 1

Mechanical and physical properties of hardened samples

Compo-sition	Density kg/m^3	Total porosity, %	Water absorbtion, %	Compressive strenght, MPa	Flexural strenght, MPa
A 10	460-510	82-83	67-70	1,1-1,4	0.08-0.09
A 7,5	580-620	80	47-48	1,8-2,3	0.11-0.12

Mineralogical composition results indicate amorphous structure of obtained material without a crystalline phase.

Obtained geopolymers have porous material structure with wide range of pores (from 87.5µm to 258µm). There were found pores with size in large scale (see Figure 1). Micropores were observed in the material walls. Some microcracks were indicated into the material structure. This could be issued due to hardening temperature regime.

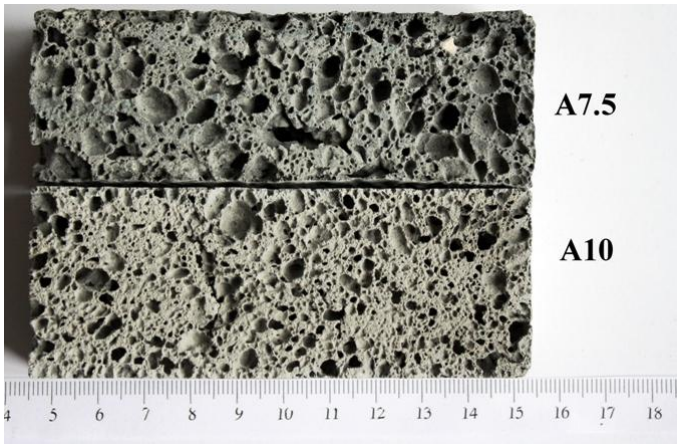

Fig. 1. Expanded geopolymer macrostructure

IV. Conclusions

This research introduces the composition of new type of porous alkali activated binder material made with secondary raw materials. Presented material possesses density in a range from 460-620kg/m^3 and density could be controlled by geopolymer composition and alkali content in activation solution.

Further investigations will be devoted to improving mechanical and physical properties of obtained geopolymers by optimization mixture composition and curing conditions with the aim of elaborating new competitive construction material.

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Influence of the Plasticising Additive on the Properties of Hardened Concrete when Coarse and Fine Aggregates are Replaced by Concrete Waste

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***Keywords* – demolition and construction waste, concrete waste, recycled coarse and fine aggregate, strength of concrete.**

I. Introduction

Concrete is widely employed construction material, for the production thereof the following raw materials are used: cement, coarse and fine aggregates, water as well as additives. Large amounts of natural breakstone and sand are used in concrete production. However, natural resources can be preserved by replacing the coarse and fine aggregates with the aggregates produced from concrete waste. Worldwide a lot of scientists perform analysis of concrete waste and its influence on concrete properties. Researchers have found that water impregnation of these aggregates increases [1]. As a result, when aggregates of concrete waste are used during the preparation of concrete mixture, amount of water, necessary to prepare the concrete mixture with the required consistence, increases. In addition, it was determined that the strength of the hardened concrete decreases when natural aggregates are replaced by concrete waste [2, 3]. Therefore scientists seek for and analyse various additives that improve the properties of the concrete produced by using concrete waste. Research deals with the investigation of the variation of properties of concrete samples when concrete waste aggregates are used. In addition, the influence of superplasticising additive on the concrete, where natural aggregates were replaced by concrete waste, was analysed.

II. General Regulations

Concrete waste with various fractions was used as coarse and fine aggregates during the research, as well as filler aggregates from the crushed concrete waste were used.

The following materials were used in concrete production: cement CEM II/A-L 42.5 N; coarse aggregate - gravel breakstone and utilised crushed concrete waste with the particles' size from 4 to 16 mm; fine aggregate - natural sand and utilised crushed concrete waste, with the particles' size from 0.125 to 4 mm; filler aggregate - crushed concrete waste, with the particles' size smaller than 0.125 mm; additive – superplasticising material based on polycarbosilicate ether polymers, where the minimal recommended amount of the additive was used, this is 0.8 % of the cement mass, and the maximal recommended amount - 1.4 % of the cement mass.

Concrete mixture composition was calculated (results are provided in Table 1) in accordance with the selected methodology for the calculation of concrete composition. Selected slumping class of the concrete mixture was S1 whereas class of the compressive strength of the hardened concrete was C30/37. Main physical and mechanical characteristics of the samples were determined through the implementation of the standard methodologies: water impregnation following the standard LST EN 1428.18:1997 whereas density was determined in accordance with – LST EN 12390-7, compressive strength in accordance with LST EN 12390-3.

Conclusions

Research results show that the crushed concrete waste can be utilised as coarse and fine aggregates for the production of new concrete products. When superplasticising material is added to the concrete mixture during the concrete production, water demand, required to prepare the concrete mixture with the suitable consistence, decreases. Results of the analysis allow us to conclude that all concrete samples, produced by using concrete waste, have reached their classical strength and density is similar as the one of the normal concrete.

When concrete waste is used, it is possible to decrease the amount of concrete waste in dump areas, preserve natural resources, i.e. natural breakstone and sand can be replaced by concrete waste.

TABLE I. COMPOSITIONS OF CONCRETE MIXTURES

Compositions									
Concrete markin g	Cement, kg/m³	Coarse aggregate 16/4 mm, kg/m³		Fine aggregate 4/0.125 mm, kg/m³		Filler aggregate 0.125/0, kg/m³	Additive, kg/m³	Water, l/m³	W/C
		Gravel	Crushed concrete waste	Sand	Crushed concrete waste				
S1	444	537	—	764	—	—	—	189	0.43
S2	444	537	—	764	—	—	3.55 (0.8%)	159	0.36
S3	444	537	—	764	—	—	6.22 (1.4 %)	159	0.36
S4	444	—	537	—	764	—	—	231	0.52
S5	444	—	537	—	764	—	3.55 (0.8%)	180	0.41
S6	444	—	537	—	764	—	6.22 (1.4 %)	167	0.38
S7	444	—	537	—	714.4	49.6	—	231	0.52
S8	444	—	537	—	714.4	49.6	3.55 (0.8%)	221	0.50
S9	444	—	537	—	714.4	49.6	6.22 (1.4 %)	217	0.49

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Sustainable Concrete with Recycled Aggregate

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Keywords **– recycled aggregate concrete (RAC), fluorescent waste glass waste, coal/wood ash**

I. INTRODUCTION

Concretes produced with recycled aggregates are the subject of several papers recently published in the technical literature. Substitution of natural aggregates can be one of possibilities to take care of landfills and increase of CO_2 emissions into the atmosphere in Latvia [1]. Recycled aggregate is a valuable resource; value-added consumption of recycled aggregate, as replacement for virgin aggregate in concrete, can yield significant energy and environmental benefits. Concrete produced with coarse recycled aggregate differs from normal concrete produced with virgin aggregates in terms of some mechanical properties and durability characteristics. The employ of wastes coming from demolished concrete structures or from industrial production of precasted concrete members is a primary choice for obtaining recycled aggregates useful in producing new concrete products [2]. As the next step from studies [1] could be the usage of waste glass as cement partial substitution at level of 20-30% in concrete mixes with recycled aggregates. "Eco-friendly" way to produce concrete consists of fluorescent waste glass powder usage in addition or partial substitution of Portland cement which manufacture as energy-intensive and highly polluting process contributes about 5-8% to global CO_2 emissions and accounts for 3% of total (5% of industrial) energy consumption worldwide, production of each ton of cement results one ton of carbon dioxide (CO_2) [3] into the atmosphere.

In present study mechanical properties of concrete with optimized utilization of recycled aggregates and partial substitution of Portland cement with glass waste are determined.

II. MATERIALS AND METHODS

An experimental study was carried out to investigate the effects on the mechanical properties determined of concrete with recycled aggregates obtained from crushed concrete specimens from previous studies which were stored as concrete waste. Crushed concrete specimens grains from coal/wood ash concrete, DRL – fluorescent waste glass concrete, DRLS - fluorescent waste glass suspension concrete were separated into fractions (4/8mm, 8/11.2mm, 11.2/16mm). Ordinary Portland cement CEM I 42.5N from "Kunda Nordic" (Estonia) was applied as binding agent. Cement conforms to standard EVS EN 197-1:2002 "Cement – Part 1: Composition, specifications and conformity criteria for common cements". Natural local aggregates (gravel, crushed stone and sand) have been used for mix preparation. A total of 8 different concrete mixes were prepared. Concrete mixes were made with natural aggregate substitution by 100% since from previous studies [1] the gain of compressive strength was the most effective and Portland cement substitution at level of 20% with fluorescent waste glass powder ground to Blaine specific surface 358 m^2/kg. All concrete mixes were made with capacity of 10.5 litres. The mixing procedure was following:

- Mixing of the dry ingredients for 120 s;
- Adding 70% of the total water for 60 s;
- Adding the rest of the water and mixing for 60 s.

As soon as the mixing finished, Abram slump test was carried out for each mix in accordance with LVS EN 12350-2:2009 "Testing fresh concrete – Part 2: Slump test". Specimens were cast in 150x150x150 mm steel moulds, which conform to standard LVS EN 12390-1:2009 "Testing hardened concrete – Part 1: Shape, dimensions and other requirements for specimens and moulds". The moulds were cleaned and lightly coated with form oil before the casting procedure. Concrete was compacted on a vibrating table. After that the specimens were covered with polyethylene pellicle and left to set for 24 hours. Then they were removed from moulds and cured in water (with temperature +20±2°C) for 28 days and then in curing chamber (with air temperature +20±2°C and relative humidity ≥95%) for other 56 days. Mechanical properties of cube specimens were determined at the age of 84 days.

III. CONCLUSIONS

In present study recycled aggregates from concrete specimens with known mix composition and Portland cement partial substitution have performed good mechanical strength results and higher permeability. The general application of fluorescent waste glass and bottom wood ash recycled aggregates and reduced cement volume could be solution for structural concrete element production in concern to reduce the amount of waste disposed and preserve natural resources, as also to reduce CO_2 into the atmosphere.

IV. ACKNOWLEDGEMENT

The financial support of the ERAF project Nr. 2010/02 86/2DP/2.1.1.1.0/10/APIA/VIAA/033 „High efficiency nano concretes" is acknowledged.

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Coal Bottom Ash as Microfiller in Conventional Concrete

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Keywords **– Coal bottom ash, Microfiller, Concrete, Compression strength.**

I. Introduction

Coal is a fossil fuel and important natural resource and combustion of coal provides high energy production. Total coal production in 2011 was 7678 Mt and lignite production was 1041 Mt. Coal provides 30.3% of total world primary energy demand and 42 % from world electricity is produced from combustion of coal. Coal production will continue to increase and in 2030ies 44 % from world's electricity will be produced from coal [1]. Coal combustion is provided in TPP. After burning coal a significant amount of coal ash are produced and utilization is an important issue in world. Coal ash utilization could improve production efficiency, reduce production costs and avoid such waste product disposal. Coal ash utilization researches are financially supported by European Union because of searches for effective ways of utilization coal ash and avoid it disposal. Some scientists have tried washed coal bottom ash as partial sand replacement [2].

In this research coal combustion product – coal bottom ash was investigated for application as micro filler in conventional concrete production. The aim of this work was to evaluate coal bottom ash integration as micro filler in conventional concrete.

II. Materials and Methods

Coal bottom ash was taken from local boiler house in Latvia and preliminary processing of coal bottom ash was done. Coal bottom ash was treated before integration in concrete by milling. Coal bottom ash was ground for 15, 30 and 45 minutes respectively. The grading analysis of obtained microfiller has been done by standard sieves and grading curves were obtained. Scanning electron micrographs were obtained and energy-dispersive X-ray spectroscopy was performed.

In the current study, conventional concrete mixture with the cement amount of 350kg/m^3 and W/C 0.61 was chosen to integrate it with coal bottom ash as microfiller. The integration ratio of microfiller was chosen 10, 20, 30 and 40% by the mass of cement for each type of prepared coal bottom ashes. Reference concrete mixture consisted of 0% coal bottom ash. The concrete workability were kept constant for all mixtures and the chosen cone slump class was S4 (160-210mm). Concrete was mixed in concrete drum mixer and cube specimens of 100x100x100mm were prepared.

Fresh and hardened concrete properties were obtained. Compressive strength was determined at the age of 7, 14 and 28 days. Water absorption and water penetration were determined for 28 days old samples.

III. Results

By increasing milling time coal bottom ash fineness increased. Particles size <0.063mm was 28.3% for ground time 15 minutes and 47.0% for 45 minutes ground time of coal bottom ash.

Fresh concrete density increased by integration of coal bottom ash up to 20% for all mixtures and further microfiller increase lead to fresh concrete density decrease. Concrete W/C ratio increased at the microfiller incorporation rate of 20% for 15 min ground ashes and at the 30% rate for 45min ground coal bottom ashes. Ashes ground during 15 min increased W/C to 0.69 at the microfiller integration level of 40%.

Reference concrete compression strength increased from 38 to 47MPa between the age of 7 and 28 days. Maximum strength gain reached mixture with 45 minutes ground ashes and 30% integration – 57MPa. Incorporation 40% of coal bottom ash microfiller lead to decrease of compressive strength for all mixtures (Fig. 1). Lowest water absorption was for concrete mixtures with 45 minutes ground coal bottom ash integration (4.6-5.0%) and lowest water penetration was for concrete with 30 minutes ground coal bottom ash integration.

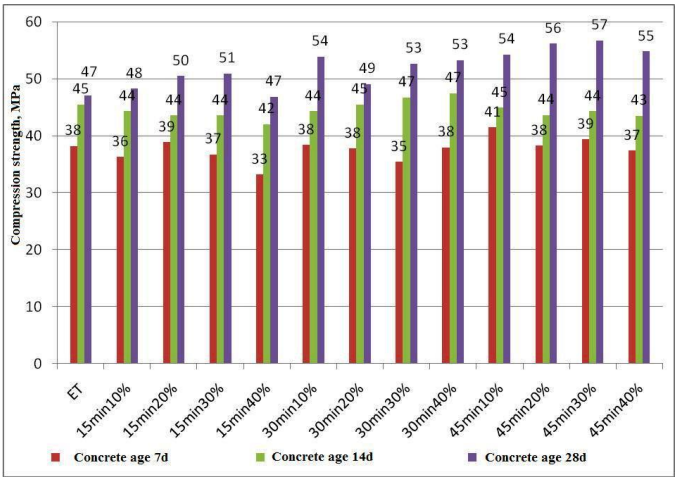

Fig. 1. Compressive strength of hardened concrete

IV. Conclusions

Processed coal bottom ash could be used as microfiller for conventional concrete production. Higher concrete strength class with the same amount of cement could bring economical benefit up to 3.6%. By increasing milling time coal bottom ash contains more fine particles and optimal milling time starts from 30 minutes. The integration level of coal bottom ash could not exceed 30% by the mass of cement. At low rates incorporation (<20%) coal bottom ash provides the same W/C for concrete and fresh concrete density increases. Significant strength gain could be achieved by using coal bottom ash as microfiller in conventional concrete. Mechanical and physical properties of concrete can be improved by choosing appropriate amount of coal bottom ash microfiller.

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Effect of Plasticizers Parameters on Refractory Castable Binder Paste Rheological and Hydration Properties

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Keywords **– plasticizer, pH, reffractory castable binder, viscosity, EXO profile**

I. Abstract

In the near future Lithuania plans to build a series of energy facilities intended for household waste and biomass combustion. This fuel is characterized by varying composition and its use damage lining and significantly reduces their lifetime and durability. For energy facilities linings expensive refractory castables are used, so their properties are relevant to development of a scientific problem. The problem is being tackled in various ways: by reducing the amount of high alumina cement, by using specially prepared expensive fillers and by using special nano- or plasticizers additives. Refractory castables also contains various ultra fine additives and in comparise with conventional concretes, a small amount of alumina cement (10-15%). High physical - mechanical properties of refractory castables are achieved by using of optimal content of plasticizers additive, wich enables to reach good rheological properties of castable, the low V/C ratio and controlled hydration process. Preliminary studies suggest that one of the more promising areas of research are composite plasticizer (plasticizer mix) application. For developing of refractory castables with a composite plasticizer additive at first must be choosed a suitable plasticizer. In our studies were examined four different plasticizers (sodium tripolyphosphate (NT), Castament FS-20, Castament FS-40, Castament FW-10). In the study were investigated the influence of plasticizer content on the refractory castable binder (high alumina cement + microsilica), viscosity, pH and electrical conductivity changes inthe binder paste. It was found that the most suitable for pastes viscosity reducing are plasticizers sodium tripolyphosphate and Castament FS-20, that why for further composite plasticizer studies were selected pointed plasticizers. It was investigated the number of composite plasticizer (with different amount of each plasticizers in composition) on the refractory castable binder viscosity and pH changes, and identified the optimal ratio of plasticizers. Upon application of EXO profile methods the study of composite plasticizer effect on the hydration of binder course were performed, and evaluated the possibilities to regulate the hydration process.

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Bending Moments in Steel Fibre Reinforced Concrete Beams Based on Waste Sand

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***Keywords* – waste sand, steel fibre, concrete beams, bending moment, load carrying capacity.**

I. Introduction

The natural environment protection requires higher and higher degree of rational exploitation of mineral raw materials (especially used for aggregate production in the building industry). A significant part of the raw material is subjected to hydraulic classification during its mining. This situation pertains different areas all over the world (e.g. north Poland) where the waste sand constitutes 75÷80 % of the hydraulic classification process residue. One of the methods used for its utilization can be its application in production of sand concrete with steel fibre reinforcement [1]

II. Calculation Methods of Beam Element Load Carrying Capacity

Several methods of calculation of the destruction moment of beam elements with bar reinforcement and steel fibres are known. The author has proposed his own method of load carrying capacity calculation based on material characteristic of the fibre reinforced fine aggregate concrete i.e. modulus of elasticity, compressive strength as well as split tensile strength. The load carrying capacity calculation pattern is shown in Fig. 1. Finally, the load carrying capacity may be determined from the following formula (3).

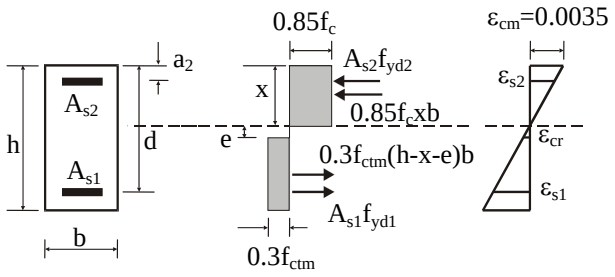

Fig. 1. Proposed distribution of stresses and strains

$$M_w = 0.3 \cdot f_{ctm} \cdot b \cdot (h - x - e) \cdot \left(h - \frac{x}{2} - \frac{h - x - e}{2} \right) + \\ + A_{s1} \cdot f_{yd1} \cdot \left(d - \frac{x}{2} \right) + A_{s2} \cdot f_{yd2} \cdot \left(\frac{x}{2} - a_2 \right) \quad . \quad (3)$$

III. Composition of Concrete Mixtures and Research Programme

The test element series consisted of 2 beams, 6 cylinders and 12 cubic specimens that were intended for the designation of strength features. The destruction moment tests were performed on 0.15 × 0.20 × 3.30 m beams. The test elements were made in 10 series that varied in the type of concrete mixture (steel fibre reinforced fine aggregate and plain concrete), steel fibres applied (50/0.8 mm and 30/0.55 mm), beam element longitudinal reinforcement ratio (0.6 %; 0.9 %; 1.3 %; 1.8 %) and application (or not) of compressed reinforcement as well as vertical stirrups.

IV. Beam Element Test Methodology

The static diagram of the tested elements was a single-span freely supported beam loaded with two concentrated forces applied at 1/3 span between the support axes (Fig. 4).

V. Test Results and Analysis

To define the theoretical destruction moments that were then compared with the maximum experimental moment values, three methods according to EC 2 [2], ACI [3] and the one proposed by the author were applied. Table V comprises the calculated and experimentally-defined destruction moments for tested beams. The author's own proposal of load carrying capacity calculation gives results that are closer (comparing to other methods) to those obtained from the tests. The mean error was 4.7 %. To verify the presented method of calculation, theoretical destruction moments for the data of other authors' tests where determined. The calculation results were then compared with the experimental results (Fig. 9).

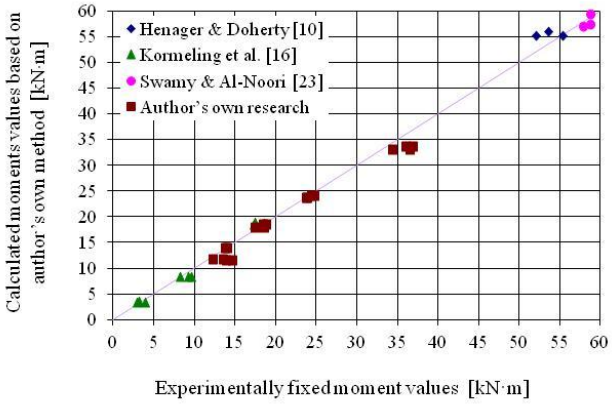

Fig. 9. Comparison of the proposed calculation method with various test results

VI. Conclusions

- The proposed calculation method of load carrying capacity of the steel fibre reinforced fine aggregate concrete beams appeared to be (after preliminary verification) a very simple method to define the destruction moment based on the primary strength features of the fibre reinforced fine aggregate concrete.
- The waste sand used in the study, being the aggregate after the process of hydroclassification, makes a perfect component for the fine aggregate concrete mixture with addition of steel fibres. Therefore, the proposed concrete mixtures (based on waste sand) can make an alternative to the plain concrete.

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Stress Distribution along the Crack in Cracked Fiberconcrete Beam Subjected to Bending

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***Keywords* – steel fiber, concrete, beam, neutral axis.**

Usually fibers are homogeneously distributed in concrete body having arbitrary spatial orientations [1, 2]. Macro crack propagation in mechanically loaded steel fiber reinforced concrete is characterized by fibers bridging the crack, providing resistance to its opening. Suppose about homogeneous distribution of spatially arbitrary oriented fibers in a volume is leading to homogeneous spatially arbitrary distributed fibers orientation on the surface of the crack. At the same time is obvious, when macro crack is cutting bended beam orthogonal crossection, fibers located close to a neutral axis are loaded very weak or not loaded at all (stretching stress is equal to zero on the neutral axis and is maximal on the outer surface of the beam). Each single fiber, depending on its location on the crack surface, crack opening, fiber orientation and its geometrical form is carrying different tensile load. Important is where is neutral axis position, in beam's crossection with macro crack, depending on crack size and opening. Because the single fiber pull-out curve is non-linear, must exists optimal fibers distribution along the crack, depending on the crack opening [3]. For this purpose an experimental program was realized. Three groups of 10x10x40 cm fiberconcrete prisms were prepared. Each prism contained the same amount of small (6mm long straight steel fibers distributed in all samples chaotically in the volume) and long (end hooked 35 mm long (Dramix)) fibers.

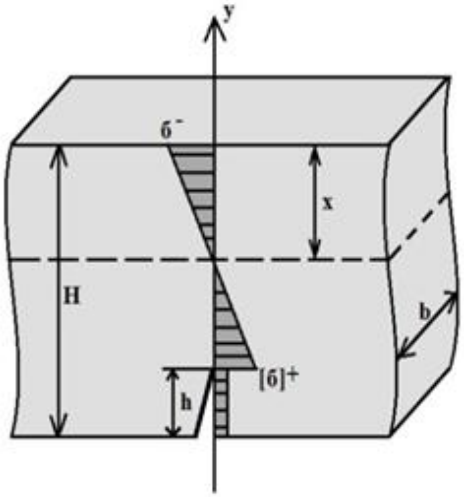

Fig.1. Tensile stress distribution in the beam with a growing crack if beam has homogeneous fibers distribution in the beam's volume.

In first group both small and long fibers were chaotically distributed. In second group chaotically distributed in the volume were only small fibers, all long fibers were concentrated in each prism bottom layer (two layers prisms). In third group long fibers were concentrated in upper and bottom layers (three layers prisms). Fibers distributions were controlled experimentally by X-ray method. Two mathematical models were used (exploiting Monte-Carlo method): a) macro crack growth model (based on loads equilibrium) and b) stable macro crack opening model.

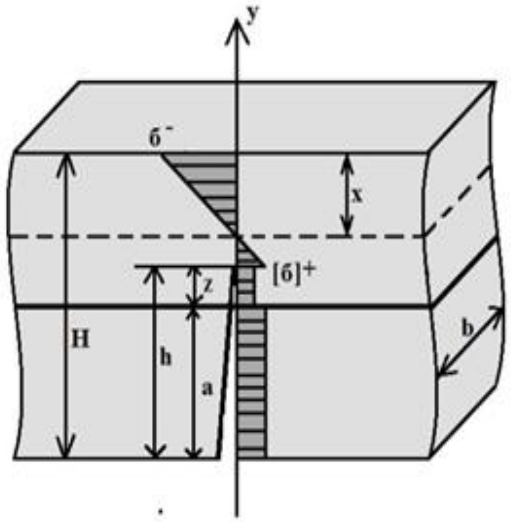

Fig.2. Tensile stress distribution in the beam with a growing crack if beam is consisting out of two layers with different fibers concentrations.

Neutral axis position in fiberconcrete beams with growing crack is shown in Fig.1 and Fig.2. Numerical simulations were recognized optimal fibers distribution in the beam volume depending on macro crack size and opening. Models predictions were validated by experiments.

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Fiberconcrete Structural Elements with Oriented Fibers Structure

Andrejs Krasnikovs (*Riga Technical University*), Videvuds Lapsa (*Riga Technical University*), Vitalijs Zaharevskis (*Riga Technical University*), Vitalijs Lusis (*Riga Technical University*), Jevgenijs Zaleskis (*Riga Technical University*)

Keywords **– steel fiber, concrete, fiber orientation, orientation function.**

During last few years steel fiber reinforced concrete has been used for tunnel linings, industrial floor slabs, piles and the field of its applications is continuously expanding. Commercially produced 0.6 to 6 cm long, with various types of geometrical and crossection's forms steel fibers are widely used nowadays as a concrete disperse reinforcement. Although there is no question about the contribution of fibers to enhance concrete post cracking tensile load bearing capacity, the question of how to reduce experimental results scatter is still very important. A number of test methods have been proposed, but all have significant problems associated with either the variability of the results and their application in structural design calculations. One possibility to solve this problem is to use fiberconcrete with internal oriented fibers structure. In this work fiberconcrete prisms with oriented (in each prism longitudinal direction) short steel fibers structure were elaborated:

a) precise amount of fibers was added to concrete, mixed and was placed into a mould;
b) two specially elaborated metallic combs (see Fig.1.) were prepared;
c) mould with fiberconcrete was placed on the shaking table and simultaneously fibers in the mould were combed. This operation was executed few times.

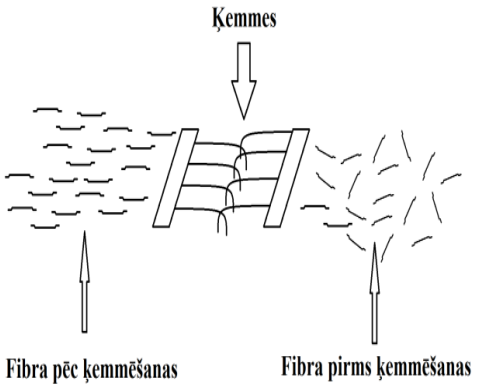

Fig.1. Method of fibers orientation.

Displacement between each comb two adjacent teeth was smaller than the length of a fiber, and was bigger than cross-section size of a bigger concrete aggregate's largest linear size. Vibration was applied during the process. Fiber orientation results were controlled by X-ray pictures analysis. Prisms with oriented and chaotically (non-oriented) distributed fibers were tested by ultrasonic device, measuring ultra-sound waves velocity dependence on fibers orientation in the samples and fibers concentration (see Fig.2). After that all prisms were loaded by 4 point bending till rupture.

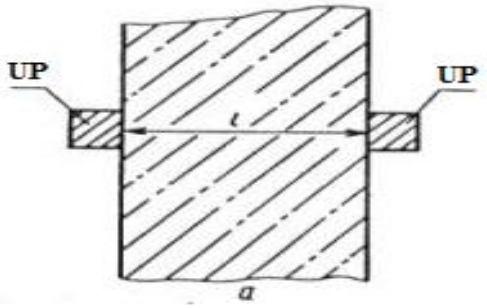

Fig.2. Samples testing by ultrasonic device, UP – ultra soud converters.

Numerical prism post-cracking behavior was modeled used previously elaborated model. Modeling results were successfully compared with experiments.

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Highway Vehicle Loads in Latvia

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***Keywords* – WIM (Weight-In-Motion), traffic load.**

I. Introduction

In the past traffic actions had an attribute of a great uncertainty due to lack of statistical data. With the introduction of Weight-In-Motion systems it is possible to collect vehicle information without interfering in the traffic. This includes data on the number of axles, wheelbase, speed and axle loads, which altogether shapes the picture of actual loading magnitude on roads and bridges.

II. Traffic Load Analysis

The traffic data directly obtained by the WIM system are mainly axle load and wheelbase. However, data used in this research contains data date, time, channel, direction, gap, vehicle speed and length.

Location for data collection was chosen at crossroads of Via-Baltica - A4 and A6. Two piezoelectric WIM sensors were placed into both traffic lanes as well as four inductive loops two in each lane.

A. Vehicle distribution according to their weight and types

The WIM system has recorded data of 1172842 vehicles on two lane two direction highways in total. 449218 of them were vehicles with gross weight less than 3,5t and 663101 vehicles with gross weight larger than 3,5t. Unreliable and false data of 60523 vehicles were filtered and removed.

The statistical result of different vehicle types indicate the critical vehicle's according to the number of axles.

The frequency of five-axle vehicle weight is shown in Fig.1, with 0,9t as the minimum, 155t as the maximum and 73t as the average, the distribution of which is also bimodal, with the two peaks in the range of 38-39t and 89-90t respectively. Similar bimodal distribution of five axle vehicles was obtained by Xin Ruan, Shanghai, China [2]. Gross weight of 95% probability is 78t.

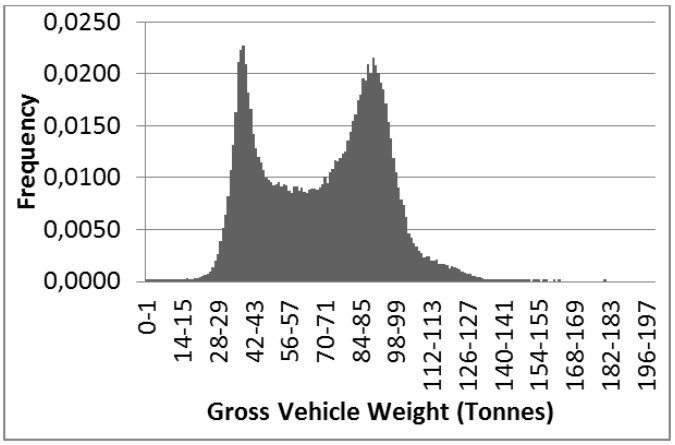

Fig. 1. Weight distribution of five-axle vehicle.

The frequency of six-axle vehicle weight is 1t as the minimum, 213t as the maximum and 75t as the average. The figure of frequency of weight clearly indicates statistical populations at least of two peaks at 51t and 96 t respectively. Gross weight of 95% probability is 138t. The weight frequency of vehicles with more than six axles is 1,2t as the minimum, 296t as the maximum and 91t as the average. Gross weight of 95% probability is 138t.

B. Vehicle distribution according to Gross and axle weight

In the 1078403 vehicle weight samples were obtained by WIM in 33 weeks, the minimum weight was 0,2t, the maximum 302t, the average 4t. Gross weight of 95% probability is 87t. The statistics indicate that the majority of vehicle weights are concentrated in the range of 3-8t, which is approximately 75.7% of the total traffic. It can be concluded from the diagram of weight variability that the distribution of vehicle weight is quite large and for more refined data analysis, it may be worth looking at different vehicle subgroups, and the data is rather discrete.

III. Traffic models

From results of traffic load analysis 25 individual load models cases were found. Determinative values of bending moment and shear force were calculated for all load cases, S-5, P-18 and P-19 were the closest three to the Euro code load case LM-1.

TABLE I

Determinative values of bending moment and shear force

Model	Span 18 m		Span 21 m	
	M [kNm]	Q [kN]	M [kNm]	Q [kN]
S-5	772,17	466,86	917,83	509,60
P-18	620,66	376,66	756,95	414,80
P-19	626,10	420,19	764,01	452,71
LM1	1047,90	604,23	1284,30	614,05

IV. Calibration of Eurocode Traffic load model 1

Bases on traffic load results in table 1, calibration factor α for Eurocode load model LM-1 are calculated in table 2.

TABLE II

calibration factor α for Eurocode load model LM-1

Model	Span 18 m		Span 21 m	
	M [kNm]	Q [kN]	M [kNm]	Q [kN]
S-5	0,74	0,77	0,71	0,83
P-18	0,59	0,62	0,59	0,68
P-19	0,60	0,70	0,59	0,74
LM1	1	1	1	1

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Load Testing Result Analysis of the Latvian Bridges

Ilze Paeglite (*Riga Technical University*)

***Keywords* – bridge, dynamic loading, load testing**

I. Introduction

Static and dynamic load tests on bridges have frequently been used to verify the actual structural behaviour of the bridge compared to the analytical analysis. In Latvia dynamic tests under special vehicle load are standard proof -load test before opening the bridge for use, heavy trucks with controlled parameters are usually used as dynamic loads. Dynamic test results obtained during more than 50 years period was analysed and the main characteristics obtained. The main values obtained from the load testing are - the vertical displacement of the deck including dynamic load factor, the natural frequency of the bridge, the dynamic amplification factor and the logarithmic decrement.

II. Method

Dynamic load testing is being done by performing excitation on the bridge structure and measuring its properties after excitation has disappeared. Different methods for excitation of the bridge are available, but the most often used in Latvia are the impact of heavy weight and the passage of the loaded trucks. The passage of the loaded truck makes the most real effect from traffic on the structure; hence it gives the reasonably accurate dynamic results.

Passage of the loaded truck is done at different speed of the truck, but before running the test, trucks are measured and weighted. The trucks used for the dynamic tests are usually with 3 or 4 axles and weight about 250kN (25tons). Until year 1995 for load testing were used 2 axle trucks with weight 160kN (16tons).

Dynamic test is being done by vehicles passing the bridge with speed 20 km/h, 40km/h and 60 km/h. To model holes or bumps on the pavement surface, in the middle of the bridge, planks with height approximately 5 cm are being put on the path of the truck. Distance of the planked surface is usually about 30 m or all spans for the smaller bridges. Distance between the planks is approximately 3 to 3.5 m (it corresponds to the distance between truck axles).

To record dynamic parameters special devices like: mechanical and electronic vibrograph, deflection measurers with video camera that can fix up to 24 sequence in a second or laser generator and receiver equipment, are being used.

III. Results

Analysis was done for 51 bridge dynamic report. Not all necessary information was available in the reports, but the main characteristic values were found and compared. There were 8 reinforced concrete pre-cast beam bridges, 5 pre-stressed precast beam bridges, 4 pre-stressed bridges, 9 reinforces concrete frame bridge, 8 composite beam bridges, 3 reinforced concrete arch bridges and 30 other type bridges.

Obtained results from reports show that the values of the natural frequency of the bridge structure are between 2 and 4 Hz.

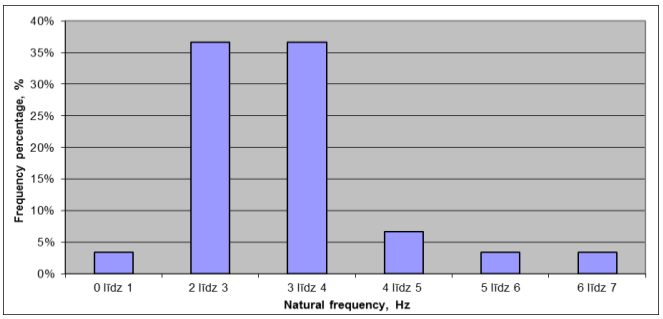

Figure 4.1. Bridge natural frequency percentage distribution.

Large amount of measurements allow assessing natural frequency dependence on the bridge length. For bridges with reinforced concrete, pre-stressed concrete and composite superstructure natural frequency depending on bridge length is given in Figure 4.5.

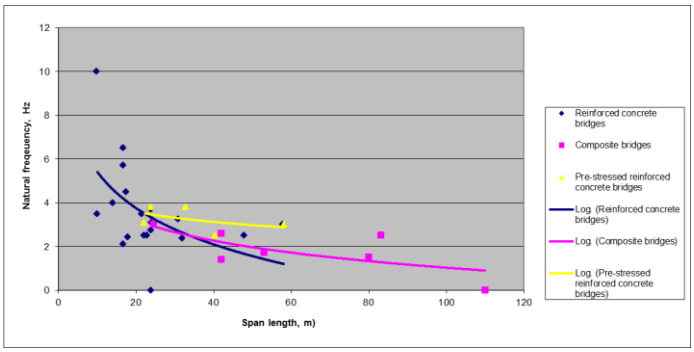

Figure 4.5. Natural frequency dependency on bridge span length and structure material.

IV. Conclusions

The paper presents results obtained from dynamic load tests on bridges in Latvia. The mains results are natural frequency of the bridge, the dynamic amplification factor and the logarithmic decrement.

The obtained results show that the natural frequency highly depend on the length of the span, static scheme of the bridge, type of the span cross-section, structural materials, construction methods, bearing type, etc. It was found that the dynamic amplification factor didn't depend on the natural frequency, but was dependent on the logarithmic decrement. The logarithmic decrement showed dependency on the length and the types of the span structures.

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Behavior of Prestressed Suspension Bridge

Vadims Goremikins (*RTU*), Karlis Rocens (*RTU*), Dmitrijs Serdjuks (*RTU*)

Keywords **– Cable Truss, Kinematic Displacements, Prestression Loss, Pylon Displacements.**

I. Introduction

A suspension bridge is the most suitable type for a long-span bridge due to rational use of structural materials. Increased deformability, which is conditioned by the appearance of the kinematic displacements, is the major disadvantage of suspension bridges. This problem can be solved by application of prestressed cable truss with two concave chords and cross web. Pylon displacements can cause significant increase of structure total displacements in main span. Prestressing losing in time decrease prestressed suspension bridge total stiffness.

II. Description of Investigation Object

Three span prestressed suspension bridge was assumed as an object of investigation (Fig. 1). The main span of the bridge is equal to 200 m and side spans are equal to 100 m.

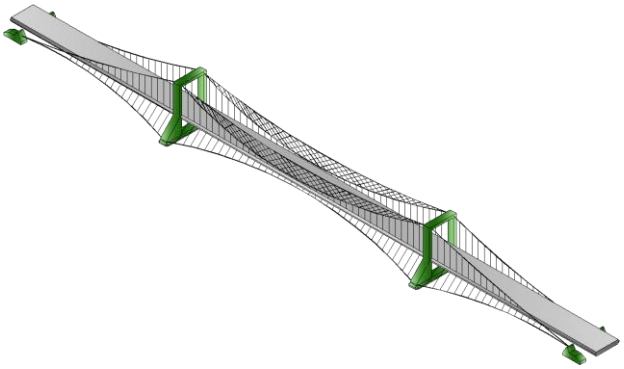

Fig. 1. Prestressed suspension bridge with cable truss

Two types of main load caring structure are analyzed – single cable and cable truss. Cable elements were made from steel ropes. Deck structure is made from light composite pultrusion profiles.

III. Influence of Pylon Displacements on Suspension Bridge Behavior

Structure of three span prestressed suspension bridge was modeled in FEM program ANSYS. Two types of structures were analyzed: structure with single cable and with cable truss. Maximum axial loads in pylons appeared in full three span loading case, but maximum moments appear in bridge central span loading case. Pylon horizontal displacements most influence on bridge total vertical displacements in the case of not enough pylon stiffness. Two types of pylon displacement decreasing can be used – pylon stiffness increasing or active tendons usage, which can automatically increase the level of side spans prestressing. Dependence of pylon stiffness and vertical displacements of suspension bridge is shown on Fig.2. In the case of small pylon stiffness (300 GN·m^2) cable truss is by 10 % advantageous to single cable form the point of view of displacements. But total vertical displacements are not in the acceptable limit in this case. To ensure serviceability limit state stiffer pylons should be used. Cable truss is by 35% advantageous to single cable in this case.

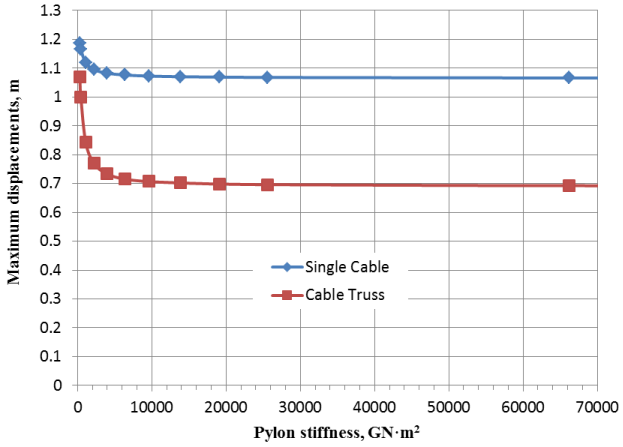

Fig. 2. Influence of pylon stiffness on displacements of prestressed suspension bridge

IV. Prestressing Loss in Time

To analyze prestressing loss in time physical experiment was performed. Small scale model was initially prestressed by the level of prestressing which exceed design level by 20%. After one day level of prestressing was lowered to design level and structure was tested 88 day long (Fig. 3). The level of prestressing changed only by 0.5 %.

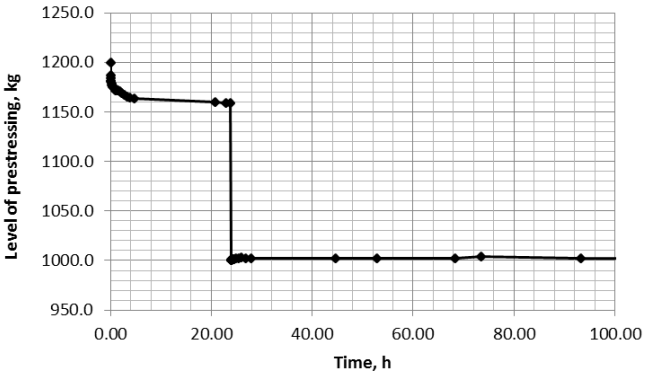

Fig. 3. Prestressing level loss in time

V. Conclusions

Only pylons with stiffness more than 10000 GN·m2 allow to ensure serviceability limit state. Cable truss is by 35% advantageous to single cable in this case.

Initial prestression by 20% and one day sustain of prestressed suspended structure decrease prestression loss in time to 0.5%.

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Evaluation of Functional Properties of Road Salt

Boriss Jelisejevs (*Riga Technical University*), Juris Naudzuns (*Riga Technical University*), Gita Laugale (*JSC LAU*)

Road maintenance, salt, melting capacity.

I. Introduction

Salt (sodium chloride, NaCL) is only a chemical deicer for needs of road transport in Latvia, which is technologically used in solid, liquid and pre-wetted forms, as well as a mixture with abrasives. Up to now, road salt is evaluated by common parameters of chemical materials and no any functional requirement for such specific kind of use raised there. In 2011 an extensive study was conducted with aim to analyze road salt quality from different producers and to set a methodology for its functional evaluation.

II. Declared Properties of Road Salt

Five different specimens from four producers were received for testing and experimental program (Fig.3). A set of tests (sieving, bulk density and chemical composition, content of moisture and mineral impurities) and visual evaluation was performed.

Fig. 3. Extracted salt specimens (Nr.1…5 from left to right).

In some cases incompliance with product's specifications was observed, e.g. specimens Nr.1.,2. and 5. contained too much small (less than 0,8mm.) fraction (Fig.4). Also, there appeared some formal problems, because required and declared properties are not covered with unified standardization approach.

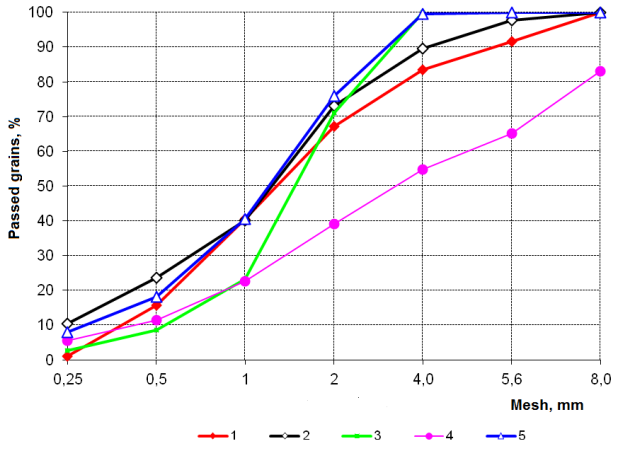

Fig. 4. Results of sieving test in accordance with LVS EN 933-1:1997.

III. Results of Experimental Program

Some other activities also were carried out to get a proper knowledge for experimental part of the project: survey of road maintenance staff and product suppliers; study on principal deicing mechanism of salt and alternative materials (Fig.2); identification of the major practical problems in road salt use etc.

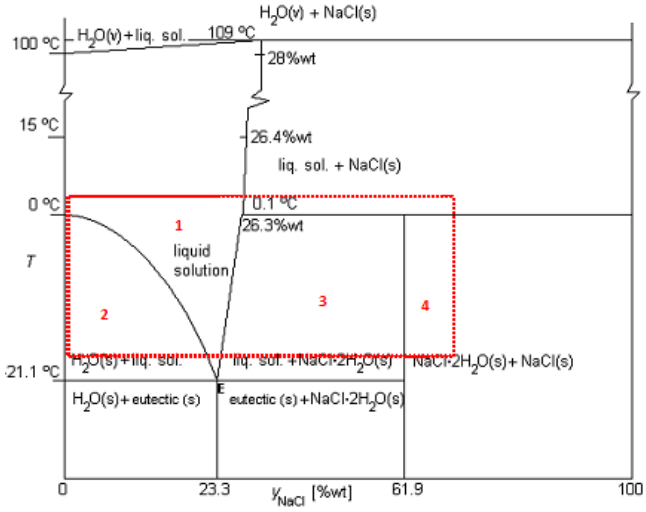

Fig. 2. Phase diagram of NaCl solution ("working" zones are marked)

Based on that, research team assumed the following hypothesis: granulometry of salt is a primary factor, practically effected results and technological approach in road deicing. Looking for the most appropriate methodology to check that, prototypes of SHRP experimental procedures were created to evaluate: ice melting capacity of salt (H-205.1) and penetration depth of salt particles into ice layer (H-205.3) [1].

Table 2

Results of ice melting capacity experiment for specimen Nr.4

Time, min.	Extrac. liquid, ml.	Av. liquid layer's depth, mm.	Liquid vol. per salt, ml./gr.	Melted ice per salt, gr./gr.	Stand. deviat., %
T= -5⁰C					
10	8,7	0,23	2,09	2,03	5,2
20	15,3	0,37	3,67	3,56	5,4
30	21,3	0,52	5,11	4,96	4,7
45	26,2	0,64	6,28	6,09	3,3
60	29,6	0,72	7,12	6,91	3,8
T= -10⁰C					
10	3,1	0,08	0,74	0,70	4,0
20	6,0	0,15	1,44	1,37	2,8
30	9,3	0,23	2,23	2,12	0,4
45	12,7	0,31	3,04	2,89	0,5
60	15,7	0,38	3,76	3,57	2,1
T= -15⁰C					
10	1,0	0,02	0,24	0,22	11,0
20	1,5	0,04	0,36	0,33	5,8
30	2,6	0,06	0,62	0,58	6,2
45	3,8	0,09	0,91	0,85	5,3
60	5,2	0,13	1,25	1,16	5,0

Experimental results correlate with preliminary assumptions (Table 2). The main conclusion was:"working potential" of road salt mainly depends on its initial amount, but its practical realization (time period and direction of melting) is strongly depending on salt granulometry. A variety of corresponding recommendations was delivered to the project's consumer.

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Concrete Bridge Deterioration Caused by De-icing Salts in High Traffic Intensity Road Environment in Latvia

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Keywords **– concrete, bridge, service life, durability, de-icing salt.**

I. Introduction

When spread on the road de-icing salt or salt solution mixes with water and is splashed and sprayed by traffic onto concrete bridge structure surfaces. De-icing salts, which contain chlorides, initiate and accelerate the corrosion process of reinforcement within the concrete structure. The reinforcement corrosion is the most common cause of reinforced concrete bridge deterioration in Latvia. Roads with high traffic intensity require a special care to maintain safe driving conditions during all kinds of weather. During winter season to prevent slippery driving conditions the use of de-icing salts is enormous. It means that bridge structures that are situated near high-traffic intensity roads are exposed to severe chloride conditions. Since the bridges are one of the largest community investments and because of ever increasing maintenance and repair costs, it is important to improve durability of these structures, which could be achieved by better understanding of the processes and environment of chloride induced deteriorations.

II. Background

The service-life of concrete structure depends on its interaction with surrounding environment. The chlorides penetrate the concrete cover, mostly by diffusion, which can be modeled by the second Fick's law of diffusion. For residual service life, in calculations one can use an empirical model (developed by DuraCrete project [1]) which corresponds to Fick's law of diffusion and is easy to use for calculations.

III. Investigation of Bridge Structures for Chloride Content

Several bridge structures near and in the municipally of Riga in high traffic environment have been investigated in this study. The structures have been built in precast concrete in time span between 1963 and 1976. The core drilling was performed, and core samples were obtained from different surfaces and positions of the structures. The samples were cut at 10-15 mm intervals. Then the pieces were examined for chloride content and chloride profiles were obtained.

IV. Remaining Service Life Calculations

The chloride profiles were analyzed for determining service life. To perform service life calculation the theoretical chloride profile line was fitted into the obtained chloride profile from the samples, and then diffusion parameters were calculated. Then the possible future profile was calculated for the target service life of 100 years. For calculation of chloride ingress parameters and the remaining service life it has been used the methodology from „Model Code for Service Life Design" [2,3]. The calculations are performed at semi-probabilistic level with reliability index β value of 1.8. In addition, the service life calculations for a case of damaged and leaking isolation or expansion joints where high concentration of chlorides reach superstructure surfaces are performed (fig.1). The remaining service life was calculated using this equation:

$$\frac{\mu_{Cover} - \left[2\sqrt{t \cdot D_{app} \cdot erf\left(1 - \sqrt{\frac{C_{crit} - C_i}{C_S - C_i}}\right)}\right]}{\sqrt{\sigma_{Cover}^{\ 2} + \left(0.5\left[2\sqrt{t \cdot D_{app} \cdot erf\left(1 - \sqrt{\frac{C_{crit} - C_i}{C_S - C_i}}\right)}\right]\right)}} = \beta.$$

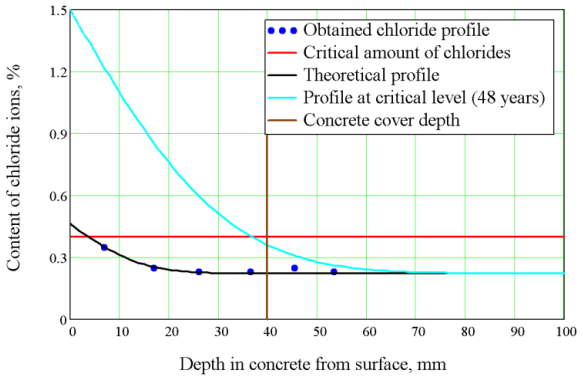

Fig. 1. The calculated chloride profile for 40 mm concrete cover in a case of a higher chloride exposure.

V. Conclusions

Chlorides from the de-icing salts spread on the roads are very unevenly distributed not only between different surfaces but also within one surface. The chloride profile shapes differentiate from the theoretical profile due to complex exposure conditions which feature constantly changing surface chloride concentration and moisture level. The chloride distribution depends on the form of the piers, position, distance from the street and the direction of traffic flow. The results show that the exposure to chlorides is generally highest for surfaces facing towards the traffic. It has been noted that the position and shape of the bridge piers are important. Severe chloride exposure that can occur on high intensity roads for bridges with leaking expansion joints and isolation can significantly reduce service life of bridge structures that are built of good quality concrete and even have a concrete cover of 40 mm.

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Creep Behaviour of Cement-based Composites

Andina Sprince[1], Leonids Pakrastinsh[2], Aleksandrs Korjakins[3] [1-3](*Riga Technical University*)

***Keywords* – FRCC, PVA fibers, creep, compression strength, modulus of elasticity.**

I. Introduction

Scientists and concrete technologists have been working on the development of new types of concrete. Newly elaborated material provides improved mechanical and physical properties. The deformation characteristics of concrete are important in the design of sustainable structures [1]. This paper introduces the recent state of research on elastic and time-dependent deformations of new high performance cement composite materials (FRCC) that are reinforced with polyvinyl alcohol (PVA) fibres and subjected to long-term, uniform, constant compressive load. In these composites, part of the cement has been replaced with micro- and nano-fillers. The experimental studies of creep in compression were performed. The concrete specimens were tested in a controlled constant temperature and with a constant level of moisture. This study was carried out on two different extreme cases of environment: the case with 100% moisture of specimens obtained by protecting to desiccation of this one and the case of air-dried specimens. Specimens were tested at age of 28 days. The compression strength and modulus of elasticity of HPFRC concrete specimens were determined. The results of the experiments permit the prediction of long-term deformations of the concrete.

II. Materials and Methods

The experimental work included the preparation of two fiber-reinforced high performance concrete (FRHPC) compositions with polyvinyl alcohol (PVA) fibers with and without nano silica. The mix compositions are given in Table 1. PVA fiber properties are listed in Table 2.

TABLE I
Concrete Mix Composition

Component [kg/m³]	**SF**	**NN**
Cement *Aalborg white* CEM I 52,5 N	1000	1000
Quartz sand 0-1mm	260	260
Quartz sand 0.3-0.8mm	400	400
Quartz sand 0-0.3mm	300	300
Silica fume Elkem 971 U	150	150
Plasticizer Sikament 56	30	30
Nano silica	0	20
Water	195	195
PVA fibers MC 40/8	10	10
PVA fibers MC 200/12	10	10
W/C	0.19	0.19

TABLE II
Properties of PVA Fibres

Fiber type	**Ø [µm]**	**L [mm]**	**f_t [GPa]**	**E [GPa]**
MC 40/8	40	8	1.6	42
MC 200/12	200	12	1.0	30

Standard sample cubes 100x100x100 mm and cylinders 47x190 mm were produced in order to investigate the mechanical characteristics of the material. The tests were performed after 28 days of concrete hardening in standard conditions (temperature 20±2ºC, RH > 95±5%). The creep was measured for hardened concrete specimens subjected to a uniform compressive load which equal to 25% of the characteristic compressive strength of concrete and which was kept constant over a long period of time [2, 3]. The tests were conducted in two extreme conditions – moist and drying. Specimens were kept under a constant load for 90 days, and for recoverable creep they were kept without load for 30 days. All specimens were kept in a dry atmosphere of controlled relative humidity in standard conditions: temperature 20±2ºC and relative humidity 40±2%.

III. Results

The highest deformation response was exhibited by the compositions without nano silica. At moist conditions this difference is 20%, while for specimens which were tested in dry conditions it is 7.7%.

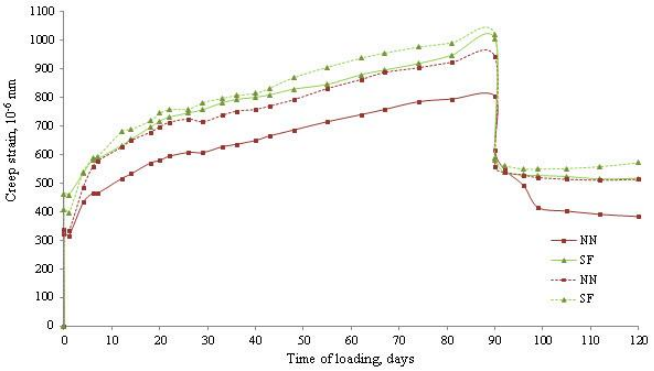

Fig.1. Creep Strain of FRHPC Compositions.

IV. Conclusion

The experimental study indicates that in the polyvinyl alcohol fibers (PVA) don't have significant influence on the high performance concrete creep in the compression properties.

V. Acknowledgement

This work has been supported by the European Social Fund within the scope of the project "Support for the Implementation of Doctoral Studies at Riga Technical University".

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Ribbed Plate Structure with Increased Specific Strength and Variable Stiffness

Janis Sliseris (*RTU*), Karlis Rocens (*RTU*)

Keywords **– plywood composite, stiffness optimization, Genetic Algorithm.**

II. Introduction

Plates with variable stiffness have been investigated in last two decades [1, 3] due to its increases specific strength and stiffness.

Variable stiffness is usually obtained by varying thickness of plate or varying ply stacking sequence [2, 3]. Ribbed plates or sandwich plates with continuous varying or discrete varying stiffness are not investigated enough and there is nonexistent stiffness optimization technique.

II.Optimization method

Optimal stiffness of orthotropic plate is defined by five independent functions $x=(x_1, x_2, x_3, x_4, x_5)$. They are used to modify the coupled bending and shear stiffness matrix D. The objective function $C(x)$ consists of two parts. The first part is used to minimize the structural compliance function and second part to minimize stress gradient

$$\min_x : C(x) = c(x) + \sigma(x) = h_1 U(x)^T \cdot K(x) \cdot U(x) + ... + h_2 \sum_i \left(\int_{S^i} \| \sigma_{kl}^i(x) | - | \sigma_{kl}^{av}(x) \| dS^i \right) \quad (1)$$

where U(x)- displacement vector K(x)- stiffness matrix, $\sigma_{kl}^i(x)$ - *kl*-th stress component in *i*-th finite element, $\sigma_{kl}^{av}(x)$ - average value of *kl*-th stress component, dS^i -elementary area in *i*-th finite element, h_1, h_2- normalized weight coefficients.

The production of constant thickness ribbed plates with variable stiffness is complicated therefore provided a method for optimal discrete varying stiffness calculation which minimize difference between continuously varying stiffness $X^j(y_1, y_2)$ and discrete varying stiffness $\bar{X}_i^j(\Omega_i)$:

$$minF(\Omega_i) = \sum_{j=1}^{n} \sum_{i=1}^{m} w_j \left| X^j(y_1, y_2) - \bar{X}_i(\Omega_i) \right|^2$$

where w_i- weight coefficient of i-th stiffness function.

The necessary internal structure of ribbed plate is obtained by minimizing the difference between actual load bearing capacity of structure $MQ^{max}(p)_i$ and necessary in each discrete domain $MQ(p)_i$:

$$minP(p) = k_i \, | MQ^{max}(p)_i - MQ(p)_i \, | , i = 1..5$$

where k_i- normalized weight coefficients.

The actual load bering capacity is calculated by using previously trained Artificial Nerual Network, but minimization problem solved by Genetic Algorithm.

I. Results

Optimal structure of simply supported plate with uniformly distributed load was obtained first.

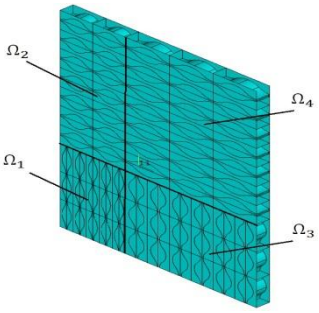

Fig. 1. Optimal structure of simply supported ribbed plywood plate.

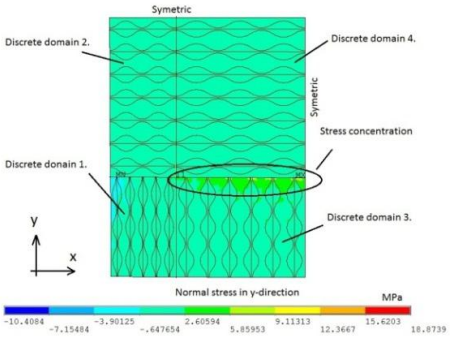

Fig. 2. Stress concentration in ribbed plate.

A stress concentration problem (see fig.2) was solved by using constant thickness skins in all discrete domains.

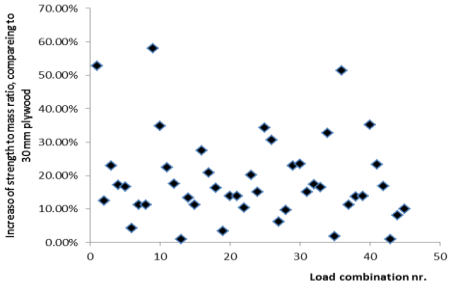

Fig. 3. Increase of specific strength for trailer floor plate

The possibility to use ribbed plate in trailer floor structure with two moving loads was analyzed. The specific strength could be increased up to 20 % comparing to typically used 30 mm plywood sheet. The possibility to replace classical plywood sheet with specific discrete variable stiffness plywood sheet that is obtained by variable veneer orientation in each layer was also analyzed.

III.Conclusions

A new optimization technique of ribbed plate with variable stiffness is proposed. The plate with optimal variable stiffness cold be up to 50 % stiffer comparing to non-optimized plate. The increase of specific strength of multispan plate with moving loads could be more than 20 %.

IV.Acknowledgement

This work has been supported by the European Social Fund within the project «Support for the implementation of doctoral studies at Riga Technical University».

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FEM Strategies for Numerical Modeling of DendroLight Cellular Wood Material Core

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Kaspars Kalnins (*Riga Technical University, Institute of Materials and Structures*)

Keywords **– DendroLight, numerical modeling, experimental validation.**

I. Introduction

DendroLight is a novel wood material primarily used as core material for furniture industry. The manufacturing of this material was started at the year 2010 in Ventspils. It is made from profiled/perforate wood boards stacked in perpendicular layers and then sliced once more in plates perpendicularly to the board's layers. The main advantage of such a solution is significant reduction of structural weight (up to 40 %) comparing to conventional timber. Material properties are not fully assessed jet, however first experimental test runs demonstrate that it has sufficient stiffness for the use as core material in wood sandwich panels in load bearing structures like walls and floors[1]. For further development of load bearing structures with DendroLight core, reliable design methodology is needed, able to assess detailed geometry component (like profiled board web thickness) influence over the stiffness for large scale structure.

In current research several numerical modeling techniques have been compared including numerical models from shell and solid elements in ANSYS and ABAQUS software. The aim is to elaborate an accurate numerical model for prediction of DendroLight structure mechanical behavior. Precision of numerical model is estimated comparing displacements of experimentally tested small scale specimens in compression and bending with mechanical responses of numerical model.

II. Numerical Modeling

In general, cellular wood structure created in sequence of real production process, starting with profiled board modelling, forming layers and cutting blocks into DendroLight® layers (Figure 1). Boundary and loading conditions have been set according to experimental test set up. Wood mechanical properties are taken according Wood Handbook for pine and spruce species. Corresponding isotropic mechanical properties have been assigned also to High Density Fiberboard (HDF) skins for bending specimens. Structural loads were assigned to sets of nodes with jointed deflections along vertical direction. Only linear analysis has been conducted to reduce calculation effort.

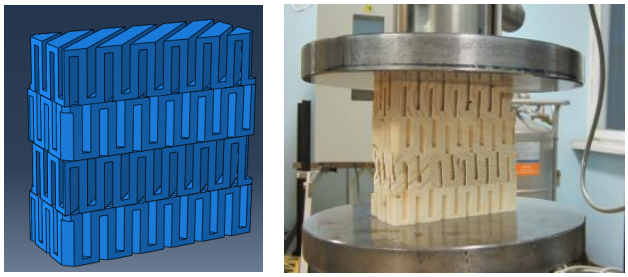

Fig. 1. Numerical model of compression specimen and equivalent experimental test (on the right)

III. Experimental Investigation

Specimens have been tested in compression and bending on ZWICK Z100 testing equipment (Figure 2). All specimens for bending set-up have 4 mm thick HDF skins. Mechanical properties of DendroLight® largely depend on wood cell direction; therefore specimens with different orientations have been evaluated. Compression specimens have dimensions of 100x100x40 mm and bending specimens 300x50 mm with 30 and 60 mm thickness.

IV. Results and Discussion

Load displacement curves from experimental tests and numerically acquired displacements are plotted in Figure 2 for compression specimen with transverse DendroLight orientation.

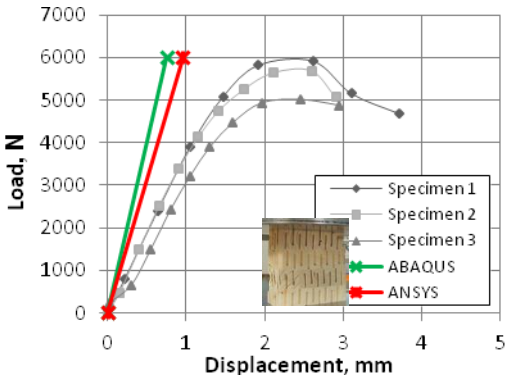

Fig. 2. Experimentally obtained displacement values compared with numerical results for compression specimens

Experimental results have clear elastic mechanical behaviour region until 80 % of critical load. In this range numerical models showed sufficient accuracy predicting mechanical behaviour of structure under loading conditions. Usually scatter between experimental and numerical results are in 20 % bounds. Largest scatter may occur for specimens with transversial DendroLight orientation (Fig.2) – up to 40 %. It might be caused by weaker wood mechanical properties in radial direction or inappropriate bounding in numerical model. Overall stiffness of numerical models is higher than experimental. Model made from shell elements in ANSYS has shorter calculation times than model from solid elements in ABAQUS.

Further investigation is required to improve numerical model's accuracy.

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Granulated Ecological Thermal Insulation Material Based on Peat Binder

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Keywords **– peat granules, ecological thermal insulation, peat binder.**

I. Introduction

Energy efficiency securing has become one of the biggest problems nowadays. Increasing energy efficiency of buildings allows not only saving energy resource, but also affects the indoor climate. According to huge amount of energy non-effective buildings and principles of ecological building, which require using of local effective materials and raw materials, we used peat and woodworking by-products to produce effective ecological thermal insulating material. Latvian thermal insulation materials market is represented with by the foreign materials, where as a binder are used different non-ecological materials. Peat is one form the widespreaded ecological products. Thermo-mechanical activation of peat allows getting ecological binder for local insulating materials.

II. Methods

Raw peat was activated in RETSCH PM 400 planetary ball mill. The initial moisture content of the raw material was 270%, but due to practical reasons, it was increased up to 380–400% in order to enable easy removal of the peat from containers.

As filler for peat binder granulated material wood fibers and fine peat particles were used. Air-dried peat particles with size under 2 mm have been obtained as by-product of peat processing industry.

Mixing of peat binder and fine fiber filler in fixed proportions allows affecting on size of granules in the mix. Three mixes with different binder/filler ratio were prepared for the tests.

Comparing plate-type insulation on peat binder base of existing producers, elaborated technology allows reducing the time of thermal drying of to 12 hours at 75°C and less, depends of granules moisture, size and thickness of the granules layer.

Shape of granulated material and skeleton which consist of binder and fine fibers of different size allows achieving adequate strength of product.

Coefficient of thermal conductivity was tasted on LaserComp FOX 600.

III. Results

Different mixes of granules were produced, including: A – binder/filler ratio 2.4:1, B – binder/filler ratio 2.1:1 and C – binder/filler ratio 2:1, the resulting granules size distribution is shown in fig. 1.

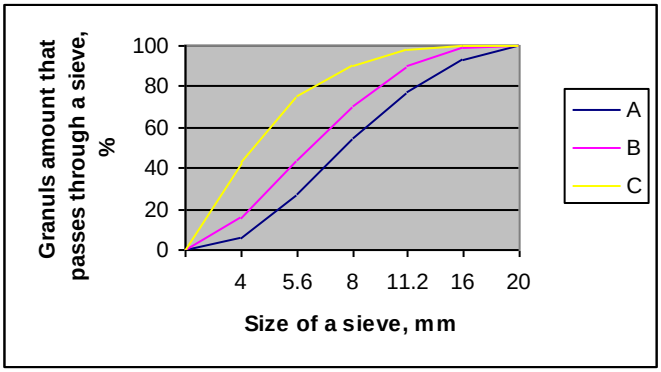

Fig. 1. Granules size distribution according to binder/filler ratio

By changing binder/filler ratio we affect not only the size of granules, but also mechanical properties of material and it's coefficient of thermal conductivity. For mix A it is 0.0773 W(mK), B (fig. 2.) – 0.0772 W(mK), and C – 0.0750 W(mK).

Fig. 2. Granulated peat insulation, B mix.

IV. Discussions

The results accomplished in the research provides an insight in the high technological use opportunities of the Latvia's peat deposit, including producing and use of peat binder, and producing of totally recyclable ecological peat binder based thermal insulation material.

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Collection of Spilled Oil Products by Means of Ferromagnetic Powder Materials

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***Keywords* – ferromagnetic powder, oil spills, collection.**

I. Introduction

Current research covers an evaluation of ferromagnetic powder materials for use as a collector of spilled oil products [1]. Extensive testing of different powders has been carried out. Current work continues a previous research on use of ferromagnetic powder materials as a collection agent for spilled oil products [2,3].

II. Theoretical Background

The ability of metal powder to collect spilled oil is associated with the surface structure of powder particles (Fig. 1) [4]. Sorption and adhesive properties of iron powders allow collecting of spilled oil products, followed by removal of a mixture of powder and oil by means of permanent or electromagnets.

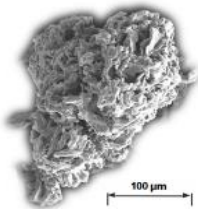

Figure 1. Particle of Hoganas iron powder M20/80-19.

III. Experimental Part

Waste motor oil was used for experiments. In the Fig. 2 below one of testing samples is shown. Spilled oil layer has the following dimensions: diameter 95 mm, thickness 4 mm, the amount of spilled oil 28 ml

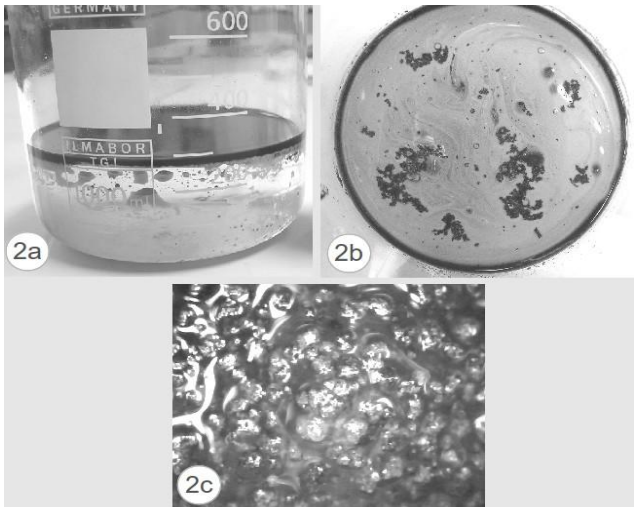

Figure 2. Experiments on collection of spilled oil products. 2a) layer of spilled oil floating above a sweet water, 2b) Most of spilled oil is captured by iron powder, 2c) Mixture of spilled oil and iron powder in form of sludge.

Experimental studies have shown that without additional processing [5] of iron powder it is possible to capture up to 0.90-1.25 g of spilled oil per 1 g of iron powder.

IV. Conclusions

Previous and ongoing research has shown an ability of iron powders in capturing and retention of spilled oil products. Due to extended surface of iron powder particles and adhesion to oil substances such materials can be considered as spilled oil collection agents for certain emergency cases.

V. Further Work

A local raw material – iron dross (produced by Liepajas Metalurgs metallurgical plant) will be tested as an alternative to more expensive commercial iron powders cheap spilled oil collection agent. An affordable method of "iron powder-oil product" sludge processing should be investigated.

VI. Acknowledgements

This work has been supported by the European Social Fund within the project "Support for the implementation of doctoral studies at Riga Technical University" and «Support for the implementation of doctoral studies at Rezeknes Augstkola».

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Cellular Structures Made of Perforated Metal Bands

Mihails Lisicins, Viktors Mironovs (*Riga Technical University, Laboratory of Powder Materials*).

***Keywords* – perforated steel band, cellular structure, through channels, deformation.**

I. Introduction

Metallic cellular materials are effectively used in production of the cellular building construction, in aircraft building, in catalyser and filter production etc. Metallic bands are already used in production of different cellular constructions. Perforated metal materials such as steel bands are of the interest for cellular materials manufacturing. Application of perforated metal materials opens up new possibilities in the production of innovative materials and cellular structures.

II. Methods of Manufacturing

There are different methods that exist for manufacturing of cellular structures from sheet material:

- Stretching method: sheets are based layer-by-layer and then joined in the lines, for example, by gluing, then received package are stretched (f.v. Fig. 1).
- The method of corrugation: during forge-rolling the sheets are obtained in defined form. After layer-by-layer placing and fastening the cellular construction is generated (f.v. Fig. 2).
- The method of plate shearing: a multilayer package is formed and fastened on one side across the width by means of mechanical clamp (f.v. Fig. 3a). Package twist around cylindrical mandrel, then punching holes with an oblique cut at an angle α is performed.
- Cutting and stretching method: on the tape on longitudinal direction the slots are done (f.v. Fig. 4a). Then the tape is stretched in crosswise direction (f.v. Fig. 4b). The form and dimensions of cells as well as parameters of tape can be easily changed by variation of length and width of slots and degree of stretching of the tape.
- Method of interlacement of the perforated tape: previously perforated tapes are interlaced for rigid construction creation. Simple but low-output method (f.v. Fig. 5).
- Method of twisting of the perforated tape: relatively simple method for obtaining single-layer, multi-layer cylindrical or conical type cellular structures (f.v. Fig. 6).

III. Materials and Experimental

As a raw material a perforated metal band made of high-quality carbon steel was used. Band specifications, such as type of perforations, location of holes, specific area of perforations, thickness and width are of great importance.

Basically, for the manufacture of cellular material a perforated tape with round and oval holes should be used, especially in those cases where final products require a certain fixed location of perforated band. Diameter of circular holes is usually in range of 1 to 10 mm. A distance between holes is in range of 0.6 - 4.0 mm what allows flexibility in combinations of different bands.

Properties data are shown in Table 1.

The main difficulty in modeling cellular structure of the perforated tape is to determine the geometrical characteristics of cross-section, as well as parameters of channels formed.

We investigated the method of layer-stacking and subsequent shear bands. This method allows obtaining a cellular structure with adjustable through-channels (f.v.Fig. 9).

TABLE I

Mechanical characteristics of perforated steel band produced by punching

Designation	LPM - 1	LPM - 2	LPM - 3
Mark of steel	St08	St50	St08
Standard	GOST 503-81	GOST 2284-79	GOST 503-81
Permeable area, %	66,97	70,50	69,97
Thickness, mm	1,50	1,20	1,80
Tensile strength, N/mm²	320,66	937,80	427,06

When a displacement of perforated elements at a step size (t) occurs, the length of through channel in the package is changed (Fig. 10).

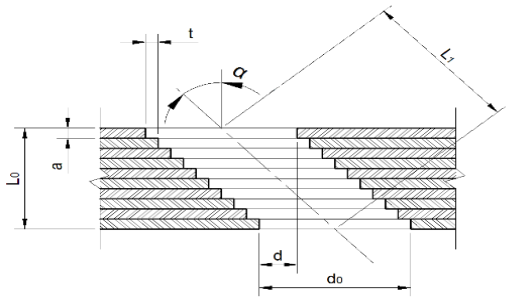

Fig. 10.The scheme for calculating the length of the through channel

Channel parameters can be determined using the following formula:

$$\alpha = ctg\,\frac{t}{a} \qquad (1)$$

$$L_0 = a \cdot n \qquad (2)$$

$$L_1 = \frac{a \cdot n}{\cos\alpha}. \qquad (3)$$

Opening ratio, depending on the angle of inclination of permeable channels (Fig. 11):

$$k = d/d_0 \qquad (4)$$

Evaluation of mechanical properties was carried out on samples (f.v. Fig. 12) of the structure shown above (f.v. Fig. 7a).

The strength of compression elements ranged from 2644 N to 2815 N. The maximum deformation of the y-axis was 1.0 - 1.4 mm.

Modeling the experimentally obtained load in the environment COSMOSWorks (linear analysis under static loading), the maximum deformation was - 1.15 mm, which is on a 1.17% lower than experimental results.

Silicon Carbide Ceramics Uses in Civil Engineering

Elina Indriksone, Viktors Mironovs *(Riga Technical University, Laboratory of Powder Materials*)

Keywords **- Silicon Carbide, Silicon Carbide Ceramics, Silicon Carbide bricks, SiC.**

I. INTRODUCTION

Silicon Carbide (SiC) Ceramics has many positive characteristics to compare with other materials and other ceramic bricks. Because of that these advanced ceramics are used as refractory bricks for using in high heat environments such as kilns and furnaces.

The goal of this paper is to characterize the bricks of silicon carbide and define its uses and perspective uses.

II. CHARACTERISTICS

Silicon Carbide is a ceramic material with an outstanding hardness, only surpassed by diamond, cubic boron nitride and boron carbide. The material is highly wear resistant and chemically inert to all alkalis and acids. It is also highly heat resistant. Silicon Carbide refractory is made from high purity refractory grade silicon carbide grains (70.5% of carbon and 29.95% of Silicon) and proprietary ceramic bonds products possess unique combination of physical and chemical properties. High quality refractory brick has a number of traits which distinguishes it from other types of bricks. It can withstand very high temperatures up to 2200°C without failing. It has low thermal conductivity to compare with aluminum and high – to compare with glass and polymers, 50 to 100 W/m⊙K, and the law coefficient of thermal expansion $5 \cdot 10^{-6}$/K. In the same time it has relatively low density 3.1-3.3 g/cm3. The hardness can compare to diamond (Mohs hardness 9.25). SiC brick has good tribological properties and high resistance to wear.

III. USES

Refractory brick can withstand impact from objects inside a high heat environment, and it can contain minor explosions which may occur during the heating process. The places where refractory bricks are used: fireplaces, wood stoves, cremation furnaces, ceramic kilns, furnaces, forges, and some types of ovens. SiC bricks are used in steel and iron smelting, in steel ladle lining, nozzle, stopper, blast furnace bottom and bosh, iron notch steel notch of rotary furnace and electric furnace and anhydrous cooling slide track. In silicate industry, used as awning and fire insulating material, such as muffle lining and casket alms bowl.

IV. PRACTICAL RESEARCH

A set of ceramic samples based on silicon carbide was studied. Ceramic samples were prepared by sintering fine powder of SiC with particle 0-90μm in size. During sintering such additives as phenol resin and carbon black were used. The sintering temperature varied from 50-70 °C. Sintered samples were in the form (pict.2) of rectangular parallelepiped approximately 170 mm in length, 40 mm in width and 40 mm high.

Picture 1. The specimens of SiC Ceramics

Density of the samples was measured by hydrostatic weighing in distilled water in order to determine characteristics of new SiC Ceramics material.

V. CONCLUSIONS

SiC Ceramics have excellent characteristics for being a refractory material. Refractory bricks are used as light-weight structural materials for high-temperature applications.

Obtained results can be used in the future to make new SiC bricks with specific properties and uses in other fields of civil engineering.

The Influence of Micro and Nano Silica to the Processes of Formation of Microstructure and Properties of High Performance Concrete

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Aleksandrs Korjakins (*RTU*), Genadijs Sahmenko *(RTU)*

Keywords **– Micro silica, Nano silica, Concrete, Microstructure, Mechanical and physical properties.**

I. Introduction

Both micro and nano silica reacts with calcium hydroxide to produce calcium silicate hydrates (C-S-H). Thus the amount of binder is increased, which both increases the strength and reduces the permeability by densifying the matrix of the concrete. As the silica reacts and produces the calcium silicate hydrates, voids and pores within the concrete are filled as the hydrates that are formed bridge the gaps between cement grains and aggregate particles [1].

Studies of the influence of micro and nano silica to the formation of microstructure and new minerals in concrete have been discussed in the given article. The main aim of investigations was to establish the time period in which the pozzolanic reactions, influencing both the increase of mechanical and physical properties as well as final strength of concrete, is still possible after preparation if it.

II. Materials and Methods

Micro and nano silica is formed of very fine spherical particles in general around 100 times smaller than the size of cement particle [2].

In order to prepare the concrete samples, Portland cement type CEM I 42.5 N was used as a binder, while as micro and nano silica - commercially produced products – Elkem Microsilica 971U with SiO_2 content 98.4 % and Elkem NanoSilica 999 with SiO_2 content 99.99 %. The water – cement ratio was kept constant in all the series – 0.25, while for the adjustment of workability of concrete – the super plasticizer on the bases of polycarboxylate ether (PCE) was used.

In order to evaluate the influence of the particles of micro and nano silica to the processes of formation of the structure as well as their integration in the matrix of concrete, the scanning electron microscope (SEM/EDX) was applied. Obtained results were correlated with the measurements of physical/mechanical properties.

III. Results

SEM/EDX analysis indicates, that the fine particles of silica are not only filling the micro and nano pores of concrete, but are also reacting with calcium hydroxide $Ca(OH)_2$ present in the concrete and thus forming the minerals of hydrated cement paste. It was detected that silica particles are more concentrated in the areas where pronounced crystals of $Ca(OH)_2$ are present (see Fig.1.). After 28 days of hardening, still non reacted silica particles were detected (see Fig.1.). What indicate, that the pozzolanic reaction between silica and $Ca(OH)_2$ will be continued and thus both the strength and density of concrete will rise. This assumption was improved by comparing the mechanical/physical properties of samples after 28 and 6 months of maturing.

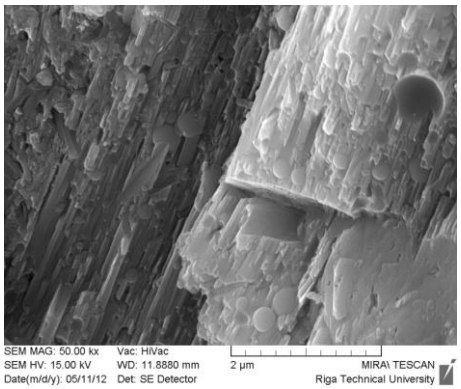

Fig. 1. Non reacted particles of micro and nano silica in a concrete after 28 days of hardening, concentrated around the crystals of $Ca(OH)_2$.

The effectivity of micro and nano silica depend both on it dispersity as well as the preparation technology of mixture. In order to improve the dispersity of silica, prior to its application it was milled and dispersed in a water solution using cavitator. The SEM images showed that micro and nano particles are not forming agglomerates but are evenly dispersed in a concrete matrix.

IV. Conclusions

It was established that effectivity and reactivity of micro and nano silica greatly depend both on the technology of preparation of mixture as well as its ability to disperse. In order to improve the dispersity and even distribution of particles in the structure of concrete it is recommended either to mill the silica or to disperse it in water using special dispergator prior to its application.

The studies of micro and nano silica containing concrete samples indicated that the compressive strength increases, water permeability decreases and other physical-mechanical properties continue to improve in a longer period. After 28 days of maturing, still non reacted particles of silica were detected in concrete, concentrated in the areas with decreased density, where crystals of $Ca(OH)_2$ were formed more intensively.

V. Acknowledgements

The research work was carried out in the frame of ERDF Project „High Performance Nanoconcretes” (No 2010/0286/ 2DP/2.1.1.1.0/10/APIA/VIAA/033).

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Use of Unconventional Aggregates in Hot - Mix Asphalt Concrete

Viktors Haritonovs (*RTU*), Guntis Brencis (*RTU*), Juris Smirnovs (*RTU*), Martins Zaumanis (*RTU*)

Keywords: **BOF steel slag aggregate, dolomite sand waste, asphalt mixture, permanent deformation, wheel tracking test, fatigue.**

I. Introduction

The dolomite and sandstone that can be found in Latvia, lack the mechanical strength and for most of the large motorways the aggregates are imported from other countries causing increase of the costs and growth of emissions from transportation. On the other hand, large amounts of Basic Oxygen Furnace (BOF) steel slag aggregates with good qualities are being produced in Latvia and put to waste. The dolomite sand waste has also been accumulating and its quantity has reached a million of tons and is rapidly increasing. This huge quantity of technological waste needs to be recycled with maximum efficiency.

II. Mix Design

Dense graded AC mixtures have been designed by using conventional and unconventional raw materials.

Three different groups of mixtures were analyzed:

– Two reference mixtures without co-products (with conventional and SBS bitumen), which were used as a control;

– Mixtures containing only BOF slag and dolomite waste sand;

– Combination of conventional and unconventional materials.

In order to determine the potential of using unconvential aggregates in the mixtures, the second and third groups of mixtures were prepared by using only conventional bitumen.

III. Performance Evaluation

The asphalt mixture resistance to permanent deformation is assessed by the depth of the track and its increments caused by repetitive cycles (26,5 cycles per minute) under constant temperature (60°C) (Fig.1.).

Fatigue properties were determined using four point bending test device (Fig.2.). This method consists in cyclic bending of prismatic specimen at constant strain amplitude. Resistance to fatigue was determined at 20°C and 30Hz.

Fig. 1. Test equipment for wheel tracking test

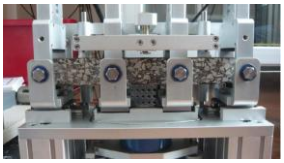

Fig. 2. Test equipment for fatigue test

Figure 3 reports the evolution of the loading cycles – rut depth curves during the test conducted. The largest plastic strain of 5,78 mm and highest wheel tracking slope of 0,29 mm in 1000 cycles appear for the reference mixture with unmodified bitumen. The asphalt concrete mixture which was produced entirely from co-products shows surprisingly good resistance to permanent deformations, having an average rut depth value of 1,54 mm and wheel tracking slope of 0,12 mm/1000 cycles. The mixture with combination of co-product and conventional aggregate had somewhat worse test results: rut depth value of 3.94 mm and the wheel tracking slope of 0,19 mm/1000 cycles.

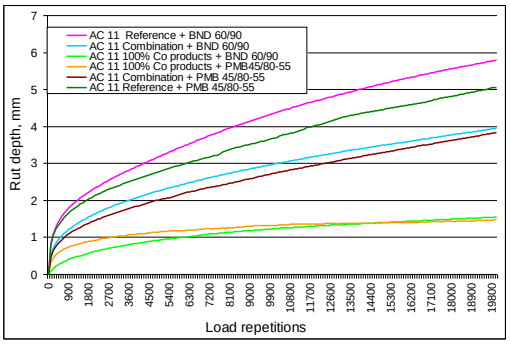

Fig. 3. Wheel tracking test curves

Fatigue tests results are given in Fig. 4. They indicate that mixture with BOF steel slag and dolomite sand waste (100% co-product) showed less resistance to fatigue, compared to results for mixture made with conventional aggregates and combined mixture. The mix designs that include exclusively dolomite aggregates as well as the combination of dolomite and slag in coarse portion plus waste sand in fine aggregate portion exhibit slightly higher fatigue life compared to other combinations.

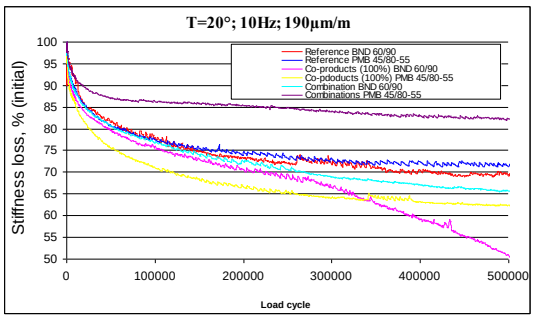

Fig. 4. Fatigue test results

IV. Conclusions

Physical and mechanical properties of steel slag aggregates are comparable with the characteristics of conventional natural aggregates. Dolomite sand waste fulfills the highest standard LVS EN 13043 category in terms of angularity

High resistance to rutting can be attained by using modified bitumen as well as by-product aggregates with rough surface texture which promise more aggregate interlock and surface friction. However bitumen content and modified bitumen improves fatigue life.

Internal Curing of Concrete by Superabsorbent Polymers

Janis Justs (*RTU*), Pietro Lura (*EMPA, ETHZ*), Diana Bajare (*RTU*), Genady Shakhmenko (*RTU*).

Keywords **– Internal curing, Superabsorbent polymers (SAP), High performance concrete (HPC).**

I. Introduction

Modern high and ultra-high performance concretes (HPC) and (UHPC) are demonstrating very good mechanical properties and durability; however these properties can be compromised by early age cracking caused by autogenous shrinkage. Autogenous shrinkage is defined as the bulk deformation of a closed, isothermal, cement-like material system not subjected to external forces [1] and its main driving force is accepted to be capillary pressure. In low water-to-cement ratio (w/c) systems, water-filled capillaries are emptied during the self-desiccation. Consequently capillary pressure builds up and it can cause crack development in the concrete. Capillary pressure can be reduced if extra water is provided for concrete curing. In low w/c concretes, providing the water externally is not effective because of the very fine porosity and resulting low permeability, which does not allow the water to access the whole volume of the material. To overcome this limitation, internal curing with Superabsorbent polymers (SAP) has been proposed [2, 3]. SAP are covalently cross-linked hydrophilic polyelectrolytes with three dimensional structures, capable to absorb high amounts of liquid without dissolving and retain the liquid even under a certain pressure [4]. They are added in the dry state during mixing, whereupon they rapidly absorb part of the mixing water and form water-filled cavities (about 100-500 µm in diameter) in the fresh concrete [3, 5]. To compensate for self-desiccation, the amount of water that will be absorbed by the SAP needs to be added to the mixing water [2].

II. Materials and Methods

Two mixtures were prepared – reference mixture without SAP (w/c 0.27) and mixture with SAP addition and extra entrained water (w/c increased by 0.05). Concrete was mixed in a high shear mixer with the capacity of 75 liters (Eirich). Total mixing time was 370 seconds. Ordinary Portland cement CEM I 42,5 N (Cemex) was used in this study.

Corrugated plastic tube method was used to measure autogenous shrinkage (See setup in Fig.1).

Fig. 1. Setup for autogenous shrinkage measurements.

III. Results

In Fig. 2 results are presented starting at 40 minutes from specimen casting.

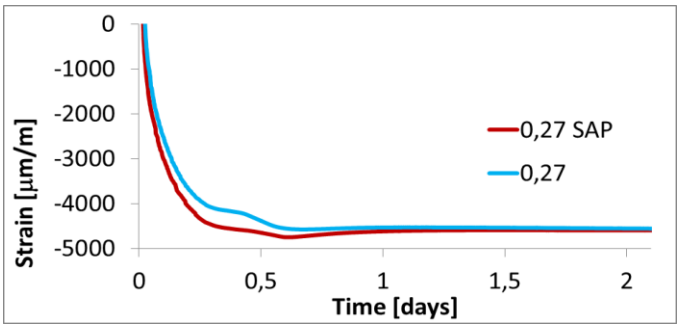

Fig. 2. Autogenous shrinkage of concrete with and without SAP. Presented starting from 40 minutes after casting.

Specimens demonstrated very high shrinkage values in the first hours after casting, however not all registered deformations can be attributed to the autogenous shrinkage. Part of deformations is material settlement in the plastic state. Only from the setting, when material starts to behave more like solid, deformations caused by autogenous shrinkage start to build up internal stresses and increase the cracking risk. Autogenous deformations starting from final setting are presented in Fig. 3.

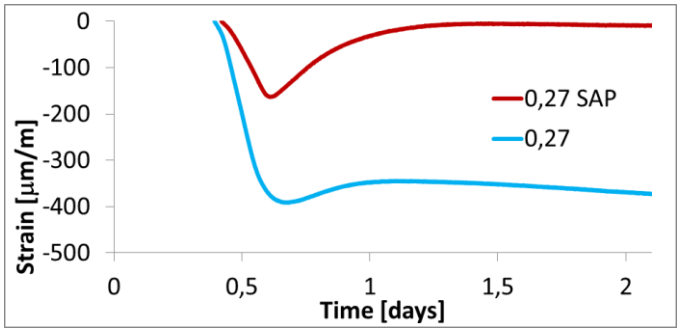

Fig. 3. Autogenous shrinkage of concrete with and without SAP. Presened starting from the final setting.

Specimens without SAP after 2 days demonstrated autogenous shrinkage of around 0.4 mm/m, while specimens with SAP addition had total deformations very close to 0.

IV. Conclusions

SAP can be used effectively to reduce autogenous shrinkage. In this study total autogenous deformations close to zero after 2 days were reached.

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High Efficiency Porous Ceramics for the Production of Insulation Buildings Materials

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Keywords **– ecological materials, insulation materials, porous ceramics, production waste.**

I. Introduction

Clay is the main raw material of production of ceramic materials and its products as well as one of the main sedimentary rocks in the area of Latvia and may be successfully used as the raw material to make the alternative heat insulation material to the current materials in the market – heat insulation materials of porous ceramics, which are made of the local raw materials, using clay as a binding agent, but the remains of woodworking, straws or hemp/ flax shoves – as filling material thus obtaining the material with the required thermal and noise insulation properties [1, 2].

During the investigation porous ceramics was developed by using not only the traditionally burnable filling agents, but using also the polymer material, which is saturated with clay soil in order to obtain porous ceramics, this allowing to form the desirable porous structures in wide range, with pore size from some micrometers up to 2 – 3 millimetres.

The objective of the given investigation was obtaining of porous ceramics materials with definite properties according to the hardness and density, obtaining the material, which could be used for building heat insulation.

II. Materials and methods

Carbonized clay with sintering temperature – 950 °C and melting temperature – 1010 °C, with volume mass – 1600 kg/m³ and humidity level of 24 % as well as milled glass were used for making samples.

Shove used in survey were sieved in beforehand so that their size did not exceed 5 mm. Clay was dried in the drying oven and milled in RETSCH PM 400 mill for 10 minutes in dry condition

When the required components were prepared, they were dosed in the required amount and mixed in dry condition, gradually adding water till the sufficiently homogenous mixture for sample making was obtained. Components of dry mixture were dosed according mass, where dry, milled clay was 40 – 70 %, glass 5 – 40 %, but the chamotte, making samples by burning of polymer material, -11 – 15 %.

Cylindrical samples up to 25 mm big diameter, as well as prism samples with sizes of 100 x 100 x 20 mm were made, using shoves as the burnable filling agent and 100 x 150 x 20 mm, using burning of polymer material. They were dried for 8 hours in temperature of 50 °C.

Samples with burnable filling agent of plants were burnt once or twice, in high burning temperature of 1000 °C, for different time.

III. Results

Usage of polymeric sponge saturation method, by varying quantity of ground glass in them, leads to development of several types of samples with volumetric mass in limits of 140 to 320 kg/m^3, where clay serves as the binding agent, chamotte provides the required strength and stiffness, making the resistant structure, burning the saturated polymeric sponge, in its turn the glass provides the better ling between the mixture and sponge as well as the better strength.

The strength of the obtained samples, using glass amount of 5 – 10 % is from 2.5 to 1.5 MPA, respectively increasing if the amount of the used glass is increased.

Using the flax shoves as the burnable filling agent, the volumetric mass of the obtained samples is within range of 320 up to 950 kg/m^3, respectively reducing, if the volume of filling agent is increased up to 20 %. The compressive strength of samples, varying the amount of glass is summarized in Table No. 1

Table 1. Compressive strength of samples depending on the amount of glass.

Amount of glass, %	5	7.5	15
Compressive strength, MPa	0,27	0,30	0,97

By using 40% of grinded glass for making of the sample, obtained compressive strength was 3.95 MPa, but density of that sample was 740 – 820 kg/m^3.

Using shoves as burnable filler, the macropores that are visible in sample structure have elongated form and a measure of pores in obtained plant matrix samples was 0,033 – 1,7 mm, but macropores got by burning of polymer material sponge, have regular form what copied the structure of sponge itself and measure of pores 0,5 – 2,0 mm and they are shown in figure 1.

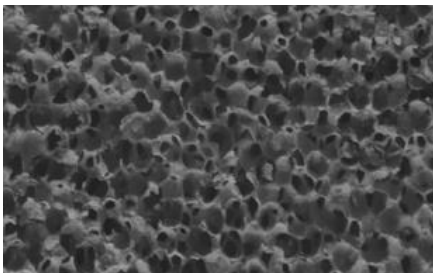

Fig.1. Structure of pores for samples made by polymer material matrix burning method.

IV. Conclusions

Porous ceramic materials developed due to burnable fillers method and obtained within the research, do not rot, are breathable and resistant against thermal and heat impact, aggressive environment and corrosion.

Reached physically chemical properties of these materials can be improved by allowing them to compete with aerated concrete and concrete blocks with expanded clay granules, because by using the method of burnable filling agent, both the pore amount and its size may be successfully regulated in the material.

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Uniaxial Tension of Wedge-Type Anchorage System

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Vladimir Kulakovs, Aleksandr Arnautovs, Georgij Portnovs (*Institute of Polymer Mechanics, University of Latvia*)

Keywords **– FRP, anchor system, wedge, FEM analysis.**

I. Introduction

Round pultruded composite rods are widely used as tendons for pre-stressed and post tensioned concrete [1-2]. The problem of application of these structures is anchoring. Present time three main types of anchorage mechanism can be classified as follows: shear friction, bond and wedge actions. A few investigations have been devoted to the calculation of the anchorage stress-strain state using finite element methods. Numerical results obtained in these investigations showed the existence of concentrations of normal and shear stresses along the anchorage length.

Aim of the research is designing of a potted-type anchor for high-strength composite rod failed in the gauge zone.

II. Numerical Analysis and Experimental Set-up

The anchorage system comprises a composite rod having a spitted end with an inserted and glued metal wedge, a metal sleeve and pottant material, connecting composite rod and sleeve. The main objective of the system proposed is reduction of high stress concentration at the loaded end, which is typical for the bond-type anchor systems.

The detailed analysis of 3D stress-strain state of the anchor was performed for pultruded UD CFRP/epoxy rod with splitted end, in which Aluminium wedge is inserted and glued. Rod with Aluminium wedge is embedded into steel sleeve filled with Epoxy pottant (Fig. 1).

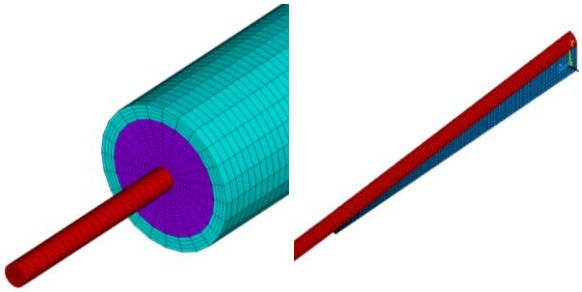

Fig. 1. Finite element model of anchorage system with metal wedge.

All calculations were made with finite element method accounting for elastic and elastic-plastic behavior of epoxy resin in shear. The principal conclusion resulting from these FEM calculations implies that stress concentration at the loaded end of the anchor system keeps independently of the wedge location if the adhesive bond between composite rod and pottant is available. The possible technical solution of this problem may be creation of a friction interface between composite rod and pottant within the anchorage length. To verify this suggestion, 3D contact FEM problems for the anchor system with the various lengths of friction interface were considered and analyzed.

FEM calculation showed that consideration of an elastic-plastic behavior of epoxy pottant in shear reduced stress concentration in anchor with a full adhesion interface of about 11%, while reduction of length of non-splitted part of composite rod (from 200 mm to 15 mm) has no practically influence on stress state of anchor.

TABLE I

Experimental results

Type of anchor	Bonding mechanism	Length, mm	σ_z, MPa	Failure mode
Without wedge	Full adhesion	300	1274.8	Not failed (pulled out)
		500	1806.9	Tensile by splitting
	Full friction	500	1694.2	Not failed (pulled out)
With wedge	Full adhesion	300	2037.6	Tensile (lateral in gauge zone)
	Full friction	300	1855.0	Tensile by longitudinal splitting

A series of the uniaxial tensile tests (Table 1) were carried out for the anchor systems made with CFRP pultruded rods of 5.5 mm diameter, steel sleeve of 300 mm length, A1 wedge of 110 mm length and cone angle of 7° embedded into epoxy resin. These experiments confirmed the working capacity of the anchor system proposed to transfer the tensile load on the high-strength UD CFRP/epoxy rod made by pultrusion. Failure of these CFRP rods was observed at the gauge section and maximum tensile stress of 2038 MPa (Fig.2). The anchor systems were fabricated with adhesive bond and only friction interaction between composite rod and pottant.

Fig. 2. Tensile failure mode at the cross-section into entry of anchoring zone.

III. Conclusions

Comprehensive parametric analysis of 3D stress-strain state of the anchor considered is carried out with variation of its geometry, mechanical properties and model of mechanical behavior. CFRP/epoxy rods, which were anchored without inserted Aluminium wedge, were pull-out or failed with premature splitting. CFRP/epoxy rods with inserted Aluminium wedge failed in the gauge zone with tensile failure mode, which peculiarity depended on the type of mechanical bond between composite rod and epoxy pottant.

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Concrete Structural Element Reinforced by Glass Fiber Fabric

Andrejs Krasnikovs (*Riga Technical University*), Olga Kononova (*Riga Technical University*), Videvuds Lapsa (*Riga Technical University*),Vitalijs Lusis (*Riga Technical University*), Jevgenijs Zalesskis (*Riga Technical University*) Galina Harjkova (*Riga Technical University*)

Keywords **– glass fiber, concrete, beam, yarn.**

Interest to concrete, reinforced by glass fibers knitted fabrics, is increased in recent years. Such materials are exhibiting attractive mechanical properties. In woven fabric, threads traditionally are running horizontally and vertically. Contrary, in the case of knitted fabric, strands are forming loops. A knitted fabric is highly deformable in all directions. Depending on fibers are used, some of them are more deformable than others. The reason is – yarns are not making any straight line anywhere in the knitted fabric, leading to technological advantage – excellent deformability, shape forming ability and flexibility, which allows it to be used in any complex shape mould without folds. In this project glass fiber yarns were investigated. Glass fiber knitted fabric was prepared using knitting machine Neva-5 (see Fig.1). Fabrics were used for concrete beam reinforcement. Fabrics were placed inside the mould during beam preparation at the equal distance from the top and bottom each prism surfaces and at equal distance one from another separating prism thickness to 4 or 5 layers (in the case of 3 or 4 embedded fabrics). Ruptured sample reinforced by 4 fabrics is shown in the figure 2. Simultaneously, mechanical performance of the beam reinforced by 3 or 4 fabrics under 4-point bending was numerically simulated. Glass fibers yarn loop in concrete matrix was modeled using FEM. It was intended that knitted fabric composite would consist of multiple plain weft knitted fabric laminas. The 3D geometrical model of the knitted fabric was accepted. Model predictions were validated by experiments. Three groups of 10x10x40 cm concrete prisms were prepared. First group was without reinforcement. Second group was reinforced by 3 fabrics each prism. Third group has 4 reinforcing fabrics inside each prism.

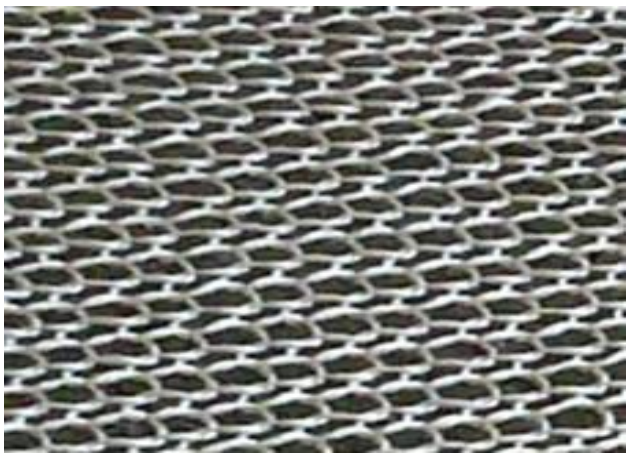

Fig.1. Glass fibers knitted fabric.

All prisms were loaded by 4-point bending till rupture. Applied load displacement curves were obtained experimentally and were compared with numerical simulation results. Results comparison showed good coincidence at starting part of non-linear applied force- beam midpoint deflection curve and was allowed to recognize mechanical picture of fracture for such materials.

Fig.2. Concrete prisms reinforced by four glass fiber knitted fabrics. One half of the beam was broken under 4 –point bending.

Vibration-Based Technique for Damage Detection

Sandris Ručevskis (*Institute of Materials and Structures, Riga Technical University*), Pavel Akishin, Andris Chate.

Keywords **– damage detection, modal analysis, scanning laser vibrometer, structural health monitoring.**

I. Introduction

Structural health monitoring and damage detection in civil, mechanical and aerospace engineering constructions has become one of the most important keys in maintaining the integrity and safety of a structure. During the last decades vibration-based damage detection methods have been attracting most attention due to their simplicity for implementation. Valuable reviews of the state of art in the methods for detecting, localizing, and characterizing damage by examining the changes in the measured vibration parameters can be found in [1-3]. Many studies have investigated the effects of damage on mode shapes and corresponding mode shape curvatures. These papers show that mode shape curvatures are highly sensitive to damage and can be used to localize it. However, the major drawback of those methods is a need for the data of the healthy structure which sometimes could be difficult to obtain or even impossible.

In this paper the damage detection technique which uses the mode shape curvature determined from only the damaged state of the structure is described and compared with other relevant damage detection methods referenced in literature.

II. Damage Index

The idea of the proposed technique is based on the relationship between the mode shape curvature and the flexural stiffness of a structure. Damage induced reduction of the flexural stiffness of the structure subsequently causes an increase in the magnitude of the mode shape curvature square. The increase of the magnitude of the curvature square is local in nature, thus the mode shape curvature square may be considered as an indicator for the damage location. The location and size of damage is estimated by application of the mode shape curvature square magnitude damage index defined as the average summation of damage indices for all modes normalized with the respect to the largest value of each mode

$$MSCSM_{(i,j)} = \frac{1}{N}\sum_{n=1}^{N}\sqrt{\left(\frac{\left(\frac{\partial^2 w}{\partial x^2}\right)^2_{(i,j)}}{\left(\frac{\partial^2 w}{\partial x^2}\right)^2_{\max}}\right)^2_n + \left(\frac{\left(\frac{\partial^2 w}{\partial y^2}\right)^2_{(i,j)}}{\left(\frac{\partial^2 w}{\partial y^2}\right)^2_{\max}}\right)^2_n} \quad . \quad (1)$$

where w is the transverse displacement, N is the total number of modes considered, i and j denotes the measurement point number in x and y direction, respectively. Damage index is formulated in both: one-dimensional space and two-dimensional space thus allowing damage detection in beam-like or plate-like structures.

III. Experimental Set-up and Numerical Analysis

The experimental modal frequencies and the corresponding mode shapes of a structure were obtained by using the POLYTEC PSV-400-B scanning laser vibrometer (SLV). The structure was excited by an input periodic chirp signal generated by the internal generator through a piezoelectric actuator (PZT). Validity of the proposed technique has been assessed by comparing it to the results obtained by the finite element simulations (FE software ANSYS) and the pulse-echo ultrasonic inspection technique.

IV. Damage Detection Examples

Effectiveness and robustness of the proposed damage detection technique are demonstrated by aluminum beams containing mill-cut damage as well as by laminated composite beams containing low-velocity impact introduced damage.

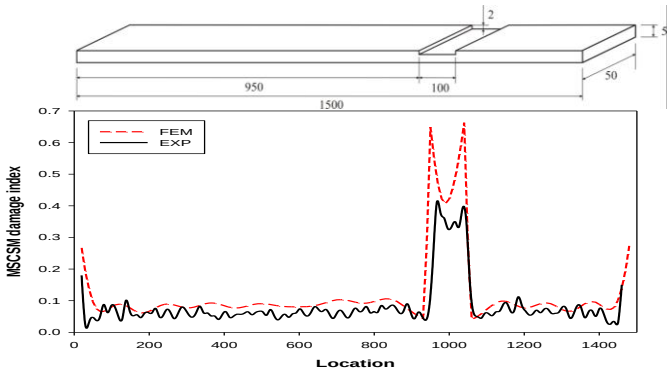

Fig. 1. One-dimensional MSCSM damage index for the aluminium beam with mill-cut damage.

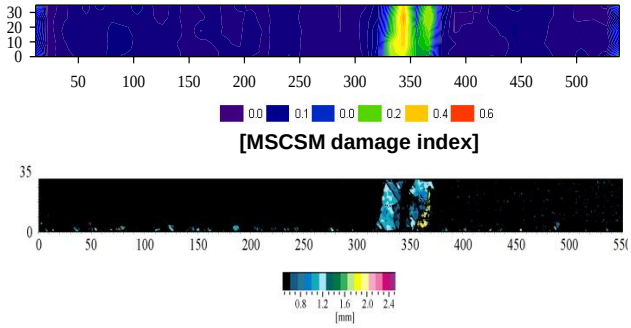

Fig. 2. Two-dimensional MSCSM damage index – top; ultrasonic damage depth C-scan – bottom, for the laminated composite beam with low-velocity impact introduced damage.

V. Conclusions

The present study focuses on damage detection by extracting dynamic characteristics obtained from vibration experiments. It was proposed to use the magnitude of the mode shape curvature square for the detection of the damage location and size. The main advantage of the proposed technique compared to the existing methods is that this method is simple for implementation and does not require prior knowledge of the healthy state of the structure.

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Heat Insulation Materials Made of Foliage Tree Fibres

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Keywords **– ecological materials, insulation materials, fibre materials.**

I. Introduction

In the time, when non-renewable resources, whereof the industries of economically developed countries are being constructed, are running out, the possibilities to develop the new technologies and usages, basing on the rapidly renewable resources, are being looked for. Wood processing in the ecological wooden fibre heat insulation material, which may be obtained from the wood product (wood chips) with relatively low added value, is particularly attractive from the point of view of ecological construction [1, 2].

Within this case study an ecological heat insulation material made of foliage tree fibres was developed in difference from the current experience in Europe and world, where only conifer fibres are used for production of wood fibre heat insulation materials, as so the natural conifer gum may be used as the binding agent. Additionally to the produced heat insulation material a manufactured composite material for partition wall made of new wood fibre heat insulation material and plaster board was produced. The aim of this work was to develop the heat insulation material, using the foliage tree fibre and determine the possibilities of its usage.

II. Materials and Methods

Within this work for the development of heat insulation material fibres of foliage trees were used whereof the sizes were: in width from 0,14 to 1,80 mm, on average 0,55 mm, but in length from 0.01 to 6 mm, on average 4,0 mm. Separate fibres reached length of 15 mm. The sizes were determined using scanning electron microscope.

Wooden fibres and flax (shove) were sieved in fractions of two types – with 4 mm and 8 mm sieve, respectively using both the fraction of small and big raw material.

PVA D3 moisture resistant glue solution was used as the binding agent in the survey.

Making samples with sizes 300x300x40 mm (+/- 20 mm), wooden fibre amount ranged within margins of 53 – 70%, flux ranged within 17 – 25%, but volume of PVA D3 glue - respectively, 5 - 11%.

Additionally to heat insulation material made of foliage tree fibre, composite material containing the newly made material and plaster board plates was produced.

Coefficient of thermal conductivity λ was determined by the meter of heat insulation "LaserComp Fox 600", but in order to determine the noise absorption of heat insulation material made of foliage tree, there was used the acoustic pipe manufactured by the company "SINUS".

III. Results

The values of volumetric mass for the wood fibre heat insulation samples A1 – G1 obtained within the project are reflected in Figure 1, concluding that the values for heat insulation materials are variable and range within limits of 76,64 kg/m^3 and 127,06 kg/m^3, keeping up with the industrially manufactured products, with optimal volumetric mass of around 100 kg/m^3.

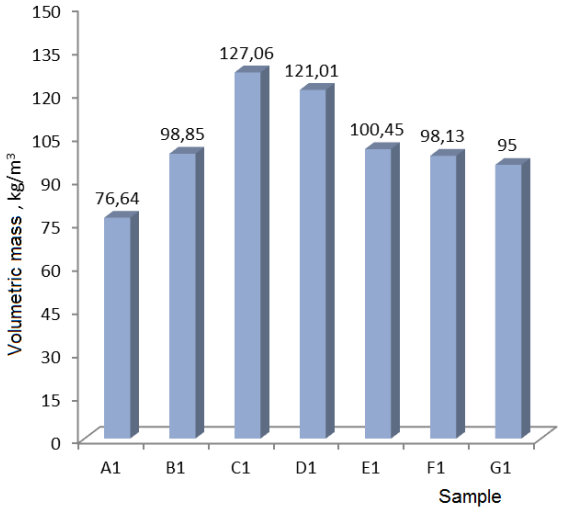

Fig. 1. Volumetric mass of wood fibre heat insulation material

The values of heat conductivity coefficient of the obtained samples is quite similar ranging within limits of 0,039 W/(mK) up to 0,044 W/mK, with the lowest value for sample A1, i.e., 0,039 W/(mK), which naturally has also the lowest volumetric mass.

Additionally to heat insulation material made of foliage tree fibre, composite material containing the wood fibre heat insulation material and plaster board was produced, the values of heat insulation coefficient for which is quite similar and ranges within 0,069 W/(mk) and 0,074 W/(mk).

Comparing the noise absorption of foliage tree fibre heat insulation material with the values of industrially manufactured production – stone wool, polystyrene foam – it may be concluded that it is up to 5,9 % lower than for stone wool, but for 3 times larger than for polystyrene foam.

IV. Conclusions

Analysing of the obtained results it may be concluded that it is possible to manufacture the heat insulation materials not only from the conifer fibre, but also from the fibre of foliage tree and residuals of the flax manufacturing (shoves, fibres) with similar properties of conifer heat insulation materials, obtaining the coefficient heat conductivity from 0,039 till 0,044 W/mK, which for the industrially manufactured production is 0,040 W/mK.

The developed composite material of partition walls from the wood fibre heat insulation and plaster board plates opens the perspective to recommend the usage of composite material not only as good heat insulation and noise insulation material, but also as ecological solution of partition walls with high fire security.

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Performance Characteristics of Two Warm Mix Asphalt Technologies

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***Keywords* – Warm Mix Asphalt, WMA, Performance Tests.**

I. Introduction

Warm Mix Asphalt (WMA) technologies allow a reduction in the production and paving temperature of conventional Hot Mix Asphalt (HMA). However, not all of the techniques can provide similar asphalt performance as for HMA; therefore the WMA design process should involve not only empirical characterization of the asphalt but also analysis of bitumen and performance properties of the asphalt.

The research presented in this paper involved evaluation of two warm mix asphalt additives – "Rediset WMX" and "Sasobit". Rediset WMX is a chemical additive combining cationic surfactants and rheology modifier based on organic additives. Sasobit is a Fischer-Tropsch process wax that reduces the viscosity of bitumen above the melting point of wax (~90°C), thus improving the wetting of aggregates and workability of the mix.

II. Test Results

A. Bitumen

The bitumen test results (Table 1) show the expected trend of viscosity reduction after the melting of additives and viscosity increase after crystallization. The aging process was simulated by the RTFOT and the results show that the influence of this procedure on Fraass temperature is significantly different for pure and modified bitumen. The breaking point temperature of the reference bitumen increased by a notable 5°C after the RTFOT. That of the Sasobit modified binder only increased by 1°C and it even dropped by 2°C for bitumen modified with Rediset WMX which suggests some anti-aging effect on bitumen of the chemical additive. This shows that the general concern that wax technology significantly worsens the low temperature behavior may not be true for all types of bitumen and must be verified.

TABLE I

Bitumen test results

Analysis	Reference 50/70	+3% Sasobit	+2% Rediset
Penetration at 25°C,	65,0	45,2	55,4
Softening point, °C	50,4	78,4	58,1
Dynamic viscosity at 60oC, Ps·2	340	2379	570
Kinematic viscosity at 135oC, mm2/s	607	485	529
Fraass breaking point, °C	-25	-20	-21
After RTFOT aging at 163°C			
Change in mass, %	-0,10	-0,09	-0,12
Retained penetration, %	70,8	72,0	69,0
Softening point, °C (change)	56,8 (+6,4)	80,3 (+1,9)	63,7 (+5,6)
Fraass breaking point, °C (change)	-20 (-5)	-19 (-1)	-23 (+2)

B. Asphalt

WMA optimal mixing and compaction temperature was determined by comparing the volumetric properties and wheel tracking test results (Figure 1) for AC-11 mixtures prepared at two different temperatures to the HMA results, compacted at 145°C. The results indicated that both WMA mixtures perform best at 120°C compaction temperature which was accordingly chosen for further testing.

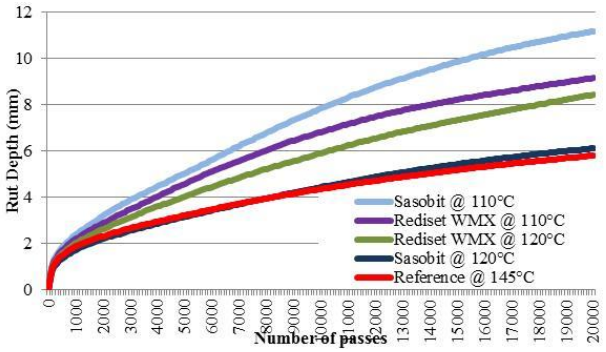

Fig. 1. Wheel Tracking Test Results (small size device in air) at 60°C

Indirect tensile testing was used to determine the asphalt stiffness at two different temperatures. The test results (Figure 2) indicated similar stiffness for reference asphalt and Rediset WMX mixture, but significantly higher stiffness for Sasobit modified asphalt. This is due to the influence of wax crystallization which stiffens the binder.

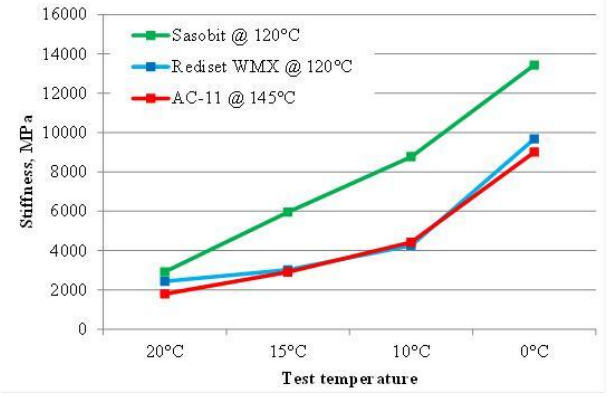

Fig. 2. Stiffness (IT-CY)

Indirect tensile strength ratio (ITSR) results showed that there should be no problem with the water susceptibility since all the specimens fulfilled the specification requirement of 80% saturated to dry specimen tensile strength ratio.

III. Conclusions

It can be concluded that both WMA technologies allow lowering of mixing and compaction temperature by 25°C without compromising the asphalt performance in medium and high temperature ranges. The Fraas braking point temperature also indicates good performance at low temperature; however further testing is required for assessment of mixture fatigue and low temperature behavior.

Slow Pyrolysis Waste-to-Energy Technology for Latvian Market

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***Keywords* – slow pyrolysis, wastes, pyrogas, district heating.**

I. INTRODUCTION

Normally any organic substance (oil, plastic, wood, paper, rubber, cloth, animal waste biomass, sludge etc.) heated above a certain temperature, about 200-300 °C, spontaneously ignites and burns, which always occurs in presence of the air (or in oxidizing atmosphere). If the heating is carried out in a special container in the absence of oxygen the substance does not burn but partially gasifies and partially transforms in char [1,2].

At higher temperatures (around 700-800°C), a total gasification of organic substances occur. The gas (pyrolysis gas or pyrogas) produced by the conversion of certain organic substances possess excellent characteristics that allow its further usage as a fuel to support the process and to recover the excess energy as a part of waste-to-energy approach.

II. THE SLOW-PYROLYSIS PROCESS

The following figure illustrates a principle of slow pyrolysis process for municipal and industrial waste treatment.

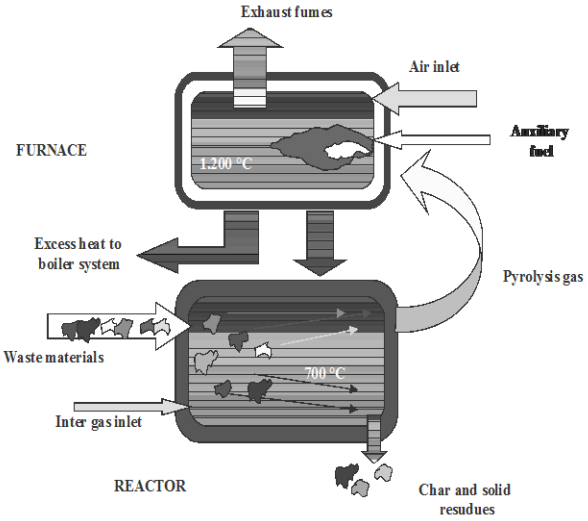

Figure 1. Schematic of slow-pyrolysis process developed by Latvian-Italian joint group.

III. INDUSTRIAL REALIZATION

Several customized pyrolysis plants have been constructed in Italy and in Europe. An average capacity of municipal solid waste processing plant is 1-2 t/h, however it can be scaled-up to 12-16 t/h of processed waste materials. In most cases, a pretreatment of raw wastes is necessary for higher efficiency of pyrolysis process and in order to ensure better characteristics of pyrolysis gas. The produced pyrolysis gas can be used either for heat production in district heating systems or for industrial application (further gasification). In the following figure (Fig. 2.), an overview of pyrolysis reactor is shown (length 16 m, diameter 0.8 m, production capacity 0.5-1.5 t/h).

Figure 2. Slow pyrolysis waste processing plant. Pyrolysis reactor (kiln).

Some characteristic parameters of pyrogas obtained from mixed organic materials (humidity 30%, organic part 40%, pyrolysis temperature ~600°C) are shown in Table 1

Table 1. Parameters and composition of pyrogas obtained by slow pyrolysis process.

Parameter	*Values*
Flow, Nm^3/h	2400 – 4200
Temperature, ^oC	400 – 650
Density, kg/m^3	1.2 (0 ^oC, 1 atm)
Composition, (% by vol.)	CO_2 ~ 5% CO ~ 10% H_2 ~ 2% N_2 ~ 60% H_2O ~ 6% Hydrocarbons (C_1-C_4) ~ 15% Hydrocarbons (C_5-C_{10}) ~ 2% Fly ash: 200 – 350 kg/h (mainly char ~ 20 g/Nm^3)

IV. CONCLUSIONS

A slow pyrolysis process can be considered as an alternative to waste incineration. It can be used for thermal treatment and decontamination of metallic wastes and contaminated soils (oils removal), as well as for processing of organic wastes of different origins.

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Traffic Flow Research of the Riga Street Network

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***Key words*. local speed, momentary speed, traffic flow density, traffic loading level.**

I. INTRODUCTION

Construction of arterial streets in the conditions of dense housing in urban territories requires significant financial investments that are connected not only to the construction of arterials itself. In conditions when the financing available for the construction of interchanges is limited, it becomes more and more important to evaluate every possible way to reduce the costs for the construction of arterial streets, and this primarily may be achieved by reducing the geometrical parameters for arterial streets. The mentioned parametres may be changed by changing design speeds, of course, with respect to appropriate level of traffic safety. Within this study the necessity to review normative documents in relation to functions and categories of city streets was evaluated [1].

II. METHODOLOGY AND INITIAL DATA

The applied methodology is based on the measurement of momentary speed and traffic intensity data on arterials with free traffic flow. The measurements were recorded on two carriage-way streets with two or three driving lanes in each direction that have different design speeds. The measurements were recorded in different time periods and at different traffic intensities from the year 2007 until the end of 2009. Data recording was performed automatically with special counters and grouped per each hour during the day throughout the whole year. The first type of measuring is done with induction loops installed in roadway pavement that register all vehicles moving along the arterial in both directions. The second type of measuring is done with laser beams where special laser system is installed on a special gantry located above driving lanes. Infrared sensors are installed above driving lanes in both directions. Processing and storing of measurements is done with special software that provides the possibility to review time diagram of each controlled sensor, as well as, collection of general statistical data. To acquire overview on average driving speeds on regulated arterials, speed measurements of vehicles driving in real traffic were performed. At the same time a number of data was recorded, such as the lengths of studied street sections, the number of driving lanes in these sections, travel time and permitted speed limits. Measurements of traffic speeds showed that the average driving speed on regulated arterials of the Riga city in morning peak hours was approximately 20 km/h in the locations where the maximum permitted driving speed was 50 km/h. At the same time the average driving speed on free-flow arterials with permitted speed limit of 70 km/h of the Riga city in morning peak hours was 50 km/h, which in comparison with regulated arterials was even more that for two times higher. This may be explained with the fact that there are no traffic lights on free-flow arterials.

III. RESULTS

The results of the study show that average speed on free-flow arterials amounts up to 50-60 % of the design speed specified for the respective road. It has to be noted that congestion peak hours in today's street network amount up to 12-14 hours, and the present study testifies that the speed that initially was used for designing the arterials streets may not be implemented in approximately half of the day. Speed measurements in the street network show that design speeds or permitted speed limits whatever they are, contribute neither to the increase of speeds nor to the time savings when driving a vehicle especially in daytime. As the study shows the main factor that influences the actual traffic speed is the density of traffic and its loading level.

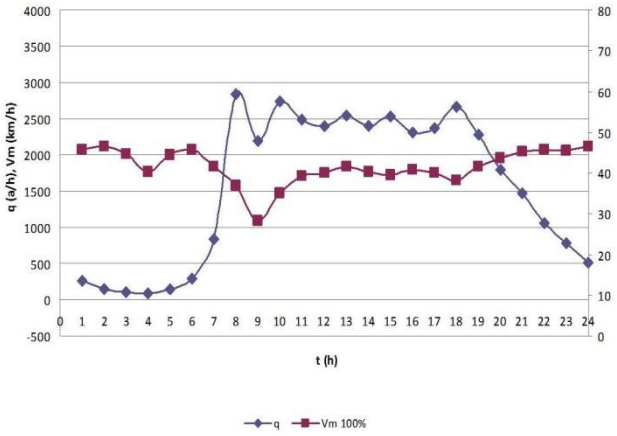

Fig. 6. Relation of traffic intensity and average momentary speed at speed limit of 50 km/h in the direction towards city centre.

The design speed used in street design is defined as the driving speed of a single vehicle on road. However, with the constant increase of vehicle numbers single vehicles on streets may not be seen even during night time. The study shows that at present and in the future when the design speed is defined it would be useful not to consider the driving of a single vehicle but to refer to traffic flow where traffic speed is depending on traffic density and limitations, speed limits and road accidents.

When analysing the data acquired on average momentary speeds it was concluded that the actual speeds on arterial streets with free traffic flow rarely exceeded the design speeds for arterial streets. Such situations were observed only in 2% of all hours per day at the speed limit of 50 km/h. However, at the speed limit of 70 km/h the situations when driving speed exceeded the design speed occurred even much more rarely – only in 0.03%. Considering the above mentioned it may be stated that significant capital investments needed to comply with the requirements set in normative documents for geometrical dimensions of arterial streets are inadequately high, as they would provide traffic safety only for 0.03% of all drivers who in their essence brutally violate the established maximum speed limit on roads for more than 40 km/h.

The results of this study may serve as the basis for determination of design speed and permitted driving speed in urban areas on arterial streets. The road parameters, such as radius of travel longitudinal profile, radius of plane curves, lane widths may be reduced. Furthermore, the general road costs can be reduced, while ensuring adequate level of safety.

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Bending Stiffness and Weight Optimization of Plywood Sandwich Panels

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Kaspars Kalniņš (*Riga Technical University, Institute of Materials and Structures*)

***Keywords* – numerical modeling, ANSYS, rib stiffened plywood structures, Pareto optimality.**

I. Introduction

Sandwich structures and rib stiffened panels from metal, fiber materials and plastics has been recognized as efficient and material saving solutions for applications requiring lightweight design elements, like ships, trains and aircrafts[1]. In addition to weight reduction, sandwich structures also allow to integrate addition properties for the panel like insulation and wave damping layers.

Wood is now widely used in sandwich design for building walls and floors, where insulation properties is most important than weight reduction. However excellent mechanical properties of plywood are suitable for manufacturing of lightweight sandwich panels for heavy duty load applications like floors in passenger transport. Mechanical properties of single plywood layer (veneer) in longitudinal direction are close to GFRP fabric ~ 17 GPa. Changing orientation of layers is possible to create tailored solutions for specific load conditions. Plywood sandwich panels with rib stiffener cores are not widely studied, thus there is potential to create more weight efficient solution than traditional plywood boards.

The aim of current research is to find most effective cross section design for plywood sandwich panels with rib stiffened and corrugated core as well as to develop overall methodology for assessing efficiency of sandwich panel, taking stiffness and volume of full plywood board as reference.

II. Numerical Modeling

The optimization work conducted in present research is based on approximation of mechanical response values of sandwich panels acquired numerically from ANSYS computer code. Sandwich panels have been made of multilayered shell elements with transverse isotropic wood properties. Numerical sandwich structures with rib and corrugated plywood core has been virtually loaded in 4-point bending. Extended description of numerical modelling and validation with experimental tests provided in previous study [2].

III. Metamodeling Technique

In current research metamodeling (surrogate modeling) were used to reduce number of numerical experiment runs. Design variables for panels with rib stiffened core are cross section parameters: overall cross-section height, distance between stiffeners, thicknesses of skins and stiffeners expressed by odd layers count. For panels with corrugated plywood core, additional parameters characterizing core is corrugated plywood thickness and angle, bonding area length. Partial polynomial approximation functions created by Adaptive Basis Function Creation (ABFC) technique (implemented in VariReg software). Metamodelling accuracy was measured using Relative Root Mean Square Error (*RRMSE).*

IV. Pareto Optimization for Sandwich Panels

Overall efficiency of plywood sandwich panels has been demonstrated by formulating Pareto optimization problem where maximization of relative stiffness ΔK is done simultaneously by minimizing the relative volume ΔV of the panel. Relative stiffness is acquired dividing numerically calculated conventional plywood board deflection with calculated deflection of sandwich panel with same length and thickness, under the same loading conditions. Relative volume is acquired by dividing sandwich panel volume with full plywood panel volume.

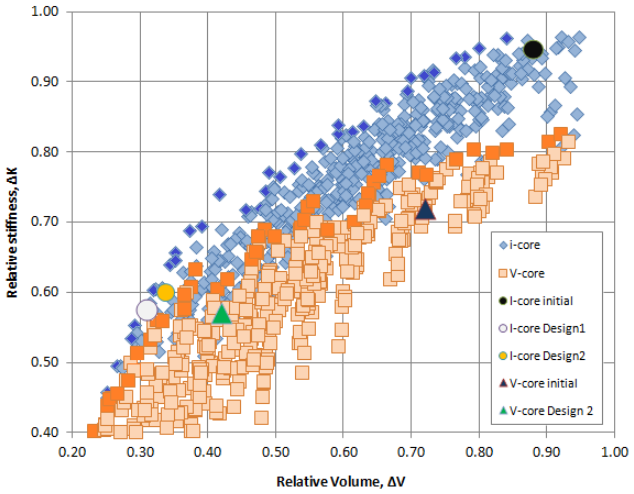

Fig. 1. Pareto optimality plots for I-core and V-core sandwich panels

Overall tendency could be observed that panels with rib stiffened core (I-core) has better stiffness ratio than panels with corrugated core (Figure 1). Using these results future decisions about direction of sandwich panels performance improvement could be done.

V. Conclusions

Comparing Pareto fronts of sandwich panels with different core types, has been find out that panels with rib stiffened core have better relative stiffness, consequently better optimization capacity. Variable sets on Pareto fronts in relative volume region from 0.3 to 0.7 could be recommended as optimal solutions for further panel manufacturing. In these cases difference between relative volume and stiffness is more than 20 %. It is also noticeable that initial designs for both panels are outside these bounds. Improved cross-section topology design drives sandwich panels closer to the optimal front.

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Optimization of Cable-Stayed Bridge Elements

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Keywords **– cable-stayed bridge; post-tensioning; optimization; active devices.**

I. Introduction

The scope of this research is an analytically obtained mathematical model of interaction between elements of cable-stayed bridges. The influence of system's geometry, mechanical and physical parameters of cables, pylons and stiffening girder on the behaviour of all structure is observed. Some results and recommendations about optimal solution from economical and technical point of view are presented.

A way to improve the fatigue conditions of the cable-stayed bridge is installation of active devices, which in an exact moment can decrease deformations and stresses from elements with poor load bearing capacity by giving them away to the others with higher capacity. Properties of such a system can be examined by the proposed method.

II. Abstract

The theoretical background of the proposed analysis method can be described step by step as follows.

1) The stiffening girder of cable-stayed bridge is observed as a multi-span beam with elastic supports at the anchor points of cables. The differential equation of deformed shape of axle for a statically undetermined beam is solved with unknown reaction forces in points of elastic supports.
2) The required (user defined) optimal bending moment diagram $M_{req}(x)$ is defined. In order to obtain the required bending moment diagram, system of equations is solved and the matrix of reactions (cable forces P) is found.
3) The corresponding stiffness of girder and displacements of elastic supports are found.
4) Resulting bending moment diagram is obtained by summing moment diagrams from dead load, live load and vertical reactions of elastic supports.
5) Stiffness of cables is determined which gives the same reactions and displacements as elastic supports.
6) Diagram of stiffness girder axial force caused by horizontal components of cable forces is found.
7) Stiffness girder diagrams of stresses caused by bending moment and axial forces are found.

The analysis of stresses in stiffening girder leads to conclusion that part of the span, which is located closer to the pylons is in a more favorable position because of higher axial compression force, which reduces or completely eliminates tensile stresses caused by the bending moment. A logical optimization is to minimize bending moments in area of stiffening girder with lower values of axial compression force – the middle of central span.

Decreasing of tensile stresses in stiffening girder can be achieved by reducing the distance between the cable anchor-points in areas where it is desirable to reduce the bending moments. The optimal solution is found by introducing a parameter dx [m], representing the difference of length of two adjacent panels. Two cases of montage of stiffening girder are observed: montage using rigid scaffolding then adding cable forces after joining of whole girder and montage using cantilevers adding cables step by step.

As a result of analysis chart with the maximum tensile stresses in the middle of the central span, depending on the parameter dx is shown in the Figure 1. Optimal adjustment of forces in cables and finding an optimal division's parameter lead to significant reduction of tensile stresses in stiffening girder. The cable forces can be unified as well.

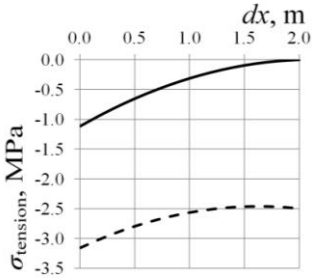

Fig. 1. Maximal tensile stresses in the stiffening girder depending on reduction parameter of distance between anchor-points dx: for montage using scaffolding (dashed line) and for cantilever method (continuous line).

The proposed methodology is developed by analyzing the impact of moving point load. The bending moment with least possible extreme values caused by variable loads can be achieved by introduction of an "intelligent" cable adjusting system – a system acting as a group of mechanisms monitoring displacements of some nodes and adjusting separate cables depending on the location and acting of the variable loads. Benefit of such system is more significant in cases with low value of η ratio – percentage of strains caused by permanent loads.

It is investigated how the tensile forces in cables should change when the point load is moving over the bridge in order to secure the desired bending moment diagram. Curves given in Figure 2 represent the vertical component of each cable tensile force. Such action of cables is required for an "intelligent system".

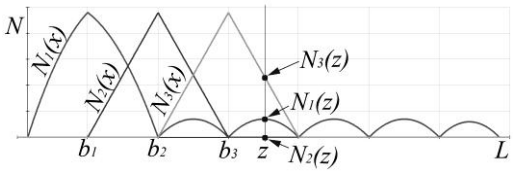

Fig. 2. The adjusting forces N_1, N_2 and N_3 of three side cables depending on location of point load P_0.

Analysis shows an important conclusion: the desired effect can be obtain with tensioning of only some cables without necessity to loosen any other which could lead to the complete exclusion of these cables (in case with relatively low value of permanent loads).

Considerations demonstrated in this paper enable economy of construction materials as well as improves the structural reliability by reducing stress and strain fluctuations in main elements of cable-stayed bridge.

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Construction Science

Heat, Gas and Water Technology

The Implementation of Building Envelopes with Controlled Thermal Resistance

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Keywords **– Indoor Air Quality.**

I. Introduction

Traditionally low energy buildings are supposed to have maximally big thermal resistance of building envelope. In reality, big thermal resistance is justified only in coldest winter days in countries with cold climate or in hot summer days with intensive solar radiation. In other periods buildings with full air conditioning would have to have different properties of building envelope that could allow heat flow in one or another direction.

Two building's components – the envelope and the air-conditioning system - have the major impact on building's energy efficiency. As a rule, the building's envelope is a passive element and the air-conditioning system is an active element regarding the possibility of regulation in order to ensure optimal indoor air parameters.

II. General Regulations

Suppose that in the room where the building envelope constructions have controlled thermal resistance R_0, solar radiation resistance R_s and vapour resistance R_v and there is air-conditioning system, it is necessary to keep constant temperature and moisture content in the work area. Also suppose that room has the heat and moisture production ($\Delta Q > 0$, $\Delta G > 0$), i.e., the direction of process:

$$\varepsilon = \frac{\Delta Q}{\Delta G} > 0 \quad (1)$$ air exchange rate 0 <m <1.

$$m = \frac{t_p - t_s}{t_e - t_s} = \frac{I_p - I_s}{I_e - I_s} = \frac{d_p - d_s}{d_e - d_s} \quad (2)$$

tI, II, dI – temperature, enthalpy and moisture content in the work area;

ts, Is, ds - temperature, enthalpy and moisture content in supplying air;

te, Ie, de - temperature, enthalpy and moisture content in exhaust air.

III. Energy consumption for air-conditioning systems with controlled thermodynamic properties of boundary constructions

In order to evaluate heat and cold consumption by air-conditioning systems the theoretical comparison of two rooms was done. One room has external elements with constant thermal resistance, solar radiation resistance and vapour resistance (R_0 = const., R_s =const. and R_v = const). The second room has external elements with changeable thermal resistance, solar radiation resistance and vapour resistance.

Point "S" characterizes the parameters of supplying air in rooms with constant R_0, R_s, and R_v. Area of the outside air changes in this case can be separated into 4 parts according to the working regimes of the air-conditioning system.

IV. Improving of air conditioning system using boundary constructions with controlled thermal resistance

There are four main temperatures that are usually distinguished in air conditioning. Two of them are widely used in all other calculations: the temperature of outside air t_e and the temperature of inside air t_i. Two others are connected to the thermodynamic processes in the air of inside space and may be higher or lower than inside and outside air temperatures [2]. These temperatures are: the temperature of supply air and temperature of exhaust air (Figure 1).

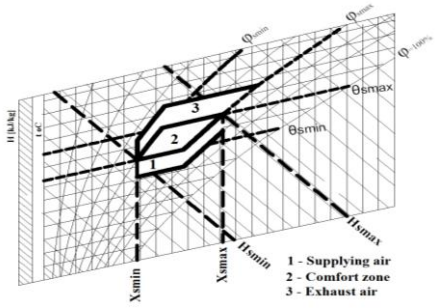

Fig. 1. Air parameters in air conditioning system

V. DISCUSSION

Some of the regulation decisions, such as shutters or solar reflectors, are known for generations. They are in compliance with the model described in the paper but they were known long before and without it. On the other hand the given algorithm shows all possible directions of technical development in order to minimize annual heat consumption of buildings.

At the present stage of scientific and technical development it is naturally to expect fast progress of technology toward the building structures with changeable characteristics. For example, even now it is possible to imagine inflatable buildings with changeable thickness' insulation air layers, or regulation of structures' vapor permeability by perforation with changeable dimensions.

Building envelope with changeable thermal resistance, solar radiation resistance and vapour resistance gives the possibility to reduce energy consumption by second heater and to reduce cooling loads.

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The Investigation of the Indirect Adiabatic Cooling Performance in Temperate Climate of Baltic States

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***Keywords* – indirect adiabatic cooling, cooling towers.**

Direct evaporative cooling strongly depends on the entering air conditions; therefore, it is the most efficient in regions which have a dry and warm climate. However, indirect evaporative cooling equipment combines the evaporative cooling effect in a secondary airstream with a heat exchanger to produce cooling without adding moisture to the primary airstream (1). B. Costelloe and D. Finn performed an experimental study in 2006 and stated that control strategy, and type of the building/ cooling secondary loop temperatures also have strong impact on indirect adiabatic cooling (IAC) energy efficiency (2). They got the best results in high – temperature-cooling systems within deep plan buildings.

The aim of the current study is to evaluate the effectiveness of IAC systems in temperate climate conditions of the Baltic States.

Recently restored building of the Riga Bourse was chosen as the subject of investigation. More than 150 years old building now is new-made and serves as an Art Museum. To preserve an artefact, the building is equipped with climate-control systems, where cooling is provided by IAC unit with compressor loop.

Fig. 1. The Art Museum Riga Bourse

To analyse the cooling system effectiveness, using adiabatic chillers' automatics and building management system (BMS) loggers, we were acquiring outdoor air, the unit power consuming, and primary cooling the loop temperature data for cooling period for year 2012. The information about electrical energy consumption, the water consumption and produced cooling energy allowed us to calculate chiller operation efficiency, and to compare it with water – cooled chillers.

Collected data and analysis provided us the basis for assessment of energy savings, which is very important to do the next considerations for similar projects.

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Airtightness Measurement Standards for Large Buildings

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***Keywords* – air leakage, standards, testing protocol, air barrier, large building.**

I. Introduction

Measurement and airtightness control of large buildings is for energyeficiency, proper operation of HVAC systems, required indoor air quality (IAQ) and fire safety. The article describes existing airtightness measurement standards and possibilities of their applying for large building airtightness measurement.

II. General Regulations

The first comprehensive standardized air leakage measurement method came from the Canadian General Standards Board or CGSB in 1980. What separated this standard from all those that come before it was that it was extremely detailed and left nothing to the imagination. For that reason it was widely adopted and used worldwide, especially in United States where the nationally based ASTM standard was not used because it left too much of the interpretation open to the user. For example, ASTM allowed any type of curve fit to be used as long as it was specified on the (false) assumption that the reader would be able to discriminate. ASTM also imposed tight weather restriction limits that force testing to occur within a narrow temperature and wind speed band. That is the reason why most states currently still use a CGSB-based standard test method. Recently the ASTM standard has been vastly improved where every detail has been meticulously laid out. It even has a working example in metric units which may have been an additional reason why the European norms standard, EN 13829 was essentially a direct copy of the updated ASTM. The UK standard (ATTMA) was modeled directly after EN 13829, except it went a good distance further when it came to spelling out the allowable air leakage values for different styles of buildings. Between standards, miniscule differences exist, like slightly different temperature or barometric pressure corrections, or slightly different reference pressures, but the results between all of them are within 0.5%.

All of these standards were based on a residential model and were not originally intended for large buildings in spite of the UK standard being used primarily for large buildings. In spite of a complex series of small insignificant corrections, which seldom amount to a difference of >1%, all of these standards seem to have missed the boat completely when it comes to creating a standardized test method that would be stable and repeatable. It is unfortunate that one global standard does not exist.

III. USACE Standard Review

The USACE standard was developed in 2008 by researchers group of U.S. Army Engineer Research and Development Center. The purpose of this research was to create an accurate and repeatable testing protocol for measuring the air leakage rate of the enclosing air barrier of any large building. Numerous tests were repeated on the same building to determine the appropriate test pressure range and number readings which must be taken to ensure an accurate air leakage measurement under typical weather conditions, to suit the requirements of the US Army Corps of Engineer's specified 0.25 cfm/ft^2 (3,95 (м^3/h)/m^2) at 75 Pa.

The USACE protocol for testing large buildings is based on the ASTM method as far as calculations are concerned. Since it was designed specifically for testing large buildings, it is the only standard where a concerted effort has been made to create repeatable readings over the widest possible range of weather conditions. The standard recognizes that an air leakage tester often has a very narrow time window in order to complete the test due to tight scheduling of job site activities. It is not possible in most cases to wait until the average wind speed drops below 5 mph (2.2 m/s), as ASTM insists, nor is it possible to perform the test between 45 and 95°F (7.2 and 35°C), as ASTM also insists. USACE protocol recognizes that large 5, 10, 15 and even 20% errors commonly result from a tester using a standardized method that was not robust enough to be used in unfavorable conditions. The USACE protocol has traded off some of the 0,5 and 1,0% errors in order to ensure that the 5 to 20% errors do not creep in to the measurement process. It has accomplished this task by taking numerous readings averaged over long time periods for both bias pressures (before and after) and building test pressure readings. It favors testing in both directions as a mandatory requirement and not optional as many other standards dictate.

TABLE I
Standards Comparision

Standard	ISO9972	ATTMA	USACE
Acceptable conditions	<6m/s, ΔT<500m°C	<6m/s, ΔT<250m°C	Bias<10% of min.test or <30% for both ways
Range	10 to 50 Pa	10 to 60 Pa	25 to 75 Pa
Number of points	5	7	12
Direction	Both (optional)	Both	Both
Results	(m^3/h)/m^2	(m^3/h)/m^2	CFM_{75}/ft^2
Required Result	N/A	2 to 10 (m^3/h)/m^2	0.25 CFM_{75}/ft^2

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Influence of Unconditioned Spaces on the Energy Efficiency Calculation of Buildings

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***Keywords* – energy efficiency, heat energy balance calculation, heat transfer, unconditioned spaces.**

I. Introduction

This study analyses the influence of assumptions of unconditioned spaces on the heat energy balance calculation model accuracy of non renovated standard residential buildings. In the Latvian legislation the accuracy demand of the heat energy balance calculation model is 10% and ≤10 kWh/m^{2}a. The current research is performed with financial support of ERAF, project realised by University of Latvia, Nr. 2011/0003/2DP/2.1.1.1.0/10/APIA/VIAA/041.

II. Methods

The heat energy balance calculation is done according to Latvian legislation norms (supported to the LVS EN ISO 13790:2008 etc.) and relevant methodological materials [1, 2]. For the calculations application EFA2 is used.

A. Equation

Unheated space together with its external construction adjacent to building can be obtained by correcting the thermal transmittance of constructions between the internal and external environment. For unheated spaces with non-insulated external envelope, simplified calculation procedure is given, obtained by treating the unheated space together with its external construction components as if it were an additional homogeneous layer with thermal resistance R_u. More precise calculation procedure requires the transmission heat transfer coefficient to be corrected with coefficient b_u.

The calculation of the temperature of unconditioned spaces uses the solar heat gains in and through the unconditioned space. Solar heat gains in the adjacent unconditioned spaces are included with coefficient b_u.

B. Assumptions for calculation models

The calculations of current research are made for the non renovated residential building of project type 464 [3], oriented with façade with loggias to the West. The assumptions of the building are following: 60% loggias are glassed; the outdoor temperature 0.0°C; indoor temperature 19.12°C; temperature of lobby 16.0°C.

The different assumptions of calculations are following:

calculation 1 – is used to validate the heat energy balance: solar heat gains in and through the unconditioned space are ignored; the transmission heat transfer between the internal and external environment through the unconditioned space is obtained by correcting the thermal transmittance of constructions between the internal and external environment;

calculation 2 – solar heat gains in and through the unconditioned space are included in the temperature of unconditioned spaces; the transmission heat transfer through the unconditioned space is calculated between the internal environment and environment of unconditioned space and the thermal transmittance of constructions between the internal and environment of unconditioned space is not reduced;

calculation 3 – the same as calculation 1, but solar heat gains are included;

calculation 4 – the same as calculation 2, but solar heat gains are included.

III. Results and analysis

TABLE II

The different parameters for calculations

Calculations number, building element	Factor	U_{iu}, W/(m^2·K)	θ_u, °C
Calculation 1, 3: Ceiling panel to roof space	Ru= 0.38	0.82	0.0 = θ_e
Calculation 1, 3: Glazing to loggia	b= 0.60	1.74	0.0 = θ_e
Calculation 1, 3: External panel to loggia		0.72	
Calculation 2, 4: Ceiling panel to roof space		1.20	6.7
Calculation 2, 4: Glazing to loggia		2.90	9.4
Calculation 2, 4: External panel to loggia		1.20	

TABLE III

Calculations results (with differences from calculation 1)

Calculations number	Q_T, kWh/m^{2}a (%)	Q_{sol}, kWh/m^{2}a (%)	Q_H, kWh/m^{2}a (%)
Calculation 1:	117.7 (100)	10.1 (100)	107.3 (100)
Calculation 2:	115.7 (-1.7)	10.1 (-0.0)	106.1 (-1.1)
Calculation 3:	117.7 (-0)	12.3 (+21.8)	106.1 (-1.1)
Calculation 4:	115.7 (-1.7)	12.3 (+21.8)	106.1 (-2.1)

To compare, if the indoor temperature is decreased by 1°C in the calculation 1, the needed energy for heating Q_H is decreased to 99.9 kWh/m^{2}a or about 7.4 kWh/m^{2}a (-6.90%).

IV. Discussion

To collect the calculations input data for the unconditioned spaces of not renovated standard residential buildings, comparatively large amount of time is needed. The difference between calculation results of the needed energy for heating is not significant. To increase accuracy and simplify the input data of standard buildings, united database is advisable.

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Supply Air Parameters Interaction on Thermal Performance of IEAC

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Keywords **– indirect evaporative cooling, IEAC, Indirect adiabatic cooling.**

I. Introduction

In an indirect evaporative air cooling (IEAC) installation air is cooled by means of adiabatic humidification process. By passing over an air/air heat exchanger this air cools the supply or mixed (supply and extracted) air. A clear interaction can be observed between the relative humidity and temperature of the supply air and the thermal comfort implemented in the building. To be able to predict the performances of this technique well, a good knowledge of the supply air relative humidity and temperature are thus important. Paper presents the results of measurements carried out in summers of 2008, 2009 and 2010 in a simulated nonresidential building in 3 cities of Latvia: Riga, Liepaja and Gulbene which make indirect evaporative cooling usable. An evaluation of the indoor summer comfort is made and the interaction between the thermal performance and outdoor air parameters (humidity and temperature) are investigated.

Work actuality is based on the Latvian Cabinet of Ministers regulation No. 534 Regulations Regarding Latvian Building Code LBN 231-03 "Residential and public buildings heating and ventilation" 118th paragraph, "If the air handling equipment for air cooling assess whether the compression cycle cooling techniques can't be replaced by a direct or indirect adiabatic cooling techniques to minimize the impact on the environment." Topic view and updating gives more understandable operating positive and negative aspects, which in turn give engineers new viewpoint to the evaporative cooling as the primary cooling type of General Regulations

II. Calculated and Measured Model

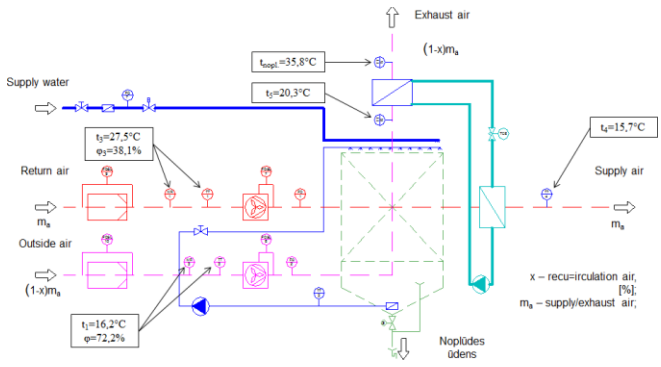

Fig. 1. Practical and calculated model of studied device

Place To validate the model; experiments were carried out in an air handling unit with indirect evaporative cooling which is installed to provide cool air in non-residential building in Essen, Germany. The installation for building was in operation since September 2010 and was dimensioned to a maximum air flow rate of 6,000m³/h. [2] Indirect evaporative cooling is operating around-the-clock The air handling unit consists of a polypropylene double cross flow heat exchanger with dimensions 1250mm x 1215mm x 997mm. The total heat exchange surface was approximately 300m² which results in an air flow rate of about 20m³/h per m² heat exchange surface.

All results are obtained by using measurement devices as shown in Figure 1 (TT- bulb, MR – relative humidity measurement device, etc.). At the return air side the air is ventilated between parallel plates while at the supply side distance holders are introduced in order to ensure stability of the parallel plates. The distance between the plates is approximately 5.1mm. [3] Both the supply and return fans are supplied with frequency control and their air flow rates are balanced. Water sprayers are placed at the top of the first part of the heat exchanger. The water is collected in a sump below and recirculated. Approximately every hour the system is replenished with fresh water to avoid problems e.g. with bacteria.

III. Conclusions

Calculations of feasibility index values in 3 cities of Latvia have been calculated. Data shows that difference 11°C between dry-bulb temperature and wet-bulb temperature is needed.

1D numerical model of counter-flow wet surface heat exchanger was developed based on the heat and mass balance of the supply and return air. Using a control volume method the outlet conditions of both supply and exhaust air can be calculated. The model assumes that the heat transfer resistance of both water film and plate are negligible and that the water film is stationary and continuously replenished with water. The model has been validated using measured data in a double cross-flow heat exchanger. The installation has been modeled assuming evaporation only takes place in the first part of the heat exchanger. The second and dry part of the heat exchanger was modeled using e – NTU correlation and linked behind the wet surface heat exchanger model in MS Excel. The supply air temperature and the return air temperature just behind the first part of the heat exchanger were in good agreement with the measured data. The model underestimated the temperature of the exhaust air because it does not take into account the fact that the return air is heated by the recirculated water in the second part of the heat exchanger.

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Influence of the River Bed Stratification on Scour Development at Engineering Structures

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Keywords- scour development in time, stratified river bed

I. Introduction

The scour at abutments of engineering structures with a stratified bed under steady and unsteady clear-water conditions was studied.

New methods for computing the depth of scour development in time and the equilibrium stage at engineering structures under stratified bed conditions are presented. Method is confirmed by tests results. The differential equation of equilibrium for bed sediment movement in clear water is used, and a calculation method for the scour development in time at the head of engineering structures in the stratified bed conditions is elaborated and confirmed by experimental data. This method allows one to calculate the scour depth in layers with different mean grain size, thickness, and sequence combination.

At a stratified river bed, the most critical conditions for structures occur when a fine-sand layer lies under a coarse-sand layer. Using the mean grain size on the top of the river bed for calculating the scour depth, neglecting stratification, can lead to wrong results and possible damages and losses.

II. Experimental Setup

The tests were carried out in a flume 3.5 m wide and 21 m long. Experimental data obtained in flumes in the open flow conditions are presented in Table 1.

TABLE 1.
TESTS DATA FOR OPEN FLOW CONDITIONS

№	L	h_f	V	Q	Fr	Re_c	Re_f
	cm	cm	cm/s	l/s			
L1	350	7	6.47	16.60	0.078	7500	4390
L2	350	7	8.58	22.70	0.010	10010	6060
L3	350	7	10.30	23.60	0.124	12280	7190
L7	350	13	7.51	35.48	0.066	13700	9740
L8	350	13	8.74	41.38	0.075	16010	11395
L9	350	13	9.90	47.10	0.087	14300	14300

The tests were carried out for different hydraulic conditions and uniform sands, with two layers and two mean size diameters, and their different sequence.

III. Method

The differential equation for equilibrium bed-sediment movement under clear water conditions at the head of engineering structure has the form:

$$\frac{dv}{dt} = \frac{3}{5}\pi m^2 h_s^3 \frac{dh_s}{dt} = a h_s^2 \frac{dh_s}{dt} = Q_s \qquad (1)$$

Using the Levi (1969) formula for the initial stage, sediment discharge upon development of the scour can be determinate as:

$$Q_{si} = A_i \cdot m h_s \cdot V_{lt}^4 = b \frac{h_s}{1+\frac{h_s}{2h_f}} \qquad (2)$$

where $B = mh_s$ = width of the scour hole; V_l= local velocity at the head of the guide bank with a plain bed; A = parameter in the Levi (1969) formula.

Taking into account and separating and integrating the variables yields:

$$t = D_i \int_{x_1}^{x_2} h_s \left(1+\frac{h_s}{2h_f}\right)^4 dh_s \qquad (3)$$

$$N_i = \frac{t_i}{4D_i h_f^2} + N_{i-1} \qquad (4)$$

where $N_i = 1/6x_i^6 - 1/5x_i^5$; t_i = time interval.

Calculating the value of N_i, we find x_i and scour depth:

$$h_s = 2h_f (x-1)\, k_m k_\alpha$$

where k_m= coefficient depending on the side-wall slope of the guide bank; k_α= coefficient depending on the angle of flow crossing.

To find the depth of scour in the second layer with a grain size d_2, we must know the local V_{lt} and critical V_{0t}velocities and parametersAi_2, Di_2, Ni_2, Ni_1, x_2 and h_s in the layer $H_{d2}$with grain size d_2.

IV. Conclusions

New methods for computing the depth of scour developing with time at engineering structures under stratified bed conditions is presented. The methods are confirmed by tests results.

The flow pattern at the head of the engineering structure was modified. It was found in the test that the flow velocities reduce almost to zero when approaching the bridge crossing construction and then gradually increase. At the head of the engineering structure, we observe the concentration of streamlines, a sharp drop in water level, and a local increase in the velocity. It is the local velocities near the engineering structure that form the scour hole.

Under stratified bed conditions, the sequence of the layers significantly affects the scour depth value. Depending on the sequence of layers, the critical velocity V_{0t} either increases, when the grains of the second layer are coarser, or reduces, when these grains are finer. The local velocity V_{lt} reduces more rapidly if the second layer has grains of a smaller size.

According to the results obtained in test sand by the method presented, the depth of scour is always greater when a fine-sand layer is under a coarse-sand layer(s).

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Heat Consumption Assessment of the Domestic Hot Water Systems in the Apartment Buildings

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Keywords **– heat consumption, domestic hot water (DHW), apartment buildings.**

I. Introduction

The Energy Performance of Buildings Directive (EPBD, [1]) in the version of 2010, demands that 'The energy performance of a building shall be determined on the basis of the calculated or actual annual energy that is consumed in order to meet the different needs associated with its typical use and shall reflect the heating energy needs and cooling energy needs (energy needed to avoid overheating) to maintain the envisaged temperature conditions of the building, and domestic hot water needs.' Usually apartment buildings have single heat meter for both heating and DHW in Latvia. Therefore if the calculation of energy performance of buildings is carried out, the energy use for heating, DHW consumption, circulation loop and others should be assessed separately. Analysis of the data helps to find the right solution to apply in case where the appropriate data are not available on evaluating energy performance of apartment buildings.

II. Methods

We have analyzed the heat energy consumption and water consumption in apartment buildings in Riga in the year 2011. Our aggregate information contained data on 39 buildings with 3167 households and total heated area of 158189 m^2. The total population on these buildings is 7139 inhabitants. Buildings were built from 1966 till 1988. Average area per person is 22.3 m^2. Buildings have 5 to 12 floors. Investigated buildings are connected to district heating network. All buildings has automatic heating unit equipped with the heat counters as well as hot and cold water meters. There is no separate heat energy accounting for heating and DHW. The average annual consumption of water in investigated buildings is 110.7 l per m^2 by month, of which 46.3 l per m^2 by month for DHW. To achieve the objective of the study we have analyzed data on DHW consumption and heat energy consumption on DHW system.

III. Results

The study shows that DHW yearly average consumption is 0.72 (range from 0.40 to 1.00) m^3 per m^2 of apartment's area, 33.86 (range from 20.34 to 52.04) m^3 per housing, 14.95 (range from 0.40 to 1.00) m^3 per person. The most accurate data on DHW consumption are per person. In addition the study shows that DHW consumption differs by season: 94% of yearly average consumption on non-heating period (May – September), 106% of yearly average consumption on heating period (November – March). Data on October and April are not taken into account because heating are started or stopped on these months. The specific heat consumption indicators are shown on Table 2. To determine the energy consumption for DHW consumption and DHW circulation loop, the study used data on energy consumption and DHW consumption on non-heating period (May – September).

TABLE 2. TOTAL HEAT CONSUMPTION INDICATORS.

	TOTAL HEAT YEARLY CONSUMPTION, MWH		
	PER M^2	PER HOUSING	PER PERSON
Minimum	0.164	5.90	3.36
Maximum	0.225	10.98	5.62
Average	0.189	9.47	4.24

Calculation results of heat energy average values per 1m^2 heated areas per month are shown in figure 6. Heat losses from DHW circulation loop on April and October are calculated by extrapolation.

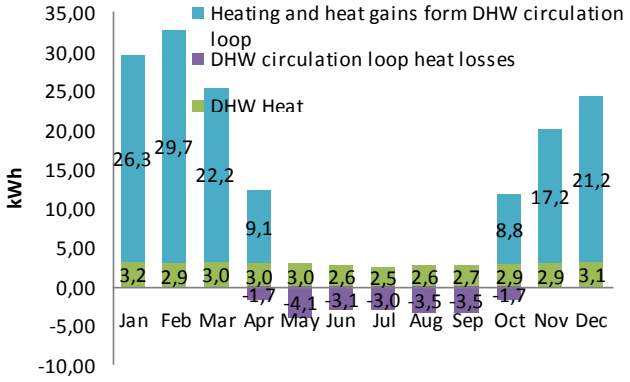

Figure 6. Heat energy average values per 1m^2 heated areas per month.

During the non-heated period average ratio of DHW circulation loop losses was 56% (ranges from 35 to 79%) from total heat consumption in investigated buildings. The DHW circulation losses in most cases range from 14 to 27 kWh per m^2 in investigated buildings. Average DHW circulation losses are 20.5 kWh per m^2 and 0.17 MWh per households. The evaluation of DHW circulation losses correlation to heated area and to number of households showed that more accurate data can be obtained from heated area.

IV. Discussion

The DHW consumption differs by season in apartment buildings with district heating in Riga. DHW consumption was 94% of yearly average on non-heating period (May – September). It should be taken into account on evaluation energy consumption of DHW system in buildings with single heat meter for both heating and DHW systems. In the case of lack of metered data on DHW consumption in apartment building, most accurate data can be determined based on number of inhabitants. In the case of lack of metered data on heat energy consumption, for evaluation of DHW circulation losses can be used average data kWh per m^2.

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Optimization of District Heating Facilities in Municipals

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***Keywords* – energy efficiency, cooling systems, heat absorption, heat evaporation pool.**

I. Introduction

The centralised heat supply system works according to a specific temperature schedule adapted to the changes in the external air temperature. The city boiler house works according to such a temperature schedule. The boiler house generally services not only tenement and private houses, but also to the office spaces, the utility consumers and often to the production facilities interested in heat absorption capacities for their cooling equipment during the summer. The purpose of this study is introducing a heat absorption system.

I.I. Purpose for increasing heat energy sales

Any heat production company's goal is to realize the greatest heat energy amount possible, it increases the company's turnover and profits.

One of the solutions for improving the efficiency of the centralised heat supply system might be introducing heat absorption systems in the centralised municipal heat supply system. In the summer period heat generation devices work with very low efficiency. In case of using absorption systems, there would be opportunity to use system capacity and produce heat with significantly higher efficiency. It would decrease fuel consumption on the produced energy unit, and increase the amount of heat energy sales, which in turn would reduce the expense of heat loss in distribution networks.

I.II. Heat evaporation pool as an alternative to a cooling tower

Heat conversion into cold energy takes place at heat absorption chillers. In order to contain a concentrated fluid, heat absorption facilities require a fluid super cooling cycle. The heat carrier temperatures within this cycle are usually low, such as 35-29°C. In order to ensure a temperature schedule for such a cycle, the manufacturer usually recommends building heat evaporation towers. For practical as well as aesthetic reasons, a heat evaporation pool may be used here, employing water sprinklers to boost cooling efficiency. Unlike an evaporation tower, which is an open system, a pool is a closed system, so a pool may also be installed inside residential areas such as cities, parks, parking spaces ect.

TABLE I

Pool Parameters

Basin surface area S	5 x 2.2 = 11m^2
Basin volume V	11 x 2 = 22 m^3
Basin temperature schedule	34 – 40ºC
Heat-flow cooler Q	3.20 m^3/h
Circulation pump productivity Q	3 – 7 m^3/h
Spray nozzle diameter F	0.01m
Basin heat consumption	59928.80 kJ/h

I.III. Pool's cooling properties

The experiment took place over the course of 104 hours. Measurements taken during the experiment:

- Temperature of hot (cooled) water (initial and final) in the heater,
- Mass, volume, feeding pressure, flow speed, throttle parameters, calculated droplet parameters, droplet area of cooling (sprayed) water,
- External air temperature, humidity, wind (flow) speed, direction, solar radiation (its characteristics),
- Distribution of water temperature along the vertical and on the surface of the water.

Sprayed water amount on cooled heat carrier:

$$Z = \frac{Vspr \cdot M \cdot c}{Qheat}; \quad Z = \frac{Vspr}{\Delta t} \qquad (4)$$

I.IV. Outdoor weather condition impact on cooling capacity

Heat flow intensity is a parameter indicating the operational capacity of the pool. Changes in heat flow affect the heat transfer ratio and change depending on external air parameters. During the experiment, heat flow in the cooler layer varied in small range. In turn, the flow of heat above the air/water contact plane is more significant and depends on variations in external air parameters. As the external air temperature increases, the intensity of removal of heat accumulated in the pool, along with the heat transfer ratio and the pool's cooling performance. The flow of heat above the air/water contact plane may be both positive and negative; in this case, the deciding factor is water temperature in the upper layer of the pool.

II. Conclusions

The pool may be used as effective cooling facility regardless of the impact of a number of external conditions. The pool can maintain a specific heat carrier temperature schedule given specific parameters.

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Characterization of Karst Springs in a typical Mediterranean fluvial landscape through an Interdisciplinary Investigation based on Radon-222 as an Environmental Indicator

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Keywords **– radon, karst springs, Groundwater/Surface water Interaction (GSI) processes.**

I. INTRODUCTION

Karst aquifers provide 25% of the overall drinking water resources to the world's population and sustain aquatic life in most fluvial systems, providing several ecological services to human beings, although, because of their complex links between surface and groundwater, turn out to be very vulnerable to contamination and pollution. Hydrological assessment of karst systems reveals to be extremely complex and difficult and requires a stepwise multi-tracers approach. This work describes some of the most relevant findings obtained from the implementation of an interdisciplinary approach based on the use of Environmental Tracers, consisting of Naturally Occurring Radionuclides like Radon-222 (referred to as Radon), for the investigation of Groundwater/Surface water Interaction (GSI) processes in fluvial water bodies [1]. In particular, Radon activity concentration measurement data having been collected from streamflow and instream springs during monthly field campaigns performed in a typical Mediterranean karst river basin: the Bussento river system (Campania region, Southern Italy) [2]. The general task has been to investigate the complex interactions and exchanges between streamflow and groundwater in a fluvial water body, at scales that are imperceptible to standard hydrological and hydraulic analyses.

II. CASE STUDY

The Bussento River basin has been chosen as a case study for the following features of extreme relevance: its location inside the Cilento and Vallo di Diano National Park, its inclusion of a WWF Nature Reserve, it represents a remarkable Drinking Water resource for the territory and last but not least its system includes Submarine Groundwater Discharges (SGD) to the Policastro Gulf. All these issues cause, therefore, that the management of its relevant water resources requires not only groundwater protection for domestic drinking use, but also riverine wildlife preservation and coastal water quality maintenance. As a support for hydro-geomorphological and hydrological modelling for planning tasks, in application of the European Water Framework Directive (EWFD), a Bussento River Monitoring System (BRMS) has been built, at basin, segment and reach scale.

III. MATERIALS AND METHODS

Experimental data about 222Rn activity concentrations, in addition to physical-chemical and streamflow rate, have been acquired and managed from BRMS selected stations, sampling the streamflow and inflow spring waters by means of the Radon-in-Air analyzer, RAD7, together with the Radon-in-water accessories, Radon Water Probe and RAD7H2O (DURRIDGE Co. Inc.), for continuous and batch sampling measurements, respectively [2, 3]. The analysis of the seasonal data trends from karst springs confirms the hydrogeological conceptual model, highlighting the complex behaviour of a multilevel groundwater circuits, the uppermost in caves, the middle in conduits and the lowermost in fracture network, corresponding to the differentiated recharge types in the fluvial-karst hydro-geomorphological system.

IV. DATA ANALYSIS AND RESULTS

The results obtained from different sampling campaigns have allowed to identify three "families" of springs, corresponding to the karst features of the analysed environment: fracture basal springs, conduit springs and cave springs [3]. A seasonal variability in radon activity concentration has been studied too (fig.3).

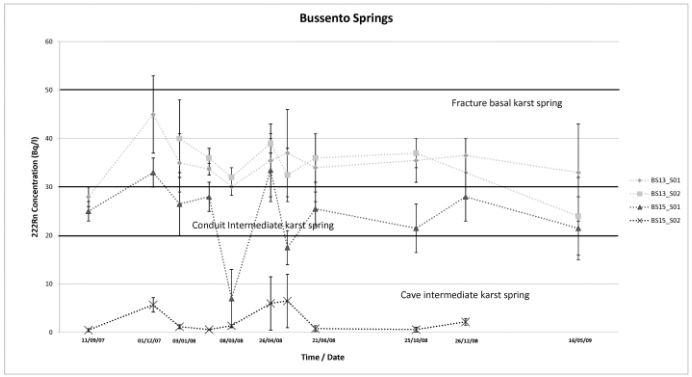

Fig. 3. Identification and seasonal variability of the three families of karst springs in the Bussento river basin.

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Local Scour Development at Engineering Structures during Multiple Floods"

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***Keywords* – scour, multiple floods, hydrograph.**

I. Introduction

The equilibrium, or temporal, stage of scour near hydraulic structures was studied by many authors, and for computing the equilibrium or temporal depth of scour, the discharge on the peak of the flood was used; it is not restricted in time for the whole maintenance period of engineering structures, but is time-restricted for temporal scour estimation. In field conditions, the scour is formed by multiple floods of different probability, duration, frequency, and sequence. The scour hole parameters (depth, width, and volume) during floods under clear-water conditions in the floodplain are summed up and increase from flood to flood.

Using the differential equation of equilibrium of the bed sediment movement in clear water, a method for calculating the scour development in time at engineering structures in river flow during floods has been elaborated. The agreement between the experimental and calculated results (Gjunsburgs & Neilands, 2004) allows us to use this method for computer modeling of the scour process in nature during floods with different probability, duration, frequency, and sequence.

II. Method

The differential equation of equilibrium for the bed sediment movement in clear water conditions was used and the method for computing the scour development with time was elaborated. According to the method, the relative scour depth at the hydraulic structures depends on the following dimensionless parameters: the contraction rate of the flow, kinetic parameter of the open flow, kinetic flow parameter under the bridge, Froude number of open flow, Froude number/slope ratio, relative grain size of the bed material, relative depth of flow, relative local velocity, steady or unsteady flow conditions, relative depth of scour developed during the previous time, stratified bed conditions, as well as the time, probability, duration, frequency, and sequence of the multiple floods, sediment transport conditions, shape of the structures, slope of the wall side, and the angle of the flow crossing.

To determine the scour depth development during the multiple floods, the hydrograph was divided into time steps with different duration, and each time step was divided into smaller time intervals. For each time step, the following parameters must be determined: the water depth in the floodplain h_f; contraction flow rate Q/Q_b, where Q is the discharge of flow and Q_b is the discharge in the bridge opening under open-flow conditions; the maximum backwater Δh, grain size d_i; thickness H of the bed layer with d_i; the specific weight γ of the bed material. As a result, we have local velocity V_l, local velocity V_{lt} at calculated scour depth h_s, critical velocity V_0, and critical velocity V_{0t} at calculated scour depth h_s, and h_s at the end of time intervals and finally at the end of the time step. For the next time step, the flow parameters were changed because of the flood and because of the scour developed during the previous time step.

III. Results

A computer modeling of the time-dependent scour during multiple floods with different probability, duration, frequency, and sequence was performed. Results are presented in figures and tables.

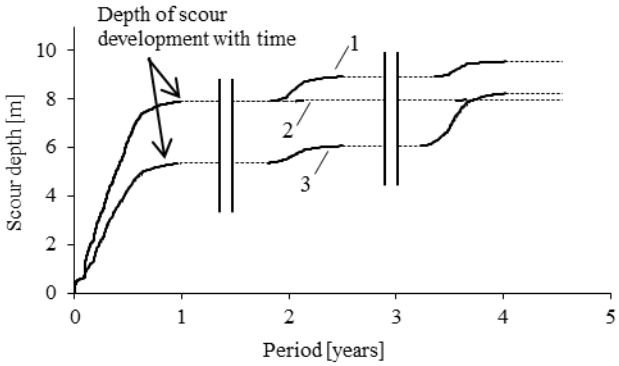

Fig. 7. Scour development with time for floods of different sequences

As seen from Fig. 7, scour development varies for floods with different sequence. Curve 1 presents scour development of the sequence of three floods of the same probability. Scour depth increases from flood to flood and sums up. Scour develops insignificant after the first high flood, if it is followed by two lower floods (Curve 2). However scour depth achieves higher value if two lower floods are followed by the high flood (Curve 3).

Modeling of multiple floods with different duration, probability and frequency shows the influence of them to the scour development with time.

IV. Conclusions

The differential equation of equilibrium of the bed sediment movement in clear water was used to elaborate a method for calculating the scour development in time at engineering structures during multiple floods. It was found that, with a less probability, increased duration and frequency of the floods, and certain sequences of different probability, the scour depth at the abutments increases. Proposed method allows computing the development of scour during expected usual or extreme flood events varying with flood probability, frequency, sequence, and duration at the stage of design or in maintenance period of the river engineering structures. Thus the most dangerous scenario of expected floods for engineering structures can be found in advance, to take necessary protection measures.

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The Effect of Chlorination on *Escherichia coli* Viability in Water Supply Networks

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***Keywords* – Water chlorination, *Escherichia coli*, Chick – Watson, Viability.**

I. Introduction

The most often used drinking water disinfection technique in developed countries is chlorination which has shown to be effective against a wide variety of pathogenic microorganisms, easily applicable and low cost. The principal factors that influence disinfection efficiency are disinfectant concentration, contact time, temperature and pH.

The effectiveness of disinfection is commonly determined by monitoring cultivable coliforms and *Escherichia coli*.

The kinetics of *E. coli* inactivation is usually described by Chick-Watson first order equation: $\log (N/N_0) = -kC^nt$, where N/N_0 is the ratio of survived *E. coli* at time *t*, *C* is the disinfectant concentration, and *k* and *n* are empirical constants.

The CT factor is defined as the product of the residual disinfectant concentration, C in mg/l, and the contact time T, in minutes when residual disinfectant is in contact with the water.

Classical identification of viable *E. coli* is based on its ability to form colonies on solid medium. However, these methods are time-consuming (usually a minimum of 24 h of incubation is needed) and it has been estimated that in oligotrophic conditions *E. coli* can be found in viable but not cultivable (VBNC) state when cells retain all their metabolic activity, e.g., respiration, enzymatic activity, but are unable to form visible colonies on nutrient rich media. Therefore, in addition to classical cultivation other methods such as direct viable count method (DVC) and cell metabolic activity measurements (5-cyano-2, 3-ditolyl tetrazolium chloride, CTC) have been used in this study, to assay the physiological state of *E. coli*.

The CTC method determines the cell respiratory activity and is a direct indicator of oxidative metabolism as well as viability. CTC is a colourless, membrane-permeable compound that produces a red-fluorescing precipitate in the cell when it is reduced by the electron transport system (ETS) of the cells.

The DVC method is based on the incubation of samples with an antibiotic (nalidixic acid for *E. coli*) and nutrients (yeast extract) [5]. The antibiotics prevent cellular division and elongated cells are enumerated as able to divide *E. coli* cells.

The objective of this study was to assess the effect of chlorination on *Escherichia coli* viability using three *E. coli* identification methods: 1) plate count (cultivable); 2) metabolic activity and 3) direct viable count method.

II. Materials and Methods

E. coli ATCC®25922 was used as an indicator microorganism for faecal contamination and microbial standard to evaluate the inactivation performance and disinfection efficiency.

Experiments were performed at pH 7 at 20°C. Inactivation kinetics was studied for 1h (30s, 1, 5, 10, 30, 60 min) after *E. coli* was inoculated into sterile (buffered) water containing sodium hypochlorite (HOCl) at different concentrations - 0.05; 0.1; 0.2; 0.5 and 5 mg/l as free chlorine. After treatment all samples were immediately quenched by adding 0.3 ml of 0, 02 M sodium thiosulfate ($Na_2S_2O_3$). Free chlorine levels were determined by the DPD colorimetric method. Each experiment was performed in triplicate.

Cultivable *E. coli*

The number of cultivable *E. coli* was estimated using the plate count technique. The determination of cultivable *E. coli* was carried out following a standard decimal dilution procedure and inoculated in TBX medium (Oxoid Ltd., UK) and incubated four 24 hours at 37˚C. The results were expressed as colony forming units (CFU) per milliliter.

E. coli metabolic activity

The samples were incubated on an orbital shaker (200 rpm) with nutrient and CTC (5-cyano-2,3-ditolyl tetrazolium chloride, Fluka, BioChemika) with a final concentration of 4 mM for 2 hours in the dark at room temperature (about 20°C). Then samples were filtered and stained with 10 μg/ml DAPI (4',6-diamidino-2-phenylindole, Merck, Germany) for 10 minutes. Metabolically active cells were visualized and counted with epifluorescence microscopy.

Direct viable count

Each sample was incubated with 0.5x Tryptone Soya broth (TSB) (Oxoid Ltd., UK) and 10 μg/ml nalidixic acid for 6 hours at 30˚C on an orbital shaker at 200 rpm. Then samples were filtered, stained with DAPI and visualized with epifluorescence microscopy.

III. Results

The results showed that first *E. coli* lost its cultivability then ability to divide and finally its metabolic activity. Results are shown in table 1.

TABLE 1
CT VALUES FOR VARIUS VIABILITY STATES OF *E. COLI* FOR 99% INACTIVATION BY SODIUM HYPOCHLORITE AT pH 7 AT 20°C

Viability state	CT value (mg/l min^{-1})
Cultivability	0,064
Ability to divide (DVC method)	0,35[a]
Metabolic activity (CTC method)	12,76

a. Values for 90% inactivation

The obtained results showed that traditional faecal indicator – *Escherichia coli* which is regarded as very susceptible to chlorination can survive for much longer periods than it is assumed when its metabolic activity, not cultivability is evaluated.

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Methodology and Results of Water Infiltration Evaluation in River Catchments of Different Lithuania's Geomorphological Regions

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***Keywords* – River catchment, infiltration, lithology, lizimeter.**

I. Introduction

The precipitation affects the groundwater resources and is responsible for substantial changes of water balance in river basins. The rainfall water infiltrating the groundwater discharge is responsible for water volume in large and small rivers, amounts of groundwater and interstitial water and their safe yields. Infiltration of precipitation depends on the lithological composition of sediments. It is determined by analysis of geological and geomorphological maps and material from the boreholes in the studied areas, if needed. The data from boreholes also is informative about the groundwater table and chemical composition of infiltrated water. The aim of the present investigation is to work out methodical principles for evaluation of groundwater quantitative fluctuations based on the methods of empirical observation and cartographic analysis.

II. Materials and Methods

Quantitative groundwater assessment was based on evaluation of a few environmental components in the small river basins (precipitation, evaporation, discharge, surface relief, deposits and land use structure). This kind of assessment employs empirical formula defining the quantitative values of the mentioned components). Regional and local features of the small river basins are an important factor. Unfortunately, their determining often is a problem.

The amount of precipitation in basins was evaluated in a few aspects: quantity, duration, intensity and frequency. The evaluations were based on the interpolated and extrapolated data from the closest meteorological stations. It is rather problematic to evaluate the amount of effective precipitation predetermining the factual water supplies of river basins. For this purpose one must be aware of the extent of retention an interception. Besides, evaluation of evaporation in the small river basins requires individual field investigations.

Infiltration properties of surface deposits are an important factor predetermining the groundwater supplies. Large-scale (1:10 000) lithological and soil maps are helpful for evaluation of deposits.

The precipitation infiltration conditions are predetermined by horizontal and vertical distribution of surface forms in river basins. Surface inclination is one of the main indices affecting the infiltration of rainfall water. Even a small slope angle accelerates the direct downslope runoff of rainfall water and reduces its infiltration.

Land use structure is one of the anthropogenic factors that predetermine the infiltration conditions in a basin and affect retention and interception of precipitation. The land use structure is evaluated using topographic maps at a scale 1:50 000 and digital databases.

In 1960–2011, the infiltration conditions and dynamics related with climate oscillations were investigated in the different sizes basins of Lithuania (Fig. 1). The influence of the annual amount of precipitation and one long intensive rainfall on formation of water supplies was evaluated. During the investigation, the climate data from the meteorological and hydrological stations, lithological, soil and topographic maps and digital databases were used.

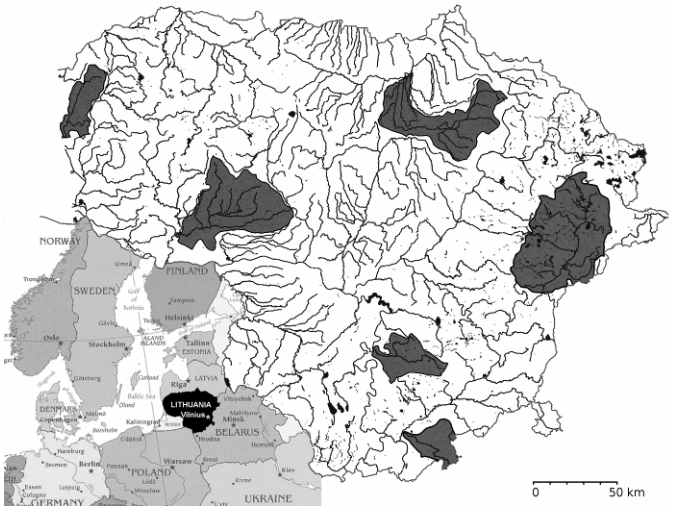

Fig. 1. Catchments of studied rivers.

III. Conclusions

The most intensive infiltration of rainfall water takes place in the basins with dominant glaciofluvial coarse grained deposits. Generally the sandy sediment infiltration coefficient concluded to 6.2 m/day.

The direct surface runoff and low infiltration conditions were mainly determined in the river basins of loamy sediment. Infiltration coefficient of loamy sediment concluded to 1.3 m/day.

The changes of direct surface runoff and infiltration conditions were mainly predetermined by the changes of land use structure in the investigated river basins and especially by the expansion of the urbanized areas.

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Research of Nutrients Migration of Aeration Zone of Latvia and Lithuania Rivers Banks in Spring

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***Keywords* – water quality, surface water, biogenic substances, lysimetric station, sediments.**

I. Introduction

The negative impact of agricultural pollution with biogenic materials on surface water bodies is a relevant problem. The biogenic materials are carried by surface or groundwater runoff. Water infiltration is influenced by the lithological composition of sediments. River basins of sandy sediment structure were selected throughout the territory of Lithuania and Latvia. An installed system of lysimeters in the boreholes allowed monitoring the change of water quality of sediments over time. The migration patterns of nutrients where identified during the investigation in the spring seasons.

II. Materials and Methods

Sandy river banks of Kekava and Dursupe basins with typical sand lithology structure were chosen for the research in Latvia, Ūla and Žeimena in Lithuania (Fig. 1). The authors state that the main migration of nitrogen and phosphorus occurs by water, which filters through sediments; meanwhile transformations depend on the amount of oxygen and acidity within the environment. All these parameters can be assessed in the borehole. The lysimetric type of a borehole was chosen for the empiric groundwater level and quality analyses. At research sites, boreholes were positioned perpendicularly to the river bank and at a 3, 5, 10 and 20 meter distance away from the river bank (Fig. 2). Boreholes were drilled down to the surface of ground water to facilitate sampling of the top layer horizon of ground water. To collect samples of water that filters down through the aeration zone, lysimeters were installed in boreholes.

Fig. 1. Catchments of studied rivers.

Initial lysimeter reservoirs were installed at 0.1 m depth from the ground surface with others following with every meter down to the surface of ground water. For laboratory tests, infiltration from reservoirs was sampled twice in spring seasons of 2012 in Latvia and 2010-2012 in Lithuania.

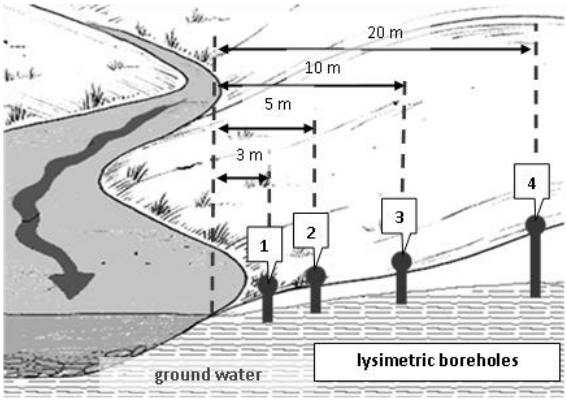

Fig. 2. Situation of lysimetric boreholes on the bank of the river.

III. Conclusions

Identified melting snow and precipitation washes nutrients down into sediments in March, when frozen ground melts out.

It was ascertained that reduction in concentrations of ammonium ions is directly dependent on increase of the sediment infiltration coefficient.

Transfer of nitrate was determined on the surface and ground water from the fields to the river. No consistent patterns were found in changes of nitrite ions at any of the research sites.

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Determination of Microorganism Growth Potential in Water Supply Systems by Flow Cytometry

Alina Nescerecka[1], Kristina Tihomirova[2], Janis Rubulis[3] (*Riga Technical University*)

***Keywords* – flow cytometry, growth potential, total cell count, water quality.**

I. Introduction

Human pathogens in the water are heterotrophic organisms, they consume organic matter as an energy source. Organic carbon, nitrogen and phosphorus in the water often act as limiting factors for bacterial growth and the changes in the microorganism count can be considered as an indication of poor water quality [15]. Microorganism growth potential shows if water parameters influence bacterial growth in number. Positive values of microorganism growth potential show, that water chemical composition and current physical condition of water support the growth of microorganisms. This concept is also connected with biological stability of water and AOC (assimilable organic carbon) method [15]. The presented method was modified in order to make water microbiological analyses more rapid, easier and much more precise.

The method of flow cytometry is presented in this study as an alternative, which can be used to determine cell concentration in water samples from the water supply system and also determine the microorganism growth potential.

The aim of this study was to determine microorganism growth potential in drinking water samples using flow cytometer.

II. Materials And Methods

Samples were collected in sterile carbon-free glass bottles. One part of the samples was taken directly from water treatment plants (WTP), which had different water sources – surface water, groundwater and artificially recharged groundwater, and consequently treatment methods. The other part of the drinking water samples was taken from the water distribution network (WDN), and the sampling points were also selected by water source used.

Each sample was analyzed using flow cytometry and fluorescent microscopy within 4h after sampling. For determination of microorganism growth potential water samples were divided into 100 ml glass bottles and cultivated at 37°C - a favorable temperature for human pathogens. Samples were analyzed using flow cytometry and fluorescent microscopy after 24 and 48 h in triplicate. Microorganism growth potential was calculated as changes in the total cell number after 48h comparing with initial microbial concentration.

Samples were stained with 10 µl/ml propidium iodide (PI) and SYBR Green fluorescent dyes mix and incubated 15 minutes at room temperature before measurement [6]. Citometric analyzes were performed using Partec CyFlow® SL flow cytometer equipped with 488 nm blue solid-state laser. Green fluorescence signals were collected in the FL1 channel (480 ± 20 nm) and red fluorescence in the FL3 channel (520 nm). FloMax software was used to record the signals and data acquisition. FL1/FL3 dot plot was used for data interpretation. Injection speed was 3µl/s and the event rate was always below 1000 cells/s.

III. Results And Discussion

Results are displayed in the table I. Obtained data shows that microorganism growth was observed only in the WDN samples. This could be explained with a decrease of drinking water quality in the distribution network. Growth potential with negative value was considered as zero. Despite the fact, that surface water is more contaminated in nature than groundwater, it has lower microorganism growth potential. The highest increase in cell number - 2.1 x 10^5 (76% from initial concentration) was observed in a WDN sample, supplied with groundwater. And the lowest was the sample with >98% of surface water – only 5.04 x 10^4 or 52% from the initial cell count. The reason of this outcome could be in water treatment, as surface water undergoes an adequate and complicated treatment, whereas groundwater is only disinfected by chlorination.

TABLE I

Microorganism growth potential in different water samples

Water sample	Microorganism growth potential, cells/ml	Microorganism growth potential, %
WDN, >98% surface water	50400	52%
WDN, 100% groundwater	210000	76%
WDN, 85% surface water, 15% groundwater	93500	59%
WTP, surface water	-6650	0%
WTP, ground water	-10600	0%
WTP, artificially recharged ground water	-24500	0%

IV. Conclusions

Microbial quality of water is good in the effluent of the water treatment plants.

Deterioration of water was observed during the water distribution in the network.

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Assessment of the Level of Security of Gas Supply: Example of the Baltic States

Indra Niedrite (*Riga Technical University*), Andra Jesinska, Namejs Zeltins, Adrians Davis.

Keywords **– security of gas supply, N-1 indicator, risk scenarios.**

I. Introduction

In the light of the increasing European concern over security of gas supply, the main emphasis is put on the increase of the security by creating the incentives to invest in necessary interconnections to meet the N-1 indicator (so called infrastructure standard). Since cooperation between Estonia, Latvia and Lithuania - the interconnected, but isolated from EU gas market countries, can enhance their individual and collective security of gas supply the joint risk assessment of security of gas supply of Estonia, Latvia and Lithuania was carried out. The joint risk assessment challenges existing security of supply indicator and places an emphasis on having a detailed understanding of a region's specific gas supply set up, the structure of its gas consumption, policies in place designed to mitigate the effects of a disruption and, in particular, on applying the method of risk scenarios.

II. Assessment of security of gas supply level

The share of gas in the Baltic region's overall energy mix is around 26%; however, the role of gas in the countries is different. All three Baltic countries are fully dependent on gas imports from the same main supplier, Gazprom OAO as the current infrastructure does not physically allow gas purchases from another source than Russia.

Three Baltic countries are interconnected and in the Baltic gas supply system gas is received through two pipelines from Russia and Belarus and in winter from the Incukalns underground gas storage (UGS).

The N-1 indicator means assessment of the situation in the event of disruption of the single largest gas infrastructure delivery connection. If in the event of interruption it is possible to rearrange deliveries without any supply disruption, the N-1 criterion is met.

Examining each Baltic State separately only Latvia with 153.85% meets the N-1 criterion. Considering all three Baltic countries as a whole in the event of a disruption of the single largest gas supply infrastructure - natural gas supply line Minsk–Vilnius, the N-1 indicator is 129.73%. Although N-1 indicator's calculation shows that in the event of the largest capacity disruption the capacity of the remaining infrastructure of the Baltic States should be able to satisfy total gas demand, risk scenarios drawn up in the joint risk assessment of security of gas supply of Estonia, Latvia and Lithuania demonstrate that there will be gas shortage in the region due to internal bottlenecks.

Three types of scenarios were applied:

- Risk causality scenarios;
- Risk impact scenarios;
- Response scenarios.

Risk causality scenarios serve to describe the possible ways of errors that lead to a gas supply disruption. The task of a risk impact scenario is to describe the variety, scope, gravity and area of influence of potential consequences of the unwelcome event if it occurs. Response scenarios, for their part, reveal the capability of the system to react properly in the cases of a variety of unwelcome events.

The risk scenarios revealed that the main bottlenecks in the Baltic gas supply system are the capacity of metering stations on the borders as well as the Incukalns UGS facility send-out capacity in the spring which could entail a gas shortage in the region during the different gas supply disruption cases.

In order to summarize the results of the comprehensive analysis performed by means of risk scenarios the matrix of Baltic gas supply disruption risk was created. The scale of probabilities of the matrix has been selected based on the event probabilities obtained in the risk scenarios. The scale of consequences has been divided into four segments of assessment of severity: losses to gas supplier; losses for gas consumers; harm to the environment; danger to human health and life. The matrix of gas supply disruption risk facilitates serves as a basis for the development of recommendations for enhancing the safety of the Baltic regional gas supply system. The following measures have been considered important for the Baltic States:

1. Improvement of operation safety, increase of injection and withdrawal capacities of Incukalns UGS;
2. Increase of Kiemenai gas metering station capacity to 12 mcm per day and construction of necessary connection. Construction of a new gas pipeline "Riga-Vilnius" ;
3. Construction of reverse connection for Karksi gas metering station and increase of capacity to 10 mcm per day;
4. Construction of connection transmission pipelines "Iecava – Liepaja", "Panevezys – Klaipeda", "Riga – Daugavpils" and "Vilnius – Visaginas".
5. Hydraulic calculation software for management and supervision for gas transmission network system;
6. Construction of regional LNG terminal.

III. Conclusions

The empirical analysis performed with the help of risk scenarios shows that the level of gas supply security in the region cannot be evaluated based only on the N-1 indicator which mostly takes into account external factors. Since there is also considerable internal risks e.g. the capacity of region's internal cross-border gas metering stations, risk scenarios or similar methods of risk analysis have to be used to evaluate the level of security of gas supply.

The matrix of gas supply disruption risk provides a clear summary of all results of the applied risk analysis and ensures the development of appropriate recommendations to mitigate the risks.

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Influence of a Regional Factor on a Fuel Choice for CHP Plants Using RES"

Tatjana Odiņeca (*Riga Technical University*)

Keywords **– CHP using RES, Sustainable Energy Community model.**

I. Introduction

To reach the long-term goals of Energy Politics of Latvia, as EU member country, it is solved to use the potential of cogeneration with common heating load about 300 MWth in Latvian big cities and 100 MWth in other Latvian cities until 2016, as well as to stimulate the development of CHP plants using renewable sources of energy (RES) [1].

One of the most important advantages of CHP is a possibility of usage of different local energy resources for energy producing. Latvia has a characteristic centralized power supply system, which means inhabited areas have sufficiently high heat loads to accommodate installation of an efficient cogeneration facility. Sustainable Energy Community Model [2] adopted for Latvian circumstances allows to analyze all types of energy resources and other factors of examined region, to work out the plan of region's energy development (both short-term (2-3 years) and long term (till 2020)) and management of its realization.

SEB model applying includes deep examination of local renewable energy sources, especially the analysis of biomass receiving potential and biomass production possibility. While units of woodchips production are situated in all Latvian territory with quite regular intervals and good system of roads can provide the delivery of wood fuel to all Latvian regions, biomass is a fuel which needs to be used possibly closer to the place of its producing. Potential of biomass production depends on fertility of the earth, which considerably varies in different regions, therefore costs of biomass receiving are different as well.

Costs of fuel component (gas produced of biomass) necessary for establishment of CHP plant can be designated as I_{bm}:

$$I_{bm} = I_{\Sigma} - I_{st} \quad (1)$$

where:

I_{Σ} – total costs of CHP plant (including producing of biogas);

I_{st} – costs of plant technological equipment.

I_{bm} includes the full volume of agricultural works (sowing and harvesting, amortization of agricultural machinery, etc.) The lower is the fertility of earth, the bigger area of earth is necessary for cultivation of biomass. Costs of earth processing can be accepted equal in different regions, though in fact in less fertile regions these costs can be higher, because of processing problems resulting with higher consumption of fuel and more expenses on machinery amortization.

There is observed practical example of calculation of biomass costs for CHP plant. The costs of biomass producing make the big part of the total costs of fuel for CHP plant and price of produced energy [3]. In the example there were calculated the costs of biomass producing in fertile region and in region with 50% less fertile earth. The costs of biomass in less fertile region are 42% higher in comparison with costs of biomass cultivated in fertile earth.

Accepting that there is no big difference between chosen technologies of CHP plants (from the point of efficiency), choice of fuel can change because of difference of biomass costs. The research demonstrates the meaning of regional factor while estimating possibilities of biomass usage in CHP plants.

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Evaluation of Effectiveness of Proportional Pressure Control of Variable Speed Centrifugal Pumps in Water Supply systems

Deniss Pilscikovs and Egils Dzelzitis (*Riga Technical University*)

Key words: **control, efficiency, proportional, pump, water supply.**

PUMP EFFECTIVENESS EVALUATION TOOL IF PROPORTIONAL PRESSURE IS USED IN COMPARISON WITH CONSTANT PRESSURE CONTROL IN WATER SUPPLY SYSTEMS

Nowadays, more attention is paid on the improvement of energy efficiency level.

About 20% of the total electrical energy produced in the world has been consumed by pumps and pumping systems and almost half of that can be saved up [1].

Centrifugal pumps in water supply system are normally controlled via constant pressure [2]. The proportional pressure control mode is the most efficient mode of the control for booster pumps in water supply systems. Thus it's very crucial to estimate the potential reduction of energy consumption, if the proportional pressure control is used in comparison with constant pressure control.

Usage of the proportional pressure control in public water supply systems can crucially influence the total efficiency and reliability level of the system in a positive way.

The proportional pressure control is generally recommended to be used in the systems where the total pressure drop is mostly dedicated to the piping system [3]. Thus the proportional pressure control is advisable to use in water supply systems with relatively long piping network.

In order to analyze the consumption of electrical energy, if the proportional pressure control with different deviations from head value of duty point at zero flow is used, the load profile of the pumping system should be taken into account.

It has been assumed that annual operation of pumping system is 3285 hours and the load profile [3] is divided into five parts with different flow values: 100%, 75%, 55%, 35% and 12% of flow rate in duty point [1].

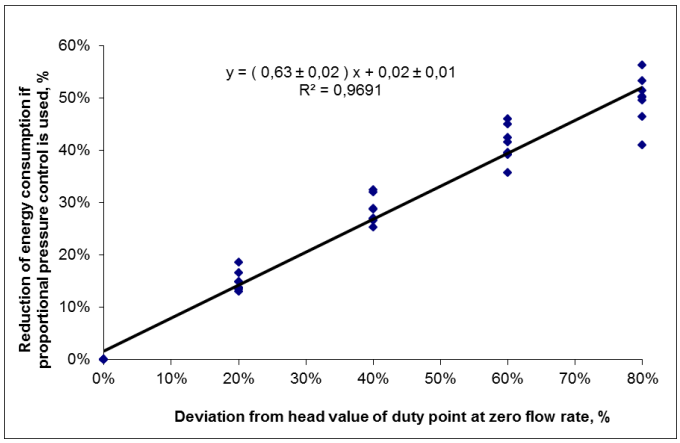

Fig. 1. Reduction of energy consumption, if calculated the proportional pressure control with different deviations from head value of duty point at zero flow rate is applied (in comparison with constant pressure control)

Each flow component corresponds to certain duration of pump operational time in the following way [3]:

100%-5%,
75%-9%,
55%-14%,
35%-27%,
12%-45%.

The energy consumption, having realized a variety of the proportional pressure variants, has been compared with the energy consumption if constant pressure control is applied.

During the analysis of the calculated proportional pressure control with different deviations (20%, 40%, 60% and 80%), there has been carried out the calculation of annual energy consumption for centrifugal pumps in the research (Fig. 1.).

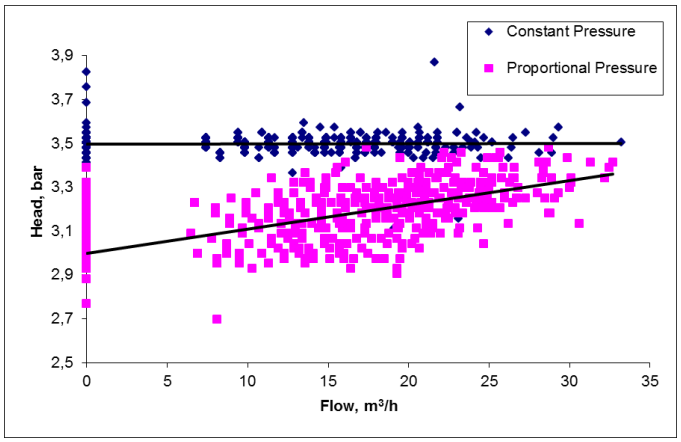

Fig. 2. Measured flow and head values if the proportional and constant pressure control modes are used

The regression equation of linear trend type and the respective coefficient of determination have been derived.

The equation can be used as a tool for evaluation of the potential reduction of energy consumption at different deviations from head value of duty point at zero flow. The potential reduction of energy consumption is estimated in comparison with the usage of constant pressure control, if the value of duty point remains invariable.

Having realized the theoretical analysis using the estimation equation, it has been found that consumed energy reduction is up to 11,5%, if the deviation from head value of duty point at zero flow is 15%.

Making experimental analysis with the measurement of flow and head (Fig. 2) as well as energy consumption, it has been found that the consumed energy reduction is up to 10,5%.

The error is 8,7%.

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Analysis of Indoor Air Quality in Primary Class of New School Building

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Keywords **– indoor air quality, class ventilation.**

As a research object was selected one of the schools in the Riga region where recently built a new school building. This is the new school's corps for primary school for pupils from class 1 to 4. The new school building was described- new architectural quality, array's building, insulated, with new heating and ventilation systems. Measurements were performed in the second year of operation in the winter. The main objective was to measure the indoor air quality parameters- air temperature and CO_2 level.

During the measurements were taken into account class capacity, the number of hours in the day, the hour, also analysis the teacher's and pupils' role model, taking into account

their knowledge of indoor comfort.

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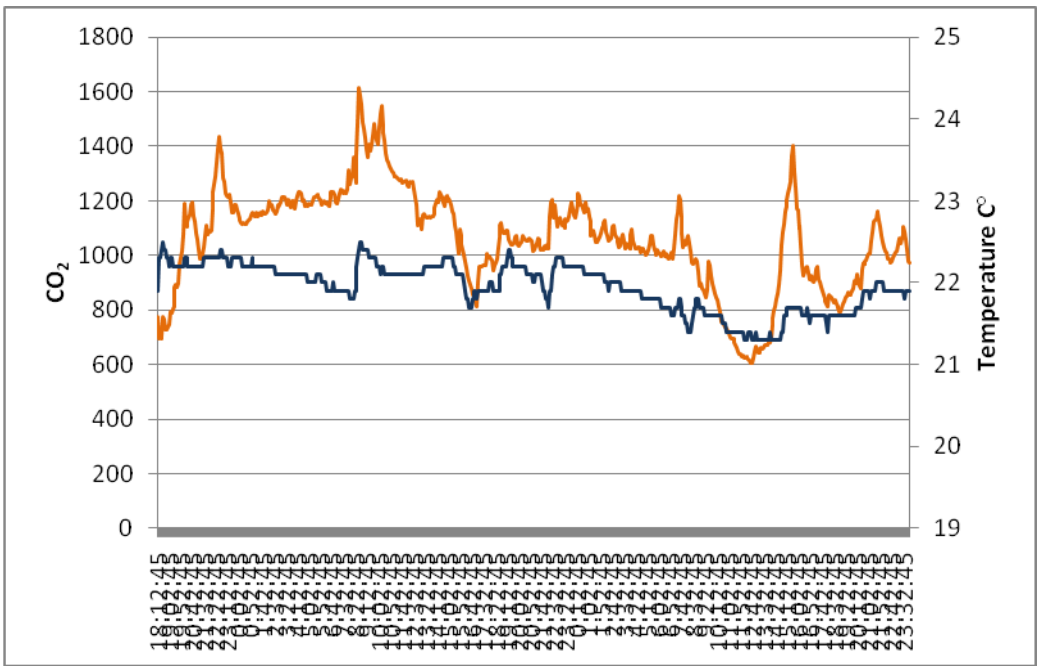

Fig.1 Temperature and CO_2 measurements in primary class of new building of school.

Limitations for Supplied Air Velocity and Draft Rate in Humans' Occupancy Zone

Aleksejs Prozuments (*Riga Technical University*) and Anatolijs Borodinecs (*Riga Technical University*)

Keywords **– Indoor air quality, humans' comfort, air velocity, draft rate, supply air diffusers.**

I. INTRODUCTION

Good indoor air quality requires sufficient amount of air to be supplied and well distributed within a space. The velocity of supplied air should be kept at a level which ensures that the mixing is effective, but at the same time ensures that the air velocity has fallen to the required level by the time it reaches the occupied zone in order to prevent occupants from being exposed to local discomfort caused by draft.

II. METHODS

The general value which characterizes the human comfort level is draft rate (DR). ASHRAE 55:2004 defines DR value as "predicted percentage of people dissatisfied due to annoyance by draft". DR is quantified by following equation

$$DR = \left((34 - t_A) \cdot (v - 0.05)^{0.62}\right) \cdot (0.37 \cdot v \cdot T_U + 3.14) \quad , \quad (1)$$

where t_A is local air temperature (°C), v is local average air speed (m/s) and T_U is local turbulence intensity (%). ASHRAE stipulates in Standard 55:2004 that DR must be <20% and air velocity must be <0.2m/s to meet the requirements for B category single-office room.

Four types of air supply diffusers (plain, perforated, swirl, nozzle) were tested to determine the air velocity and draft level at variable flowrate. The tests were performed at certified aerodynamics laboratory in specially designed test chamber which represented single office room. 24 probes were installed in humans' occupancy zone (feet, waist and head area of a standing occupant) to measure air velocity and air temperature. The supply air temperature was kept 8K lower than ambient air temperature. Data was measured and reported every 20 seconds over the period of 2 minutes so that any fluctuations and deviations in average result were excluded.

III. RESULTS AND DISCUSSION

Table 1 shows an overview for specific diffusers in terms of draft risk (ASHRAE 55: 2008) and noise level, which should not exceed 35 dB with regards to requirements for B class single office room (CR 1752: 2008).

TABLE I

COMPARISON OF DIFFERENT DIFFUSERS (∅ 160 MM)

	Flowrate range (l/s)	Plain diffuser	Perforated diffuser	Nozzle diffuser	Swirl diffuser
1	5 – 10	Draft	Draft	Draft	Draft
2	10 – 15	Draft	Draft	Draft	Draft
3	15 – 20	Good	Draft	Good	Draft
4	20 – 25	Good	Draft	Good	Good
5	25 – 30	Good	Draft	Good	Good
6	30 – 35	Good	Draft	Good	Good
7	35 – 40	Good	Good	Good	Good
8	40 – 45	Good	Good	Good	Good
9	45 – 50	Good	Noise	Good	Good
10	50 – 55	Good	Noise	Noise	Noise
11	55 – 60	Noise	Noise	Noise	Noise
12	60 – 65	Noise	Noise	Noise	Noise
13	> 65	Noise	Noise	Noise	Noise

At the flowrate range where diffuser performance is indicated as "good" the values for air velocity, draft rate and noise level are below those as stipulated in related standards. Figures 1 and 2 quantitatively display the maximum v and DR value out of 24 at given flowrate.

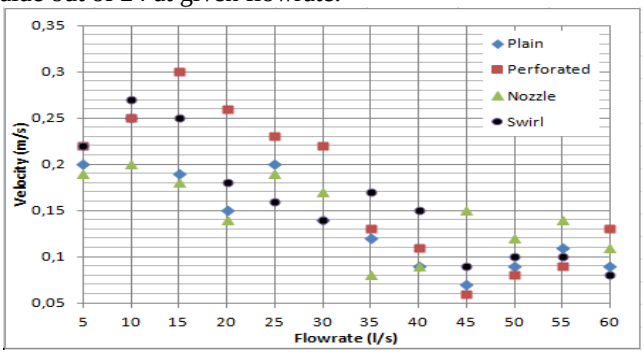

Fig. 1. Test results for air velocity values using different diffusers (Δt = 8K).

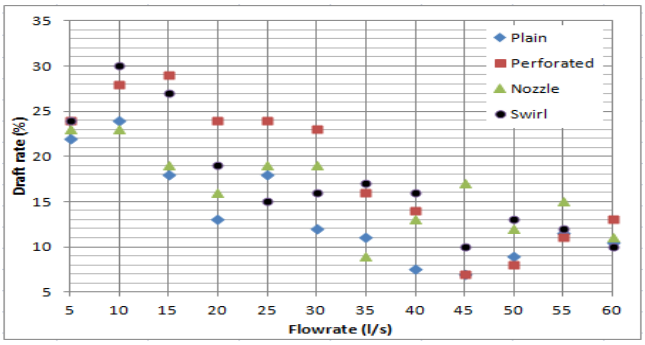

Fig. 2. Test results for draft rate values using different diffusers (Δt = 8K).

Test results showed how applicable are specific diffusers (∅ 160 mm) at variable flowrate. Plain and nozzle diffusers create lower air velocity and draft rate in occupancy zone (Fig. 1, fig. 2). The stable air distribution pattern establishes at 15 l/s and continues to the certain flowrate value which significantly exceeds noise level threshold (Table 1). Swirl diffusers have nearly the same characteristics at high flowrate, however at low flowrate (5 – 15 l/s) humans are exposed to discomfort. Perforated diffusers are not applicable to be used at particular conditions due to extremely short range where all requirements are complied. Perforated diffusers are recommended when warmer air is supplied or at low-impulse supply conditions when contaminated air needs to be displaced by clean air.

Although this article provides technical information on air supply diffusers with 160 mm diameter, the overall study showed similar correlations for other sizes. The acquired data can also be used in ventilation systems which are operating at variable air volume (VAV) mode to determine the optimal operating range for air supply diffusers.

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Ceiling Panels Radiant Heating Systems

Jelena Psenicnaja (*Riga Technical University*)and Andris Kreslins (*Riga Technical University*),

Keywords **– radiant heating ceiling panels, radiant and convection heat flow.**

I. INTRODUCTION

Radiant heating ceiling panels with low temperature heat carrier were chosen as an object of theoretical evaluation and experimental tests. To understand system's working outlines is important for us to show percentage ratio of radiant and convection heat flow in the heated area. Proposal of destratifacators usage for warm air of upper indoor air layers of the heated area to heat the area additionally was described. The experimental polygon is one of industrial buildings, where production of building construction prefabricated components modules are planned to be done, for production process heavy machinery transport is necessary. The building is meant for a warehouse and production areas. This plant is situated west part of Latvia territory, in Tukums. According to the technical design radiant heating panels were installed to compensate heat losses of the plant and heat amount required by ventilation system for afterheating of supply air. Heat carrier inlet temperature parameters were defined as 40-55^{0}C. This type of radiant panel is used for heating as there is topside insulation on the panel. Partial sensible load of a panel can be controlled by the supply water temperature. Panels are situated in different zones that could provide convenient regulation if indoor air temperature.

II. METHODOLOGY

All the values of for theoretical evaluations such as heat losses of the building, heat carrier supply temperature and as also constructive parameters are shown in the publication. The characteristic values and correspondent coefficients of the experimental polygon are shown, based on formulas mentioned in the theoretical part of the case study the evaluation has been made and results are presented.

III.RESULTS AND DISCUSSION

Gained results can serve as material that will assess availiable variety of heat energy consumption decrease in terms of heat carrier in transmission from heat channel to room where temperature is controlled. Difference between effective panel surface temperature and indoor design temperature of a heated space mostly effects on the convective heat flux. Percentage ratio of the convective heat flux is in range from 58.91% to 63.63% with heat carrier supply temperature range from 37 to 55 °C.

In practice radiant and convective heat fluxes have not been measured in details, but smoke tests have been performed. Lightened roofing farms allow air to spread across all the building, not concentrating in one separate section of roofing.

To improve the situation destratificators are proposed to be used. These devices are designated for destratification of the air for industrial areas with high ceiling height to lower useless consumption of heat. Blasting grid is design allow to change air deflation angle in dependence on installation height and required comfort level. Destratificator design is aimed achieving maximal effectively of the system, by aspirating air from areas under the roof and direct it to the work zone.

Measurement instrument was installed in the industrial plant for period of a week. Black ball thermometer measured radiant temperature, while the installed thermometer was put to measure indoor air temperatures and relative air humidity.

The graphical information indicates that during only one day the outdoor air temperature ranged from -13°C to 0°C and heating system with heat carrier temperature 45°C successfully managed to provide indoor air designed temperature. These conditions allow using heating source economically, which provides a positive effect. In Latvia in March and October, as well as partly in April, September and November traditional heating system with high heat carrier inlet temperature mostly does not work on a full capacity, it is switched on and off periodically, which is not effective, as system is heated and cooled down completely. As mentioned period of the year is about 30% of all heating season, economical effect could be impressive.

IV. CONCLUSIONS

In conclusion it must be mentioned that having the experimental data, we managed to estimate theoretically radiant and convective percentage ratio. The temperature difference between the heating panel surface temperature and the temperature of the building envelope is the main value influencing on the range of percentage for radiant heat flux. Smoke tests showed "warm air pillow" effect spreading across all the building due to lightened roofing farms, destratificators are proposed to be used to improve the situation. Taking into the account that sharp changes of outdoor temperature are typical of transient season, economical effect of low temperature heating system's usage could be impressive. The positive effect is possibility of using natural resources as an energy source, as for example ground heat pump could provide required temperature for heat carrier inlet without additional heat up.

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Methods and Problems of Natural Gas Filtration

Mg.sc.ing Pavels Skackovs (*Riga Technical University)*

Keywords **– filter, cartridge, pressure drop, pollution,magnet.**

I. FILTERING FOR NATURAL GAS NETWORKS

If the gas has been correctly purified when it is introduced in the network and in the arrival nodes of methane ducts for transportation, upstream the regulating and/or metering installations a ‘’safety’’ filtering system is necessary to filter in general:

- Residuals of solids that may be present because of maintenance works or actions on the network caused by micro flaking of pipes (i.e iron oxides)
- Traces of water vapour as residual of hydraulic tests for upstream effective separation.

Traces of oil can be occasionally detected in inlet gas regulating installations due to leakage from compressors in compression and restart stations.

II. GAS FILTER CLASIFICATION

Filters can be classified based on the system they operate.

For GAS – SOLID systems

- Mechanical gravity filters
- Mechanical inertia filters
- Centrifugal force filters
- Hydraulic filters
- Sieve filters
- Electrical filters

For GAS – LIQUID systems

- Condensation filters
- Coalescence filters
- Absorption filters
- Inertia filters
- Centrifugal force filters

In all Europe the biggest quantity of gas filters are cartridge filters.

Two basic requirements are requested from user for cartridge filters installed in regulation and/or metering installations, and they are:

1. High reliability to removal of undesired well – defined contaminants (retention power)
2. Long operating life of filtering compartments for operating economy (dimensioning and selection of constructive type of cartridges)

III. PROBLEMS DURING THE NATURAL GAS FILTRATION

The main problem which take place with the natural gas filter, is the pollution of the filtation cartridge. The main indicator of the gas filter pollution is the pressure drop. The maximal pressure drop can reach even 800 mbar, but usually even on 400 mbar pressure drop filtration cartridge must be replaced.

Poluted gas filter can course the following problems for the natural gas network:

1. Flow decrease
2. System outlet pressure decrease
3. Boiler or cogeneration station power decrease
4. Equipment life term decrease
5. Ofter service of gas system network and the replacement of the gas filter cartridge
6. Expenses increase

IV. USING OF THE MAGNETIC FIELD DURING THE NATURAL GAS FILTRATION.

More then the 50% of the pollution which stay in the gas filters is the metallic parts which came to the gas filter from the upstream.

As it is possible to see, there is no magnetic filters mentioned in the gas filter classification.

Author of this work think that if before the usual cartridge filter place the special equipment whith the magnet, it will help to reduce the pollution of the filter downstream and prevent the problems mentioned before.

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Influence of Thermal Insulation on Solar Thermal Systems Efficiency

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Keywords **– Renewable Energy; Solar thermal systems.**

I. Introduction

Annual global solar radiation is lower in Baltic countries region in comparison with other European countries where solar collectors are more common. And outdoor air temperature range is below average values in Europe. This creates the need for solar thermal system optimization in Baltic countries region. Determination of regularity of the main factors which could influence STS productivity is necessary for STS optimization.[2].

II. Methods

Heat losses in different parts of STS change with weather condition. For quantification of these effects, computer simulations are necessary. POLYSUN was used for determination of annual productivity of solar collectors and quantity of heat losses from thermal conductivity coefficients of the single component of the STS. POLYSUN is dynamic simulation program specified for the STS.

The weather condition data from "solar energy testing polygon" was integrated into the program with an hourly resolution. Solar energy testing polygon is located at the Institute of Physical Energetic in Latvia. High accuracy measuring equipment was used for weather data collecting. Global solar radiation was detected with CMP3 and CMP21 pyranometers. Outdoor air temperature was measured with PT100 resistance thermometer. Period of data collection is 4 years, from 2008 to 2011. A lot of results data from dynamic simulation program were analysed with the table calculation programs.

III. Results and Discussion

The biggest heat losses of STS are from solar collectors. It is necessary to determinate regularities between solar collector field yields and η_0, c_1 and c_2 solar collector coefficients in each particular region.[1] It is necessary to determinate this regularities according operation of the solar collectors in the whole STS for determination of accurate solar gross heat gain. Then the characteristics number of η_0, c_1 and c_2 will be the criteria for comparing the qualities of different collectors.

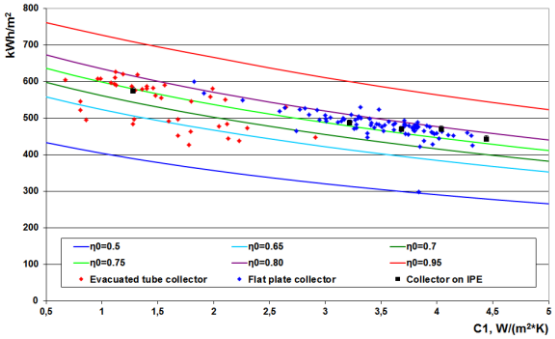

Fig. 1. Regularities of c_1 and solar collector annual field yield, taking into account η_0.

The fig.2 shows results of STS simulations with different η_0 and c_1 solar collector coefficients. The results with different type of solar collectors were also displayed at fig.2. There are popular flat plate and evacuated tube solar collectors with Solar Keymark testing certifications. Results show that field yield is from 420 to 530 kWh/m^2 per annum for flat plate, and from 450 to 610 kWh/m^2 per annum for evacuated tube solar collectors. c1 is about from 0.8 to 2.4 W/(m^2*K) for evacuated tube solar collectors, and about from 2.6 to 4.3 W/(m^2*K) for flat plate solar collectors.

Dispersion of η_0 for evacuated tube collectors is more than for flat plate solar collectors. This is probably because of evacuated tube solar collector manufacturers pay more attention on solar collectors thermal conductivity than optical transmittance. The results show that booth parameters have relatively big effects at solar collector field yield.

The results of solar collectors testing on solar energy testing polygon are displayed at fig.1 with black points. These solar collectors were tested in real weather condition. The some nominal parameters of STS on solar energy polygon are different from nominal parameters of STS in simulating program. Therefore quantity of solar collector produced energy lower by 1.8% at solar energy polygon than in simulation program.

The efficiency of the same solar collectors is lower in Baltic country region in comparison with other European countries where solar collectors are more common. Mostly it is lower because of higher thermal losses of solar collectors.

IV. Conclusions

Heat losses are higher in Baltic countries region in comparison with other European countries where solar collectors are more widespread.

Solar collectors productivity dependence from the η_0 solar collectors optical efficiency, c_1 linear and c_2 quadratic heat loss coefficient of solar collector was determined for Baltic countries region. This gives the possibility of comparing the quality of different collectors in according to weather condition in Baltic countries region by using characteristics of η_0, c_1 and c_2.

V. References

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Method to Investigate Effects of Indoor Climate on Energy Consumption and Productivity in Offices

Galina Stankevica (*Riga Technical University*), Andris Kreslins

***Keywords* – Air conditioning, employee productivity, energy consumption, office buildings.**

I. Introduction

Most of people in urbanized countries spend about 90% of their lifetime indoors, from which many spend their working hours in office buildings. Therefore it is very important to create and maintain a healthy, comfortable and productive work environment that majority of building occupants will find pleasant and stimulating to stay and work in. Effects of indoor environmental quality on employee productivity and performance are well established in literature [1]. Even though investigation of combined effects of energy use, indoor climate and office work performance was carried out in several studies, including [2], further justification and quantification of costs for maintaining optimal indoor conditions for maximized employee productivity are necessary. This paper presents graphic-analytical approach to investigate the effects of indoor climate on energy efficiency and productivity with respect to costs for maintaining optimal indoor air conditions in office buildings.

II. Methodology

Thermodynamic analysis of air conditioning processes is performed using statistical data for outdoor temperature and relative humidity, measured at a meteorological station in Riga (Latvia) during 2010. The economic evaluation is based on introduction of coefficients describing the price of heating and cooling energy and consumption of water, expressed as heat energy.

III. Results and Discussion

The possible working regimes of ventilation system, presented on the h-x diagram, including combinations of frequencies of outdoor temperature and relative humidity, are shown in Fig.1.

Optimal productivity zone, having highest relative performance, includes rectangular area confined by lines of indoor air temperature from 21-23.0°C and RH of 30-60%.

In Zone I, the desired set-points of temperature and RH can be achieved, first by cooling the air, and consequent heating after the condensation process. When outdoor air parameters are in Zone II, it is possible to achieve desired values for optimal productivity through the process of air heating. In Zone III, it is possible to achieve a required temperature set-point first by air heating, followed by humidification process. In Zone IV only humidification is required to reach set-points. If the outdoor air condition corresponds to values in Zone V, it is better to start with air cooling and then humidification process. In the latter case, it is always cheaper to cool air to a higher temperature, and therefore it is better to start exactly with cooling process.

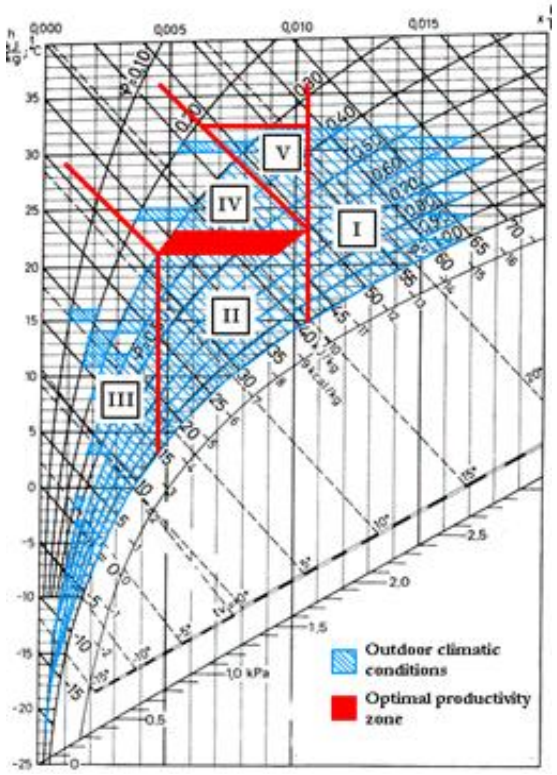

Fig. 1. Latvian climate parameters and ventilation system operation regimes in the h-x diagram.

Outdoor climate deviation from the optimal indoor air condition increases energy consumption and decreases the total profit.

IV. Conclusions

The maintenance of optimal indoor air conditions throughout the entire year is not economically viable, and allowance for deviation of temperature and humidity should be considered during certain periods, especially in cold and humid climate. The proposed approach was developed for typical office building in Latvia and can be used for optimization of operation of air handling equipment, and determination of maximum economically viable capacities of heating, cooling and humidification equipment, using profit as a criterion.

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Outdoor Climate Data for Building Energy Calculation

Galina Stankevica (*Riga Technical University*) and Andris Kreslins

Keywords **- Energy, humidity and temperature, HVAC systems.**

I. Introduction

Building energy performance as well as operation of heating, ventilation and air conditioning (HVAC) systems is directly affected by outdoor climatic conditions, indoor climate and building characteristics. Several methods (e.g. degree day) are available for energy analysis and estimation of energy demands, differing in complexity, amount of ambient condition data that needs to be taken into account, time increment used for calculations, detail of description of the building etc. [1]. Accurate and reliable ambient data are very important for building energy analysis. The changes in bio-climates in different climates and their implications for the built environment were studied [2] and it was found that generally decreasing trends of cold stress and increasing trends of heat stress, indicating higher energy consumption for cooling in the future.

II. Methodology

For this study the outdoor temperature and relative humidity data for Riga was obtained from Latvian Environment, Geology and Meteorology Centre. Since the data was provided as three hour averages, hourly values were further determined by interpolation principle for further estimation of cooling degree days, and analysis of trends in outdoor climate.

III. Results and Discussion

A. Outdoor climate

Combinations of temperature and relative humidity for year 2010 expressed in hours and calculated for 06:00-18:00 schedule which represents typical operating regime for air handling unit in an office building, are given in Fig. 1.

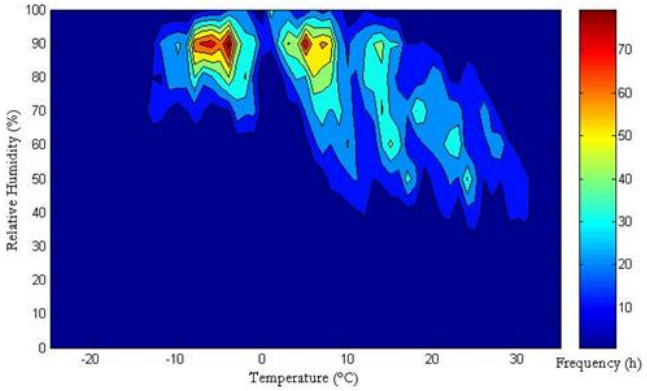

Fig. 1. Frequencies of outdoor temperature and relative humidity combinations.

Outdoor climate in Latvia is rather cold and humid. During 2010, the outdoor temperature varied between -23.1°C and 31.9°C, and the relative humidity was in a range of 21-99%. The most frequent combinations of temperature and RH in 2010 were as follows: temperatures about -5.0°C and +5.0°C and RH 80-90%. The RH was rarely below 30%. Data provided in Fig. 1. could be further used for economic evaluations regarding the necessity of conditioning the outdoor air. For example, when making decisions whether to keep a desired room set-point or allow it to deviate during certain 'extreme' outdoor conditions, which last just a couple of hours.

The mean outdoor temperatures calculated for period 2001 to 2010 were as follows: 15.8°C, 19.3°C and 18.2°C for June, July and August, respectively. Thus, the latest tendencies indicate generally higher mean temperatures in Riga than provided in existing Latvian climatology norms developed for building engineers.

B. Degree days

Calculation of heating or cooling degree days (CDD) or hours (CDH) is currently one of the most commonly used steady-state methods in HVAC industry to describe the effect of outside air temperature on building heating/cooling energy consumption. In the degree day method it is assumed that energy demand for a building is proportional to the difference between the mean daily temperature and a base or reference temperature. Comparison of CDD and CDH expressed as days is showed in Fig. 2.

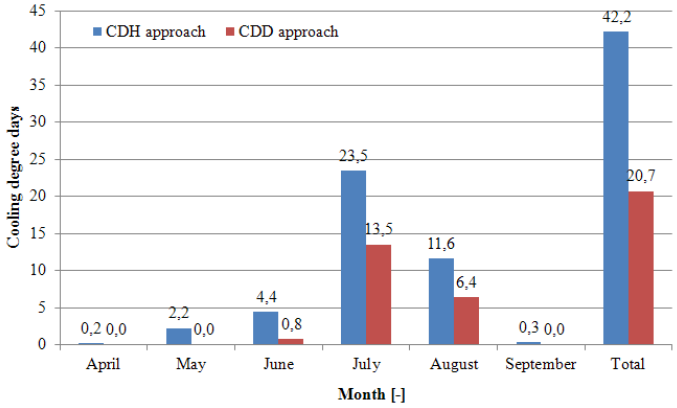

Fig. 2. Calculated cooling degree days and hours expressed as days for the base temperature of 22°C.

When using CDH method in calculations, some cooling would be required also during April and September months. The total number of CDDs is almost 50% higher compared to calculations using CDHs approach, and therefore it is suggested to use cooling degree hours method when estimating energy consumption for cooling.

IV. Conclusions

This paper presents processed outdoor climate data for Riga, Latvia, applicable for energy management in buildings, with respect to HVAC systems.

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Improving the Heat Transfer of Batch-Fired Straw Boiler

Klāvs Vagoliņš *(Riga Technical University)* and Guntars Frīdenbergs *(Riga Technical University)*

Keywords **– Batch straw boilers; efficiency improvement; straw boiler, biomass boiler.**

I. Introduction

Use of straw for farm heating system purposes is growing, as it reduces farmers' dependence on fossil fuels and associated costs, instead of creating a practical and environmentally friendly alternative fuels. In addition, they always have access to cheap fuel. Much of the farmers annually produce enough straw to ensure their heating systems with fuel. However, if they would have to buy straw, it usually pays off, as part of the agricultural straw waste is to be somewhere is to be exercised or converted into compost.

II. Description of Boiler

Object that the researches are based on is classical round bale straw boiler, which is used for producing heat energy to provide temperature regime in greenhouse. Greenhouse is used for growing vegetables here in Latvia that are being sold in Latvian market.

The research object has a classical assembly installation where all system water is circulating through the accumulation tank to reduce temperature differences, so the heat exchanger is heating up all the amount of water in the accumulation tank. The accumulation tank has a huge heating surface of 45 m3 so it's not so energy effective. But this assembly still has a drastic temperature differences which are not acceptable.

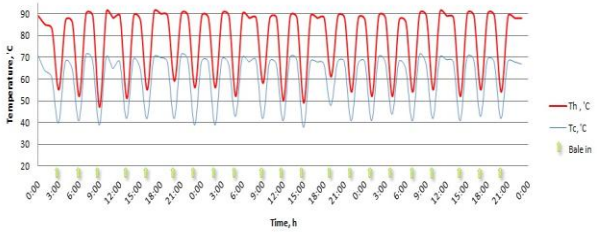
According to the problem of temperature differences it's necessary to improve the classical assembly installation system to reduce fluctuations of temperature.

Boiler is able to operate for long periods at a steady mode. Critical are moments of time when a "portion" of straw is burnt out, and while the other is inserted into the furnace and until the furnace starts working at a nominal capacity. These time instants, last up to 20 minutes, which means that the accumulation tank has to ensure temperature uniformity of heating circuit for only 20 minutes.

The solution is following; during the time when the boiler is being burnt, the circuit is heated up directly from the boiler's heat exchanger. At the same time, separate accumulation tank with a relatively small volume is heated up through the flue-gas economizer and the door of boiler's furnace. The volume of this accumulation tank ($20m^3$) is smaller than the one that's used in classical assembly installation and has small heat transfer surface. The boiler is not usually used with a nominal capacity, which results in excess heat energy, thereby economizer with the help of this energy is returns the heat to accumulation tank.

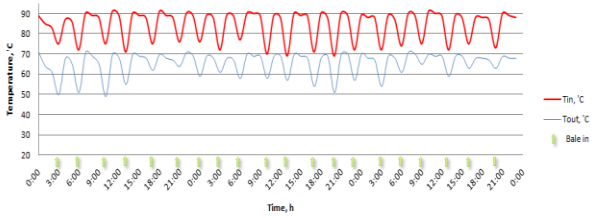
At a time when the furnace filled up with the next "portion" of fresh straw, temperature in the heat exchanger begins to reduce and the sensor gives an impulse to the boiler's control system to switch direction of 3-way valves and to start using the heat accumulated in the tank. When the furnace is burning again and the temperature of the heat exchanger reach the required operating temperature, sensor dives an impulse again to boiler's control system and 3-way valves are switched to the standard mode.

III. Results



T_h, °C – temperature of flow water;
T_c, °C – temperature of return water;
Bale in – time when fresh 2 bales are inserted.

Fig. 1. System temperature regime before improvements



T_h, °C – temperature of flow water;
T_c, °C – temperature of return water;
Bale in – time when fresh 2 bales are inserted.

Fig. 2. System temperature regime after improvements

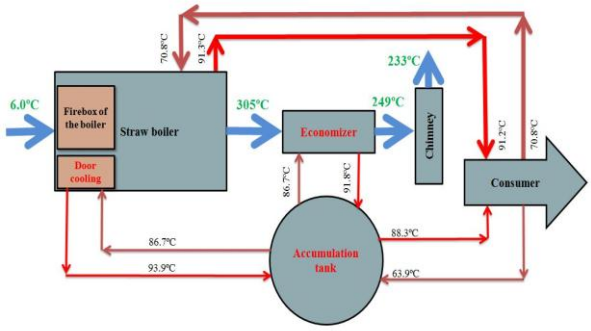


Fig. 3. Heat production process.

IV. Conclusion

There's one more way to improve the existing system. It's possible to increase diameter of the heating main pipes so that one could reduce system resistance and to increase a naturally insulted accumulation volume. This solution will be viewed in further researches.

V. References

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Optimisation of the Heating Period according to the Calorific Characteristics of the Building

Andris Kreslins *(Institute of Heat, Gas and Water Technology, Riga Technical University)* and
Valdis Varavs *(Training centre JSC "RIGAS SILTUMS").*

With the application of centralised heat supply systems to ensure heating, appropriate attention is not always paid to individual calorific properties of apartment houses. In Latvian cities and other settlements the heating season begins due to administrative decisions, which makes it difficult to ensure the comfortable temperature in facilities connected to the heating system when the outside air temperature falls below the building equilibrium temperature. Similar problems also emerge upon termination of the heating season. Usually, the buildings connected to the single centralised heating system are constructed at different times and their time of construction may vary by 50 or more years, but the building enclosure structures are designed in accordance with the heat engineering requirements prescribed during construction. With rising costs of energy resources, there has been a gradual increase in heat stability requirements for building enclosure structures. In normative documents governing construction, the permissible heat transfer coefficient U [W/m^2 K] value for building structures has been gradually reduced and with the use of even more efficient insulation materials in construction, options for the reduction thereof are not exhausted. During the last 30 years, Latvia has experienced a fourfold reduction in the heat transfer coefficient permissible in the design of residential buildings. Currently, available insulation materials are easy to handle for thermal insulation of in-service buildings and in the light of rising prices for energy resources, heat insulation measures are cost-effective for owners of the buildings. Through performance of such energy efficiency measures, calorific indications of the enclosure structures are substantially modified.

Currently, the centralised heat supply companies must provide heating for residential apartment buildings, which are connected to a single district heat supply network, but calorific properties of their structures are very different.

Therefore in order to provide a persistent indoor comfort temperature to all the facilities connected to the centralised heat supply system, it is necessary for each building to determine the specific equilibrium temperature appropriate for its calorific properties, taking into account the thermal inertia of the building to also determine the optimum outdoor air temperature for commencement of the heating season and for termination of heating. Individual planning of the building heating season will also create the preconditions to evaluate the impact of local factors on the start and termination of the heating period. Now the factors influencing local geographical, topographical and other local climatic conditions are not sufficiently estimated. By using the possibilities of individual heating units with automatic regulation of the apartment buildings, the mode of heat supply specific for each building can be provided, and connection and disconnection of heating at certain climatic conditions can also be enabled, by ensuring the optimum duration of the heating period.

Strategy for Development of Energy-efficient Ventilation System

Aleksandrs Zajacs (*Riga Technical University*) and Jurgis Zemitis (*Riga Technical University*)

Keywords **– Low pressure ventilation, night cooling, diffusive ceiling, low pressure heat exchanger, detailed simulation of indoor climate.**

I. Introduction

There are 160 million buildings in the European Union, which consume more than 40% of all energy in Europe. Thus, energy use in buildings is one of the main factors affecting the fossil fuel consumption and CO2 emissions. Under the Kyoto Protocol, the European Union has to reduce emissions, but it should be noted that the amount of energy used in building services is increasing. Ventilation and air conditioning systems today are complex and highly automated systems that are able to maintain required internal air characteristics and quality. But together with system's complexity and automation level power consumption grows as well and sometimes may reach up to 40% of the total building energy consumption. Due to the regulation of 2010/31/EU directive that starting from the 2020th all new built and reconstructed buildings should be "nearly zero energy buildings", this article aims to clarify the energy-efficient ventilation system development strategy as well as overview of detailed indoor climate simulation applications.

II. Methodology

Determination of minimal requirements: LBN 231-03 "Heating and ventilation of residential and public buildings,", and European Standard of European Committee for Standardisation EN15251:2007. Analysis of physical characteristics for air movement and development of energy-efficient ventilation system design strategy. House of quality method - defining the relationship between customer desires and the product capabilities. And whole year detailed simulation of indoor environment for INTEND office building.

III. Results and Discussion

Air velocity in the ventilation system ducts is the vital parameter that defines the total pressure drop of the system and noise level as well. The aim is to reach the total pressure drop of 40-60 Pa and noise level not to exceed 35dB. The concept of low-pressure ventilation system is shown in Fig.1.

There are following points that have to be implemented in order to achieve desirable result:

Oversizing of ventilation system elements (air velocity 1-3m/s) and consideration of placement – gives beneficial wind pressure of ~10Pa.

Low pressure liquid-coupled heat exchanger with 80% efficiency and only 1.2 Pa pressure drop. [1]

Usage of electrostatic precipitator as air filtering unit would decrease pressure drop down to 2Pa.

Perforated suspended ceiling improves comfort level and reduce pressure drop on air inlet. [2]

Usage of underground air ducts in order to increase buildings thermal mass.

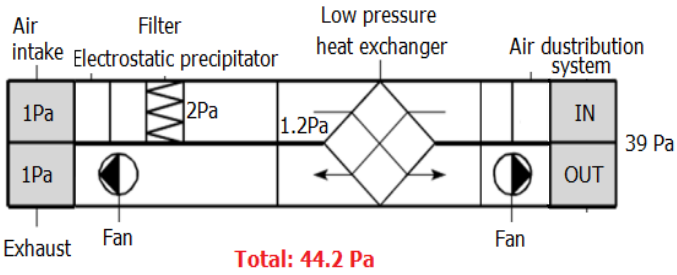

Fig.1. Low pressure ventilation concept

Night cooling helps to reduce necessary cooling power by accumulating of cooling potential during night hours.

House of quality method helps establish the relationship between customer desires and the product capabilities thus making possible to achieve certain system parameters and air quality with respect to client, user, building manager and society needs.

Implementing of some mentioned above points in the design of energy-efficient ventilation system for INTEND office building has given average energy use of **20.1 kWh/m^2/year**, calculated by iDBuild program for Denmark's climate. The energy mostly was used for heating, artificial lightening and hot water.

Whole year detailed simulation programs that are can be used: Riuska, IESVE, TRNSYS, iDBuild, PHPP 2007, Ekomaja and EkEnAp. Some of the programs allow inputting whole building geometry and orientation of all windows and doors, when iDBuild allows simulating room with only one window so it is necessary to split your building into relatively similar rooms.

IV. Conclusions

Low pressure ventilation-cooling system is the main aim to achieve in order to reduce energy use of whole building and reach the low energy class 0. Low pressure ventilation and high building thermal mass with night cooling are tools that lead to it. Whole paper has theoretical and practical value and can be used as a source of information and as guidelines for real ventilation system design.

V. References

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Passive House Solutions for Climatic Conditions of Latvia

Jurgis Zemitis (*Riga Technical University*) and Anatolijs Borodinces (*Riga Technical University*)

***Keywords* – passive house, insulation, climate, Latvia**

I. Introduction

Starting from the year 2021 all new buildings will need to be zero energy therefore increased attention must be paid to ways how to reduce the energy consumption of buildings. The zero energy level can only be achieved by consuming very small amount of energy for heating, ventilation, electricity and hot water so this necessary energy can be produced by renewable sources. Therefore these buildings will be similar to today's buildings of passive house standard. The paper provides conclusions about what should be the necessary thickness and heat transmission coefficients of insulation for opaque elements - exterior walls, ground slabs and roofs as well as the optimal sizes of the windows, their orientation and heat-technical properties to achieve passive house standards in Latvian climate. Also the paper presents economical estimation and payback time calculation of zero energy building constructions and engineer technical systems in Latvia.

II. Potential of Passive Houses in Latvia

The most common definition of passive building describes it as building with low energy consumption where, for the most part of year, usage of supplementary heating system is not necessary. The necessary heat in passive houses is provided using existing internal heat sources, solar energy and ventilation system. The passive house standard states that total energy consumption for heating should be less than 15 kWh/m^2/year.

A. Climatic characteristics of Latvia

Every building is defined by its unique location and in cases when extremely low levels of energy consumption need to be achieved this can be important factor. The table I presents climatic data of Latvia's largest cities. These cities show the full range of climatic characteristics of Latvia due to their spread placement.

TABLE I

Climate of Latvia's largest cities [1]

Name of City	Design temp. (°C)	Average temp. of heating season (°C)	Heating degree days (HDD)	Solar radiation (kWh/m^2/y)
Riga	-20,7	+0	4060	1109
Daugavpils	-24	-1,3	4367	1190
Liepaja	-18,3	+0,6	3744	1230
Aluksne	-25,1	-1,9	4687	1160
Ainaži	-23,2	-0,5	4202	1050

B. Calculation of heat transfer coefficients

The analysis of energy balance in built passive houses shows that about 75% of energy losses occur through opaque elements while the rest are associated with ventilation and thermal bridges (see Fig. 1.).

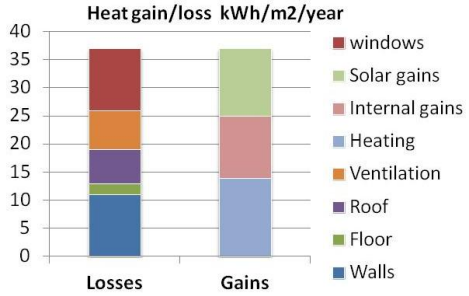

Fig. 1. Energy balance of typical passive house [2]

Using this information the average allowed heat transfer coefficient for building envelope was calculated. The results are shown in table II. However they may slightly vary in each case depending on the placement of the building, specific area of windows, geometry of building, available sunlight, etc. Also value of one elements heat transfer coefficient can be lowered if another one is increased.

TABLE II

Calculated heat transfer coefficients to reach passive house level and necessary insulation thickness

Building element	Heat transfer coefficient (W/(m*K))	Necessary thickness (mm)
Exterior walls	0,08-0.06	500-600
Ground slab	0,1-0.08	300-400
Roof	0,1-0.08	400-500
Windows	0,75	-

C. Economical feasibility of passive houses in Latvia

One of the most motivating factors to build passive houses would be their economical feasibility. As the existing experience of built passive houses shows their construction costs are on average 5-15% higher compared to standard type building which are in accordance with local regulations. The payback period of these buildings vary from 20 to 25 years, the large the built are the shorter the period. [3]

III. Conclusions

The gained results show that it is both possible and economical to build passive houses in Latvian region. This is a good indicator that the set goal that from year 2021 all new buildings must be zero energy is reachable. Also the passive buildings have added benefits of better indoor environment, longer lifetime, higher market value as well as they are environmentally friendly.

IV. References

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Construction Science

Geomatics

Results of the LatPos Coordinate Estimation

Didzis Dobelis, Janis Zvirgzds *(Latvian Geospatial Information Agency)*

Keywords **– GNSS, LatPos, coordinate estimation.**

Global navigation satellite system continuously operating network of Latvia called LatPos is managed by Latvian Geospatial information agency since year 2005. LatPos consists of 23 permanent GNSS base stations over territory of Latvia. Through the years this system has developed – more stations have been added and some of them moved to different locations due to property rights. In year 2011 planned network development has been done and necessity of complete network coordinate estimation run out.

On 10th of November in year 2011 there were two GNSS sessions made on 4 G0 Global positioning network points for 4 hours each. The height of GNSS antennas was changed between sessions to avoid rude errors of measurements. Measurements on these G0 points where made with 5 sec rate and sessions planned with Trimble Planning software to provide at least 4 satellites any time.

Network coordinate estimation has been done with Bernese GPS software version 5.0. For coordinate calculation there RINEX data for 23 LatPos permanent base stations and IGS station RIGA from 3rd to 24th of November taken (see figure 1.).

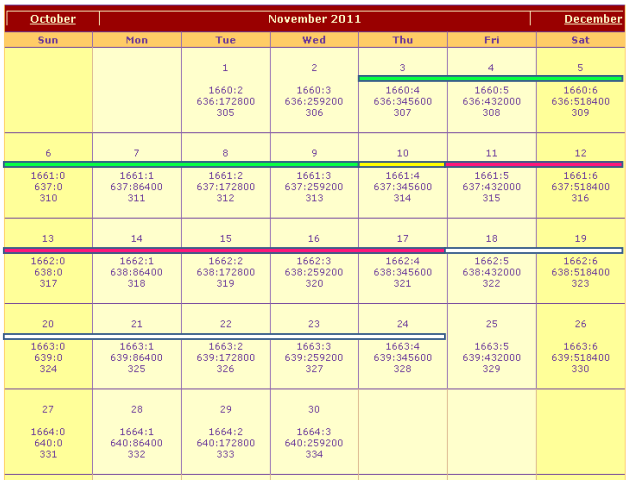

Fig. 1. Time series of used GNSS observations.

Overall there were 467 baselines calculated separately that connects closest base stations and which standard deviation do not exceed 10mm. Baselines were selected to made independent triangles by time.

For most of baseline calculation the QIF (quasi ionosphere free) ambiguity resolution were done due to distance between stations. Baseline RIGA IGS station to RIGA 1884 G0 point and RIGA IGS station to permanent base station Ojars was calculated with SIGMA ambiguity resolution strategy, because of short slope distances due to other baselines.

In computations the precise satellite orbits were used from www.ngs.noaa.gov home page for each computed GPS day. Europen global ionosphere models were used in vector computation taken from Bernese home page - ftp://ftp.unibe.ch/aiub/BSWUSER50/ATM/2011/

LatPos permanent base station network coordinates estimated with following settings:

- Elevation cut off angle for LatPos stations - 15°, for G0 points - 20°;
- RINEX data rate for Latpos stations – 30s, for G0 points – 5s;
- Confidence level: 1 sigma;
- Maximum iterations: 10.

Coordinates have been estimated to GRS-80 rotation elipsoid and given in WGS-84 coordinate system (X,Y,Z). For transfering to LKS-92 TM local coordinate system the coordinate calculator from LGIA home page used.

On the Vertical Deflection Measurements for Improvement of Latvian Geoid Model

Inese Janpaule (*Riga Technical University/University of Latvia*), Ansis Zarinsjh (*University of Latvia*)

***Keywords* – geoid, vertical deflections, digital zenith camera.**

I. Introduction

The high precision geoid model is essential for the normal height determination when the GNSS positioning methods are used. In order to improve the Latvian geoid model quality and accuracy the development of mobile digital zenith telescope for determination of vertical deflections is commenced at University of Latvia, Institute of Geodesy and Geoinformation. The results obtained using digital zenith telescope will be used for the studies of anomalies of regional gravitation field.

II. Digital Zenith Camera

In spite of the fact that recently gravimetric measurements have been carried out in Latvia, very limited local gravimetric information has been used till now for the development of international geoid models covering Latvia. The national geoid model LV'98 mostly was based on the former Soviet gravimetric map data obtained by digitizing the gravity field isogonic lines [1]. The estimated accuracy is about 7 cm. To achieve geoid accuracy of 1 cm, ~65 000 gravimetric measurements in the territory of Latvia are required. With digital zenith telescope only ~4000 measurements are needed.

Currently the project of digital zenith camera and its control software is under development at the University of Latvia, Institute of Geodesy and Geoinformation. Objective of the project is to design a geodetic instrument for determination of vertical deflections with an accuracy of at least about 0.05" (arc seconds). Such measurements might significantly improve knowledge about local geoid structure. Recent success in a number of scientific and technological fields has made this task real:

1) accurate and representative astrometric star catalogs,
2) development of CCD technology, providing unprecedented sensitivity, accuracy and ease of automated usage of astrometric imaging devices,
3) achievements in high accuracy tiltmeter technology, allowing fast, accurate and easy determination of plumb line direction,
4) GNSS precise positioning and timing.

Zenith cameras for this kind of measurements have been designed and are being designed by some research groups [2], yet their number and accessibility is still small. The goal is to make a portable, cheap and robust instrument, using standard components and ensuring necessary properties by sophisticated data processing algorithms.

III. Vertical deflections

Vertical deflections are defined as the angle between physical plumb line and the ellipsoidal normal at points on or just above the Earth surface.

Vertical deflections provide information on the structure of Earth's gravity field. Vertical deflections can be obtained from measurements of zenith cameras. They can also be derived from high-degree spherical harmonic models (e.g. EGM2008).

Vertical deflections play important role in geoid determination, in the concept of astronomical leveling they represent the inclination of the geoid with respect to the ellipsoid. Astronomical leveling can be applied for accurate determination of geoid and quasigeoid along profiles. Because of high accuracy that can be obtained by digital zenith camera, vertical deflection data can be used for the validation of geoid models.

To date vertical deflection data contribute to considerable reinforcement in the determination of geoid particularly in mountainous regions, though they could be successfully used also in comparatively plain regions as Latvia.

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GNSS Scintillation: Detection, Forecasting and Mitigation

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***Keywords* – GNSS, Ionosphere, Scintillation, Error detection and mitigation.**

I. Introduction

Global Navigation Satellite Systems (GNSS) such as the Global Positioning System (GPS) and the soon to be completed European and Russian equivalents, Galileo and GLONASS, are susceptible to many different error sources. Many of these error sources can be modelled to a level that allows precise positioning (<1cm). The ionosphere of the Earth is the largest contributor to the GNSS error budget. One particular shortcoming of these GNSS systems that is not currently adequately modelled is the phenomenon known as ionospheric scintillation. Ionospheric scintillations are rapid fluctuations in both amplitude and phase of the GNSS signals as they pass through plasma irregularities in the ionosphere[1]. GNSS receivers are not robust to scintillation events, which can degrade signal accuracy, and in extreme cases lead to loss of lock.

II. Objectives

The Engineering and Physical Sciences Research Council (EPSRC) UK has granted a collaborative project between the Universities of Nottingham, Bath and Newcastle to investigate the problem of scintillation with regard to GNSS receivers. The project aims to establish a network of 12 GNSS scintillation-monitoring stations across Europe and parts of Africa. The overall aim of the project is to quantify positioning errors over the next solar maximum (2011 – 2013) and to develop forecasting and mitigation techniques that would move towards making GNSS receivers robust to scintillation events.

In general, scintillation effects are characterised by two indices, namely the amplitude scintillation index, S4, which is the standard deviation of the received power normalised by its mean value, and the phase scintillation index, SigmaPhi (σ_ϕ), which is the standard deviation of the detrended carrier phase. These indices are considered at every 1-min interval.

Ionospheric Scintillation varies across different geographic locations and at any one location the temporal occurrence is unpredictable, but is modulated by the 11-year solar cycle. At high latitudes ionospheric scintillation is driven by auroral precipitation or instability of structures formed on polar cap patches. At high to mid latitudes scintillation may be due to the expansion of the polar cap. At southern mid latitudes, scintillation is related to the equatorial ionosphere where the dominant process is the instability of structures on the edges of the equatorial anomaly. As the mechanisms are different in each region it is necessary to establish a network over a wide area and extended time period.

The proposed GNSS monitoring stations are currently operational. The scintillation parameters (S4 and σ_ϕ) are also affected by multipath making it difficult in some instances, particularly at lower elevations, to distinguish between scintillation events and multipath. Each of the scintillation stations will be analysed and filters developed and tested so that multipath may either be removed from the data from each site or made easily and consistently identifiable from scintillation events.

In addition to this the effect of scintillation events on the quality and availability of position will be analysed. The effect of scintillation on both baseline positioning and Precise Point Positioning (PPP) are being analysed as part of the project using the scintillation network already mentioned as well as other GNSS networks throughout Europe. It is envisaged that methods will be developed and tested, to help mitigate this problem within the GNSS receivers [2].

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GNSS Station Kinematic Coordinate Analysis

Diana Haritonova (*Riga Technical University*)

Keywords **– GNSS, permanent network, kinematic coordinates, station displacement.**

I. Introduction

The daily movements of EUPOS®-RIGA and LatPos stations have been studied. EPN reference stations have been used and Bernese GPS Software, Version 5.0, was applied in kinematic mode. The standard data sets were taken from IGS data base – ionosphere and troposphere parameters, satellite orbits, satellite clock corrections, as well as the Earth rotation parameters.

II. Data processing

The Bernese GPS Software allows the estimation of kinematic, i.e., epoch-wise receiver coordinates. This feature has been applied and kinematic parameter estimation for LatPos and EUPOS®-RIGA permanent GNSS network stations has been carried out. Processing of mixed – kinematic and static, stations has been performed in the same solution allowing to process data from several stations in baseline mode, one of them kinematic, the others static. From seven to nine EPN stations (JOEN, JOZE, MDVJ, METS, RIGA, TORA, VAAS, VIS0, VLNS, WROC) were fixed, i.e., static for datum definition in each kinematic double-difference network solution.

The static processing strategies have been applied enabling the kinematic positioning for selected station at the last stage of data processing – after the ambiguity resolution.

The result file includes a priori station coordinates in the IGS05 coordinate system and estimated displacements and RMS in north, east, and up components of rover station in meters with 5-minute sampling interval.

Site displacements due to solid Earth tides as well as ocean tidal loading were considered for all types of stations irrespective whether they are static or kinematic.

Figure 1 shows daily vertical displacements at the AIZK station for 30-day observation period.

The results from a similar way obtained network solution for station LUNI displayed in Figure 2, where three components of station displacement with RMS values are shown.

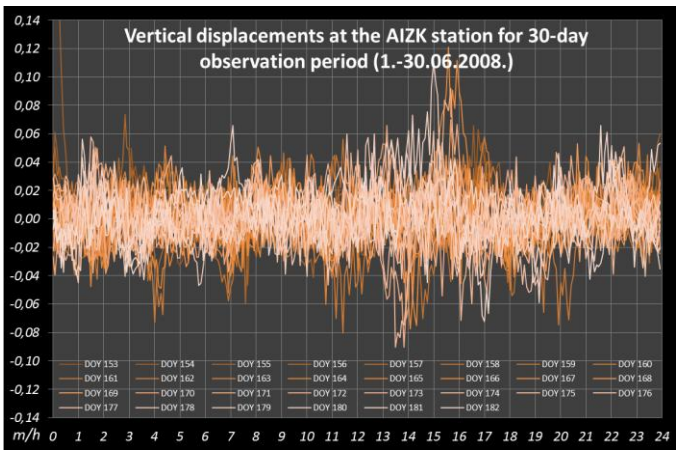

Fig. 1. Vertical displacements at the AIZK station for 30 days of June 2008.

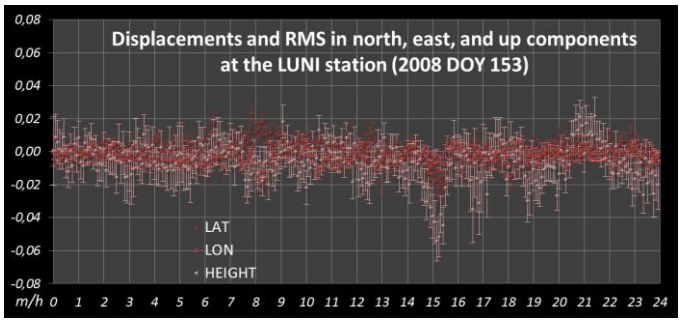

Fig. 2. Displacements and RMS for three components at the LUNI station.

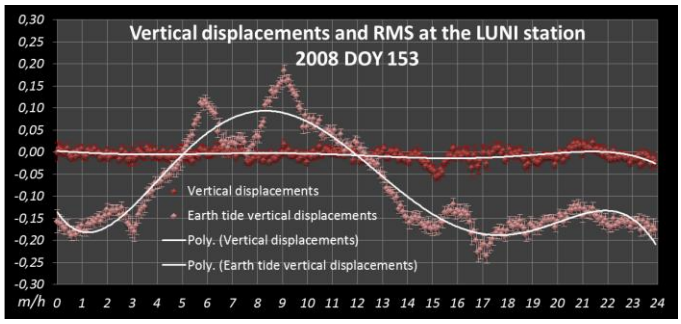

Fig. 3. Vertical displacements at the LUNI station.

Earth tidal vertical movements at GNSS stations have been studied as well. Figure 3 shows one-day vertical displacements and solid Earth tide caused vertical displacements at the LUNI station. Such displacements can be obtained by modifying the routine of Bernese GPS Software computing tidal station displacements. It is necessary to define that the tidal impact corrections will not be introduced for kinematic stations.

III. Results

Research findings have shown that the highest RMS values correspond to up component of GNSS station displacement and are more than 1 cm, the lowest RMS values can be observed for east component and reach 6 mm.

IV. Conclusions

The goal is to get as many epochs with reliable kinematic coordinate estimates as possible. However the low redundancy makes it difficult to detect bad observations. The results are very sensitive to data quality. This makes it difficult to give a ready-to-use recipe for a robust analysis of data from kinematic stations.

The study of the Earth's oscillations is a key part of the theory of the Earth's dynamic response to external or internal forces. However it is hard to reach necessary accuracy to register such phenomenon. The main problem is due to influence of ionosphere and weather conditions on GNSS observations. It would be better if each GNSS receiver was equipped with a meteorological station for data control.

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Obtaining Aeronautical Data in Global Height System - Example of Latvia

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***Keywords* – aeronautical data, global height system, ICAO.**

I. Introduction

A specialized agency of the United Nations, the **International Civil Aviation Organization (ICAO)** was created in 1944 to promote the safe and orderly development of international civil aviation throughout the world. It sets standards and regulations necessary for aviation safety, security, efficiency and regularity, as well as for aviation environmental protection. ICAO set out "World Geodetic System- 1984 (WGS-84) Manual" [1] for use of global geodetic system in aero navigation. In WGS-84 manual and ICAO annexes 14 and 15 are data quality requirements for geodetic data. Geodetic data is separated in type of height, coordinate, geoid undulation and magnetic variation. Data quality requirements are accuracy, publication resolution and integrity. EUROCONTROL to meet requirements of Commission regulation (EU) 73/2010 for the single European sky provides "Specification for the Origination of Aeronautical data". [2] In specification are set out requirements and geodetic reference systems for single European sky. Paper mainly focuses on obtaining aeronautical height data in scope of Europe.

II. An Overview Of Latvia

In Latvia as height system reference surface Baltic 1977 year normal height system (BHS-77) with zero point at Kronstadt (in Russia) is used. Nowadays BHS-77 is out of date and is not a representative gravity related height system. For single European sky as height reference system European Vertical reference system (EVRS) with datum point Amsterdam pail (in the Netherlands) shall be used. EVRS is gravity related height system with decimeter accuracy over scope of Europe.

EVRS served as global height system in area of Europe and as gravity related height system can be transformed to any equipotential surface above the Earth.

Height data for aeronautical purpose in Latvia are created with reference to BHS-77. Height data before global positioning era was created by classical geodetic connection (leveling and tachometry) to reference surface, after-using height transformation surface Latvia quasigeoid model of year 1998 (LV´98).

EVRS data for all European countries are obtained by national first order leveling network. Latvia is connected to EVRS and obtained height values for first order leveling network in 2011.

All height data for aeronautical purpose shall be representative in EVRS not in BHS-77. One of the ways how to do it is transform height data from BHS-77 to EVRS.

III. Transformation from BHS-77 to EVRS

Data quality requirements for height values are set to be round for publication resolution. Publication resolution for height data varies from one meter for obstacle in area 1 till decimeter for runway threshold (precise approach). Each height data must have difference description have to transform it. A strategy depends on data accuracy, integrity and area in which height data point is located.

Height differences between BHS-77 and EVRS in territory of Latvia vary from +12 cm till +18 cm. Mainly differences are created by post glacial rebound effect in fennoscandia which change height values in Latvia approximately by 1mm per year.

ICAO set two kind of publication resolution for height data one meter and one decimeter.

One meter publication resolution is for data with accuracy of 30, 3 or 1 meter. Data with accuracy 30 and 3 meters are insensitive to height change between BHS-77 and EVRS thus our changes are negligible compared to accuracy so they will have same height values in EVRS as in BHS-77. 1 meter accuracy data must be reviewed in respect to changes from BHS-77 to EVRS. Transformation must be done with height data using height values before rounding to publication resolution.

One decimeter publication resolution is for data with accuracy of 0.5 or 0.25 meter. Evidence of proving connection accuracy to BHS-77 of data must be checked before obtaining transformation. Height values before rounding to publication resolution must be used as input data.

If there is lack of evidence of proving accuracy of height data re-measurements shall be done.

IV. Conclusions

1) Different strategies depending on the accuracy, integrity and publication resolution must be obtained for aeronautical data for changing from BHS-77 to EVRS.
2) Height data with publication resolution and accuracy 1 meter must be transformed with height values before rounding values.
3) Height data with publication resolution 1 decimeter first must be checked for accuracy evidence and then transformed with height values before rounding.

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What Height System is used in Latvia?

Janis Balodis (*University of Latvia*), Diana Haritonova (*Riga Technical University*), Ieva Lasmane (*University of Latvia)*,Inese Janpaule (*Riga Technical University/University of Latvia*), Madara Normand (*Riga Technical University/University of Latvia*), Gunars Silabriedis (*Riga Technical University*)

Keywords **– GNSS, geodesy. Height systems.**

I. INTRODUCTION

Within the *EUPOS*® network the LatPos and EUPOS®-Riga RTK base station networks are designed in Latvia since year 2006. Time series of GNSS station results of both the EUPOS®-Riga and LatPos networks have been developed at the Institute of Geodesy and Geoinformation (GGI) using Bernese v.5.0 software. The base stations were selected among the EPN and IGS stations in surroundings of Latvia. The results of time series are analysed.

II. IDENTIFICATION OF VERTICAL DISPLACEMENTS

However, the behaviour of the RTK base station network approves to have similar stability comparing with EPN/IGS station network. Besides the RTK application for land surveying the possibilities to use RTK methods for the verification and validation of the height values of geodetic levelling benchmarks established historically long time ago have been studied. The differential GNSS and RTK methods appear very useful to identify the vertical displacement of landscape by means of inspection of the deformation of levelling networks. Preliminary results of the deformation of Riga levelling network have been discovered [2].

III. SINEX SOLUTIONS. GNSS STATION OBSERVATION TIME SERIES

Eight base stations were selected from a set of stations {BOR1, JOEN, JOZE, MDVJ, METS, POLV, PULK, RIGA, TORA, VAAS, VISO, VLNS} for the coordinate determination of EUPOS®-Riga and LatPos network base stations. Above mentioned international stations are placed up to 700 km far from Riga. Their coordinates monitored in International GNSS Network and European Permanent network. Consequently, the resulted coordinates of Latvian stations are highly reliable. The time series of computed daily coordinates of Latvian stations are designed as coordinate time series. Results are analysed. Coordinate velocity vectors are calculated for the period of 2.5 years.

Within the initiative of EUPOS the weekly SINEX solution (introduced to EUPOS Combination Centre) calculations have been performed by GGI for both LatPos and EUPOS®-Riga network stations. EPN Analysis Centre Guidelines (Final IGS satellite orbits, Ocean-loading corrections, 10° elevation cut off angle, Niell mapping function) were taken into account. Bernese GPS Software V5.0 was used in solutions for 1486-1616 GPS weeks. The calculated results are used for the studies of the environment of Latvia in order to identify the vertical displacements where also the gravity field could be influenced.

The results are quite a different when comparing them with conclusions of Latvian leveling network adjustment [3]. However, the doubts on reliability of time series disappear when the results of time series and the map of tectonic faults in Latvia are compared [4].

In conclusion the hypothetical question aroused – what height system currently is used in Latvia? Is it really the Baltic Height system 77? Will be correct the conversion to EVRS using current input data?

IV. ACKNOWLEDGMENT

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EIROPAS REĢIONĀLĀS ATTĪSTĪBAS FONDS
EIROPAS SAVIENĪBA

Combination of KTH Geoid Solution with GPS-levelling Data

Inese Janpaule (*University of Latvia*), Katerina Morozova

Keywords **– EGM2008, GPS/levelling fitting, Stokes Integral, least-squares analysis.**

I. Introduction

Computation of a precise local gravimetric geoid model with sparse and limited data is a difficult task. This research investigates the procedure for gathering evaluating data and combining them with grid data in order to determinate an optimum gravimetric geoid model. We compiled a new geoid model at the computation area of Latvia using the method developed at the Royal Institute of Technology (KTH) in Stockholm. This method utilizes the least-squares modification of the Stokes integral for the biased, unbiased, and optimum stochastic solutions. The modified Bruns-Stokes integral combines the regional terrestrial gravity data with a global geopotential model (GGM).

II. Main part

The only regional gravimetric geoid model LV'98 has been determined for the Latvia area, and a problem is to improve the local geoid model; the selection of the best Global Geopotential Model (GGM) model for the region is essential, to be used in a combined solution from GGM and local gravimetric data. We discuss these problems by taking advantage of more than 200 GPS/levelling points as an external tool for validation of different local geoid models. By using relative comparisons of the height differences between precise levelling and GPS/geoid models we avoid possible unknown systematic effects between the different types of observations.

According to the KTH method, the gravimetric geoid height N is computed as a sum of the following components:

$$N = \tilde{N} + \delta N^{T} + \delta N^{A} + \delta N^{DWC} + \delta N^{ell}, (1)$$

where $\tilde{N}$ is is the approximate geoid height, δN^{T} the combined topographic correction, δN^{A} the combined atmospheric correction, δN^{DWC} the downward continuation correction, and the ellipsoidal correction for the formulation of the Bruns-Stokes formula in the spherical approximation to the problem. The approximate geoid height $\tilde{N}$ in Eq (1) is computed using the modified Bruns-Stokes formula in the following form (Sjöberg 2003d):

$$\tilde{N} = \frac{R}{4\pi\gamma_0}\int_{\alpha=0}^{2\pi}\int_{\psi=0}^{\psi_0} S^{\bar{n}}(\psi)\Delta g \, sin\psi \, d\alpha \, d\psi + \frac{R}{2\gamma_0}\sum_{n=2}^{\bar{n}} b_n \Delta g_n^{GGM}$$

To transform the coordinates from one system to another and notify residuals with respect to improve local geoid Helmert transformation was used:

$$\begin{pmatrix}\tilde{X}_i\\ \tilde{Y}_i\\ \tilde{Z}_i\end{pmatrix} = (1+\mu)\begin{pmatrix}1 & \gamma & -\beta\\ -\gamma & 1 & \alpha\\ \beta & -\alpha & 1\end{pmatrix}\begin{pmatrix}X_i\\ Y_i\\ Z_i\end{pmatrix} + \begin{pmatrix}\Delta X\\ \Delta Y\\ \Delta Z\end{pmatrix} \quad (3)$$

where $\tilde{X}_i, \tilde{Y}_i, \tilde{Z}_i$ are transformed coordinates, $X_i, Y_i, \quad Z_i$ are the initial coordinates; parameters: μ – scale factor, $\Delta X, \Delta Y, \Delta X$ - translation parameters, α, β, γ – rotation parameters.

III. Conclusions

We have applied the KTH method to determine the geoid model at the computation area of Latvia. The KTH geoid model was compiled in two principal numerical steps. First, the approximate geoid heights were computed using the modified Bruns-Stokes integral. It combines the regional terrestrial gravity data with the EGM2008 GGM coefficients. The gravimetric geoid heights were obtained after applying four additive corrections. These additive corrections to the approximate geoid heights account for the effects of the topography, atmosphere, downward continuation reduction, and spherical approximation. The final KTH-geoid model was obtained after combining the gravimetric geoid with GPS-levelling data using a parametric model. The KTH-geoid model was validated at the GPS-levelling

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Coastline Change Detection Using Remote Sensing

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***Keywords* – coastline change, remote sensing, satellite image, vegetation indices, Landsat TM/ ETM+.**

I. Abstract

Coastal zone monitoring is significant task in national development and environmental protection.

Study area of this work is Ventspils region, particularly focused on the coastline changes in Staldzene. Staldzene has one of the highest steep shores in Latvia and is well known as beautiful recreation zone. The biggest problem of Staldzene is the sea storms that wash away steep shore - according to the projection of Professor Guntis Eberhard a coastline from 30 to 100 meters in Staldzene will be washed away during the next 50 years [1].

The aim of this research was to estimate coastline change detection. One of the most popular methods for coastline change detection is vegetation indices method. Research was done using vegetation indices (most often used of them are NDVI, NDWI), the impact of several modifications for it was evaluated as well. Training samples were obtained from Landsat TM and ETM+ satellite images.

The result of research the coastline changes in recreation zone Staldzene were estimated (Fig. 1., 2.).

II. Acknowlegements

Funding for the research was provided by EU EuropeanSocial Fund Financed Project "Signals related to Artificial Earth Satellites:Technologies of Receiving, Transmitting and Processing" No. 2009/0231/1DP/1.1.1.2.0/09/APIA/VIAA/151.

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Fig. 1. Coastline changes between 1999-2009 (NDVI based method)

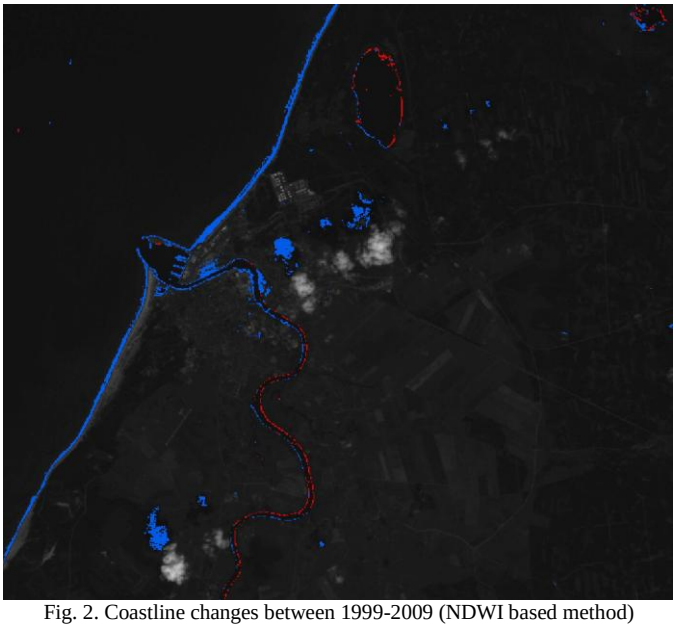

Fig. 2. Coastline changes between 1999-2009 (NDWI based method)

Development of Geodesy Education and Science in 150 Years of Riga Technical University

Janis Kletnieks *(Riga Technical University)*, Janis Strauhmanis *(Riga Technical University)*

***Keywords* – geodesy, geomatics, Riga Polytechnic School, Riga Polytechnic Institute, Riga Technical University.**

The development of geodesy science and education in the territory of Latvia started in the second half of the 19th century when the Department of Land Surveying was opened at Riga Polytechnic School (1869). It was headed by the first professor in geodesy Anton Schell (1869 – 1873) and professor Alexander Beck (1873 – 1889). Their contribution to the development of geodesy education is very great. A.Schell published more than 24 works on geodesy problems, invented several original geodesic instruments and discovered new methods in topographic surveying and photogrammetry. During A.Beck's time, the Astronomy Laboratory of Riga Polytechnic School became the basis of scientific research, but it should be stressed that his contribution to the creation of the first triangular network of Riga City was of special importance. In the mid – 1870s, studies in separate branches of geodesy and land surveying lost importance, because the first schools of land surveying were opened in Russia at that time, and many Latvians who were graduates of these schools made a great contribution to the development of geodesy science and education during the time of the first Republic of Latvia. During the existence of Riga Polytechnic Institute (1896 – 1918) departments were created and the way of rational technical thinking began to prevail, and therefore it became possible to include the latest achievements of geodesy science in training would-be specialists. In 1907, the Department of Geodesy was created, and it was headed by Victor Ehrenfeucht (1907 – 1917). He wrote the first course – books in higher and lower geodesy which were published in Riga. It should be stressed that Alwill Buchholtz (1880 – 1912) who is the founder of photogrammetry in Latvia started his studies in the field of stereophotogrammetry under the guidance of V. Ehrenfeucht. In 1920, the Department of Cultural Engineering was created at the Faculty of Engineering Sciences of the University of Latvia and one of its tasks was to train geodesy specialists. Until 1940, six people obtained the degree of geodesy engineer. The Institute of Geodesy founded at the University of Latvia in 1924 became the scientific centre of geodesic research in Latvia, and it was headed by professor Alwill Buchholtz. Already in 1923 – 1924, the first aerophotogrammetric images were obtained and a plan with a scale of 1: 10 000 was made for the area around the New Gertrude's Church in Riga and later the first photo plans of Kuldiga and Riga with a scale of 1: 5 000 were made (1928 – 1930). The methods of aerophoto surveying were also used in making cadastre and topographic plans. A. Buchholtz conducted researches in geodesy, photogrammetry and the theory of observation errors and published more than 110 scientific works. He also worked at Dresden Technical University (1947 – 1960). Gravimetric studies were made by V.Jung (1904 – 1942). Until 1944, several other significant studies were made at the Institute of Geodesy. After World War II the development of geodesy science and education continued at the Department of Geodesy of the Latvian State University (1944 – 1955) under the conditions of strict soviet censorhip. During this period the diplomas of geodesy engineer were awarded to 11 graduates. The main scientific researches focused on the problems of geodesic network processing. Until 1967, the geodesy course at Riga Polytechnic Institute founded in 1958 was taught at the Department of Civil Construction, later the Department of Geodesy was created (1967 – 1975), but the USSR institutions of higher education did not allow to offer higher education in the speciality of engineering geodesy. In early 1991, the Department of Geodesy was created at Riga Polytechnic Institute, and it was headed by ass.professor J.Kletnieks until 1996, later – by ass.professor J.Bikse (1996 – 1997). In 1998, it was transformed into the Body of Professors of Geodesy and Cartography headed by prof. J.Balodis, and in 2003 the Department of Geomatics was created on the basis of this body. The Department of Geomatics conducts research in the fields of geodesy, cartography and land management, and the latest methods and technologies are used in the studies. The research conducted by the Department of Geomatics, which is the only department of this type in Latvia, has gained international recognition in documenting and modelling ancient monuments in Egypt (J.Kletnieks, M.Kalinka).

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Prospects of Updating Land Cover Spatial Data at Smaller Scale in Lithuania

Lina Papsiene (*Vilnius Gediminas Technical University*)

***Keywords* – significance of a feature change, update of spatial data set, generalization, GIS.**

I. Introduction

In Lithuania the major land cover spatial data is stored in the state reference spatial data set at a scale 1:10 000. Interpretation of up-to-date orthoimages and field measurements are used in updating process of this data. State reference spatial data are additionally stored at scales of 1:50 000 and 1:250 000. These smaller scale data are, as a rule, updated at different time intervals, the process being only partially automatic. Therefore, upon finalization of their update the spatial data have actually been outdated. However, the new 2010 Law on Geodesy and Cartography stipulated that state reference spatial data sets of all three scales would be updated on a regular basis. Thus, implementation of such provision requires (1) a regular supply of changes in larger scale spatial data for smaller scale spatial data sets; (2) rendering the spatial data update of smaller scale more automatic as far as possible, that is, identifying places under the update and generalization of the corresponding spatial data.

II. Possibilities of Land Cover Spatial Data Generalization in Updating Process

Advantages of automatic generalization of spatial data were acknowledged already in the 20th century. Generalization is a process where the amount of information is reduced and complex feature representation is simplified retaining significant and eliminating insignificant elements of the feature characteristics.

Based on Li classification (2006) one may distinguish principal generalization operations that have to be used for generalization of land cover spatial features in state reference spatial data sets: (1) simplification, that makes the feature shape simpler; (2) for group of features: aggregation, that combines polygon features within a specified distance to each other into a new polygon; dissolving, that aggregates features based on the specified attribute; merging, that merges polygon features with the common boundary.

Automatic spatial data generalization calls for thorough modelling of the process, which, taking into account the requirements for spatial data in different scale, would include generalization methods, algorithms and their order of priority (Papsiene *et al.* 2011).

III. Land Cover Spatial Data Changes Affecting to Update Process

Most often, when updating land cover spatial data of smaller scale, data of larger scale are employed. Anyway, optimizing the update process requires identification of only those changes in larger scale data that would be “interesting” for smaller scale, that is, the change would be “visible” in a smaller scale spatial data set. Therefore, the significance of change has to be evaluating after detecting changed feature.

As this process includes comparison of spatial data before and after the update, it is important to support feature life cycle and to establish a relation between identical features in different versions and scales. Otherwise, the process of identification changes will be costly.

In evaluating the significance of changes in spatial features the changes were following procedures have been established depending on the type of change: for (1) new feature, (2) feature with updated attributes, (3) feature with changed shape, and (4) deleted (eliminated) feature.

IV. Relation between Land Cover Spatial Data Changes and Updating Operations

Analysis of the land covering updates in different scale data sets allowed distinguishing actions and generalization operations that may be applied in the update of smaller scale data. These actions depend on the type of change in the spatial feature (Table 1).

TABLE 1
Relation between change and update at smaller scale

Basic nature of change at larger scale	Possible operation at smaller scale	Possible generalization operation
Created new feature	(a) create new feature (b) update object shape	(a) simplification (b) aggregate neighbours features
Updated attribute of feature	(a) create new feature (b) update feature attribute (c) deleted feature (d) update feature shape (delete part of feature)	(a) simplification (b) aggregate neighbours features
Updated feature shape	(a) updated feature shape	(a1) simplification or (and) (a2) aggregate neighbours features
Deleted feature	(a) delete feature (b) update feature shape (delete part of feature)	

This principle relations allows to model the processes of spatial data updating, involving identification and evaluation of changes, and operations for updating.

V. Conclusions

Implementation of a regular update of land cover spatial features of smaller scale in Lithuania requires development of a model comprising processes, which would allow identifying significant changes in land cover spatial features and initiate their update.

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Assessment of "Radon-prone Areas" with an Interdisciplinary Hierarchical Multi-scalar Approach Integrated in a GIS-based Management Procedure

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Keywords **– Radon Prone Areas, Natural Radioactivity Assessment, GIS mapping of Radon Potential, Environmental planning.**

I. Introduction

In order to afford the problem of Radon assessment, prevention and remediation, also in relation to the radioprotection of population and workers, an interdisciplinary research program, named "RAD_CAMPANIA", with contributions from Geology, Geomorphology, Soil Science, Environmental Physics, Building Engineering, Medical Physics and Epidemiology, has been proposed and implemented [1,2]. It is aimed to the development of a standard methodology, based on a multi-scale hierarchical (regional - provincial - sector- zone site) procedure of assessment of the Radon exhalation from soils, It is based upon an integrated and adaptive approach to the problem, requiring the use of techniques of analysis, differentiated at the different scales of the territorial surveys and analysis, and, at the same time, progressively more deepened and more specific, from the regional to the zone mapping and modelling at the scale of a single site. The investigation procedure is supported by a regional built-in database, consisting of both suitable territorial information and experimental data, provided by Radon concentration measurements in soil gas performed in several sites and indoor measurements, integrated in a GIS-based management procedure.

II. The RAD_Campania Program

The Program is articulated in different Projects and Sub-projects. Here, the preliminary results from one of them, the "*Radon-prone Areas*" Sub-project, are summarized, focusing the attention on the hierarchical methodological approach and the used multi-scale procedure, which foresees subsequent levels of the investigation and their cartographic representation, with greater and greater detail. The approach, called "*Hierarchical and Multi-scale Areas Zoning*", already usefully and widely used in the fields of the environmental planning and landscape ecology, is finalized to the individuation, multi-scale classification and assessment of the *Radon-prone Areas,* coherently organized in the following hierarchical levels.

The Regional Level of analysis provides specific mapping tools, (scale 1:250,000), suitable for the regional planning, i.e. the Radon Regional Plan, and liable for the implementation in a more general regulation of territorial policy, like the Regional Territorial Plan (PTR). The Provincial Level of analysis and mapping, (scale 1:100,000), can be suitable and useful for the sub-regional territorial planning, like the Province Coordination Territorial Plan (PTCP). At the District level, the analysis, (scale 1:50,000 to 1:25,000), are suitable for Inter-municipal Plans, where high values of the Radon concentration have occurred in the previous analysis level, and is suitable for the Territorial Planning of aggregates of municipalities (Strategic Urban Plans) and for institutional subjects with tasks aimed at epidemiological investigations, like the Local Sanitary Authorities. The analysis at the Zone level represents the Radon-soil gas concentration spatial distribution (scales 1:5,000-2,000); it is useful for a planning like Municipal Urban Plan. The Site analysis is useful for Executive Planning, at the scale 1:2,000, like Executive Plans and for the Radon-soil gas and Radon Indoor Modelling spatial representations to apply remediation rules and actions.

III. Preliminary Results

The application of this methodology has enabled us to set up a preliminary Map of the *Radon-Prone Areas*, at the Regional Level, but developed for the "Salerno province case-study", considering the geological background and more complete data sets of Radon soil-gas field measurements. The *Radon-prone Areas* Map is built up with the following steps: i) "geology-based" correlations from more specific bibliography; ii) more geological detail than the one at the Regional Level, with the individuation and mapping of Lithological Complexes; iii) setting from Radon soil-gas experimental measurements in different sample sites, located in lithological complexes representative of the provincial landscape; iv) compilation of a map of interpretative synthesis, obtained from the spatial analysis rules, applied in GIS environment, taken into account the specific contributes to the exhalation deriving from various factors (geology, geomorphology, hydrogeology, vegetation etc.) and progressive calibration of the weighted values by the real data acquired from the *in situ* measurements, opportunely recorded and managed in an appropriate Relational Database. The general procedure for the compilation of the *Radon-prone Areas* Map at the provincial scale (Fig. 9) is based on the *Factor Rating Method*, implementing a *GIS_Raster* procedure and adopting"cascade" criteria from progressive analysis steps of the basic factors, grouped in landscape *transfer factors*. The final Radon-soil Map of Salerno Province (Fig.11) shows a preliminary spatial distribution of the classes in Radon-soil gas concentration and, then, enables to locate the contiguous areas. In a preliminary comprehensive analysis of map, the areas with relative higher levels coincide with radioactive, permeable sediments in plain and valley floor affected by active tectonics and karst springs inflow into main river system.

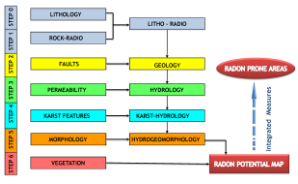

Figure 9 : Flow-chart diagram for the production of the *Radon-prone Areas.*

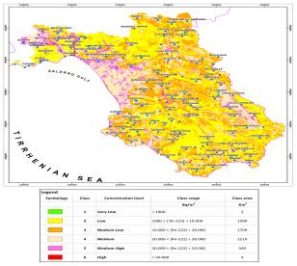

Figure 11: Radon-prone Areas Map at Province scale.

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The Problem of the Quality of Cartographic Works

Janis Strauhmanis *(Riga Technical University)*

The number of users of cartographic works: maps, plans, blocdiagrams, geographic globes has always been and will be great. Therefore, the quality of these works is of great importance; serious concern about this problem has been expressed in several international conferences, because the quality of these works, especially that of geographic maps is becoming worse, which can be partly explained by the fact that the level of cartographic understanding in public has not risen. It should be stressed that cartographic images belong to the group of geoimages, but a geoimage is defined as a spatial, up-to-date, mathematically fixed and generalised model of the earh's features and phenomena expressed in the form of graphic images. This definition is mainly applied to geographic maps.The quality is determined by the established requirements that the work has to meet, but so far these requirements have been applied only to maps, which, certainly, form the largest group of cartographic works. It should be noted that certain quality requirements have been mainly established for thematic and special maps but requirements concerning topographic maps are not mentioned in literature. However, errors can be found in all types of maps.

The main errors are the following:

1) in the scale of the maps,
2) the cartographic projection,
3) the altitude, relief fixed on the map,
4) the generalisation of the content of the map.

The quality of cartographic works can be defined as the adequacy of the content of the map for solving certain tasks. It is of special importance at present when the use of digital maps in mobile telephones and cartographic images on the internet is rapidly growing. Unfortunately, there has been almost no discussion on the quality of cartographic images placed on the internet neither in cartographic publications nor in scientific conferences.

It should be added that the assessment of the quality of the map is influenced by the ways of using maps, including visual reading (e.g. maps on the internet) and making measurements on the map. In our opinion, the quality of cartographic images, irrespective of the way they are made, should correspond to two main requirements in order to ensure that they can be safely used for solving various tasks and problems. These requirements are:

1) the content of cartographic images should be up-to-date, which should be indicated on the map,
2) the precision of the cartographic image should correspond to the task of the theme, first of all, it refers to the vertical precision.

It is not an easy task to implement these requirements and it cannot be done quickly, because, as it was pointed out by professor of Dresden Technical University, in the 21st century the prevailing trend in cartography is business. However, in our opinion, it is the task of the International Cartographic Association to start dealing with the problems of the quality of cartographic images.

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Weatherford Energy Services GmbH

Directional Surveying and MWD

In the early days of drilling, no one worried about hole deviation. The whole objective was to get the well drilled down, completed and producing as quickly as possible. Many drilling personnel assumed the wells were straight - others simply did not care.

Subsequently, wells were deliberately drilled in some unknown direction. This began as a remedial operation to solve a drilling problem - usually a fish or junk left in the hole. Today, with the advent of tighter legal spacing requirements, better reservoir engineering modelling and drilling of multiple wells from a single surface location, it has become very important to both controls the wellbore position during drilling and to relate the position of existing wellbores to lease boundaries, other wells, etc.

The development of the skills and equipment necessary to direct these wellbores is the science of directional drilling. **Directional Drilling** is the science of directing a wellbore along a predetermined path called a trajectory to intersect a previously designated sub-surface target. Implicit in this definition is the fact that both the direction and the deviation from vertical are controlled by the directional driller from the surface.

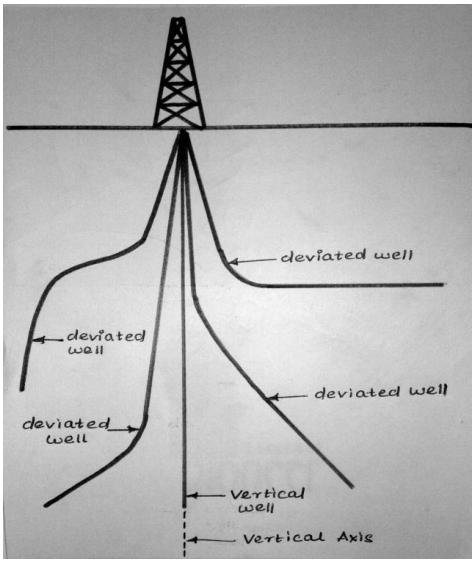

Fig. 1. Types off drilling wells

Objectives for Surveying:

- Determine location of borehole
- Monitor well path to ensure target intersection
- Orientation of directional tools
- Anti-collision
- Determine TVD
- Evaluate dogleg severity of borehole
- Fulfill regulatory requirements

Traditionally to control the hole inclination and azimuth is used MWD system. MWD system – measurement while drilling. Weatherford's broad portfolio of MWD and surveying systems deliver accurate directional survey and tool face data in all types of drilling environments.

Company Weatherford have telemetric systems with cable, mud and electromagnetic communication channels at hand to provide build-up rate and well path adjustment parameters:

- MWDQ 55–1 Becfield - hydraulic communication channel;
- EMPulse - electromagnetic communication channel;
- PrecisionPulse - hydraulic communication channel.

A common method of deflecting wellbores is to use a downhole motors. Weatherford Frontline™ and Hyperline™ downhole motors represent the culmination of extensive drilling experience and technical ability.

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Analysis of Dynamic Parameters of Timber and Steel Observation Towers

Liga Gaile *(Riga Technical University)*

***Keywords* – Damping, Frequency, Human-induced loads, Observation tower.**

I. Introduction

Observation towers located in the countryside are designed to allow viewers an unobstructed view of the landscape and their design is mostly driven by economic aspects. With generally flat terrain, Latvia has a numerous observation towers mostly located in Latgale and Kurzeme regions. The structural design of all of them is mostly based on the previous experience. It is because of lack of understanding how these structures dynamically perform under human induced loads [1].

II. Methods and Materials

The purpose of this research is to identify the performance of most of the light weight observation towers open for public in Latvia. It analyzes their structure, condition, dynamic parameters (fundamental and natural frequencies, damping, frequency, which amplitude amplifies due to towers visitors' movement) as well it analyzes the loading scenarios to identify the critical ones based on the experimentally obtained data.

A. Experimental Program

During the experiment the vibration accelerations of the observation towers were measured and recorded. The accelerometers where located on the upper platform of the tower. The accelerations were measured under the following conditions: very mild wind and no visitors on the tower, two visitors moving upstairs and afterwards downstairs, two visitors moving along the upper platform in transverse direction and in circular direction. Additionally, the geometry of the structure and the weather conditions during the experiments were measured.

B. Observation Tower Description

Locations of experimentally measured observation towers are presented in Fig. 1.

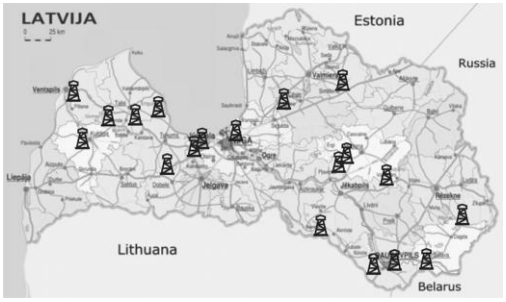

Fig. 1. Location of observation towers in Latvia.

The height of the observation tower is in the range of 19m to 36m, a plan dimension of main lateral load resisting system varies from 1,5m to 9,5m. 70% of inspected towers are a traditional timber structure design towers with non-uniform cross section. Others are made of steel where in most cases the plan dimension over the height does not change. The slope of stairs is in the range of 30^0 to 70^0 but most of the observation towers' slop of stairs is around 45^0.

III. Results

Although the most of observation towers are less than ten years old their technical condition widely varies. Only those timber towers that have less than five years are in good condition. Most of the damages are located in the main column areas (Fig.2), whereas the steel towers columns' splice seems to be affected by the tower's vibrations (Fig.3).

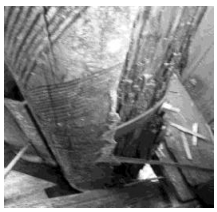

Fig. 2. Typical damage for timber structure

Fig. 3. Typical damage for steel structure

A. Dynamic Parameters and Dynamic Response

The critical range of the structure's frequencies *f* when it is prone to human-induced vibrations [3]:

$$0.666 \pm 0.147\,Hz \le f \le 3.300 \pm 0.147\,Hz \qquad (1).$$

All inspected observation towers in Latvia are in this critical range. The measured noticeable acceleration amplifications from human movement confirm that all lightweight observation towers should be designed considering human-induced dynamic loading. Timber observation towers' fundamental mode damping varies from 6% to 10% but steel towers' – 2,5% to 4,6%.

IV. Conclusions

Timber observation towers have very short service life but they perform better under human induced loads due to higher damping ratio than steel structure towers. Steel towers are very prone to human induced vibrations and there is a necessity to develop suitable damping devices. It has been observed that tower responded to human induced loads not necessarily with lowest frequency but with frequency that has lower damping ratio and still relatively close to the typical pacing frequency.

V. Acknowledgements

This work has been supported by the European Social Fund within the project "Support for the implementation of doctoral studies at Riga Technical University".

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National Economy and Entrepreneurship

Scientific Problems of Technogenic Environment Safety

The Analogous Workplace Method

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***Keywords* – labour protection, internal monitoring of working environment, analogous workplaces.**

I. INTRODUCION

From the point of view of labour protection, road construction is considered to be comparatively dangerous field – every year many accidents happen and many employees get permanent health problems – occupational diseases.

Typical for motor road maintenance working environment is characterised by constantly changeable workplaces at different objects, great number of heavy machinery and equipment, high risk of traffic accidents, higher level of noise, vibration, dust and other chemical substances. As well employees are subject to different biological risk factors, climate situations and radiations. Main method for creating safe working conditions is training workers in safe working methods and techniques. [2]

For labour protection system at an enterprise to work and bring desirable results, it should not only be introduced and maintained, but also systematic and effective inner monitoring of the system should be ensured.

Statistic data testify that bigger part of accidents at work are the fault of workers themselves. The cause of them is employees' inattention, as well as ignoring the requirements of labour safety.

The problem discovered in the field of road construction and maintenance is the circumstance, that the biggest part of this field employees are employed in several workplaces. Especially it refers to construction equipment drivers. As a result, the problem is caused by excessive amount of information presented to employees. Mainly it refers to the volume of documentation on the analysis of working environment risks employees should be acquainted with. As a result training is not effective and employees get acquainted with it very superficially.

II. METHOD

For employees' training to be more effective, I propose, on the basis of analysis of workers' survey results and the analysis of working environment risks, to combine into groups workplaces, where the factors of working environment risk are identical (analogous) in this way reducing the volume of documentation and information every employee should get acquainted with.

To be able to objectively evaluate working environment risks and how essential they are, it is important that the employee of definite workplace also took part in the inspection of workplaces, as he exactly knows better, what working environment risks are there at his workplace. In addition, workers' survey should be noted as good practice. Specially elaborated questionnaires handed out to employees for filling in serve this purpose. [1]

While performing the analysis of employees' questionnaires, as well as the analysis of documentation on working environment risks crystallise the workplaces, where existing working environment risk factors are analogous in their structure. For example, on the basis of this research, I propose to establish the following groups of workplaces:

- **Workplace of construction equipment driver**

In this group, taking into account the fact, that working environment risks are analogous in their structure, such workplaces as road grader driver, excavator driver, bulldozer driver, tractor driver, car driver and lorry driver can be also included.

- **Working place of engineering personnel**

In this group, taking into account specific features of work and existing risks, accountant, work superintendent, brigade leader, personnel manager, production engineer, executive director, road master, mechanics engineer, production dispatcher, building and territory keeper, labour protection engineer, mechanic and road construction engineer are included.

Creating such groups of workplaces, which are combined into analogous workplaces according to the working environment aspects, the volume of documentation employees should be acquainted with can be reduces sufficiently. Quality of information presented does not lower, so this presentation would be more effective and valuable, as well as it would significantly ease the work of the person in charge of labour safety. I believe that this improvement would also reduce the number of accident at work risks, as employees would get acquainted with documentation on the analysis of working environment risks at their workplaces more carefully.

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Analysis of the inertial parameters of fire detectors

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A.Golubevs (*State fire and rescue service of Latvia, Latvia)*

Keywords **– ugunsbīstamība, detektori, parametri.**

I. INTRODUCTION

This work is devoted for studying of various parameters of fire detectors, operation principles and features of structure. In the study the description of parameters and constructive differences of smoke, thermal, gas and flame detectors was performed. The special attention is given to the basic principles of fire recognition by different types of detectors. For convenience of perception, the description of fire detectors is according certain logic sequence, relying on classification of detectors by a distinguished factor of fire existence: thermal, smoke, flame and gas. Video fire detectors are described in separate chapter, as, using various algorithms of computer processing of a signal, these can aid smoke and flame detectors. Information about video detectors is given only for outlook expansion in the field of fire detectors. Detailed algorithms of video signal processing should be looked for in specialized literature.

In a practical part of this work comparisons of various smoke and thermal detectors was performed. Time of a response of detectors for the various test centres of ignition was fixed. At the end of work is given the conclusion on the performed tests.

II. DETECTORS

Fire detector is a component of automatic fire detection system that includes at least one sensor, which continuously or in a certain period of time controls at least one physical or chemical parameter connected with process of burning.

Usually fire detectors are divided into two basic groups: manual and automatic alert devices. Manual alert devices are placed at the exits or along evacuation ways as required by Latvia standard LVS CEN/TS 54-14. [1;4] In many cases it looks like red button on the wall. In emergency situation a person should push this button, but it can be too late when someone notices fire flames or clouds of smoke [1].

Nowadays automatic fire detectors are used to discover fire at its initial stages. Detectors work in day and night without interference from any person. Automatic fire detectors can be divided into several subtypes: smoke, flame, thermal, video, carbon monoxide detectors, etc. There are spot detectors which are installed in certain places and have definite operation range and linear detectors that consist of a transmitter and a receiver and are based on laser technologies. The latser create invisible for people infrared “barrier” with direct visibility 100 and more metres long.

Each of the three standards testing methods in different conditions for each detector type are described in detail. All types of detectors are tested for different stoppage resistance, life span, instability of parameters that can appear during operation. However in testing description of the standards minimal time of reaction on any of dangerous factors is not mentioned. Requirements for detector marking are described in detail. Each standard has its own classification of detectors. In general, the requirements for fire detectors determined in the standards are similar. [2; 3]

III. CONCLUSION

After reviewing various literary sources and based on the experience in applying fire detectors one can conclude that operation of smoke and thermal detectors depends on air convection, which transfers hot gas and smoke from source to detector. Disposition and installation of fire detectors must be based on the necessity to limit the time spent on air transfer and with sufficient concentration of the products of burning in detector installation place. In general, hot gases and smoke will concentrate in the highest parts of a room, that is why smoke and thermal detectors should be placed there.

As smoke and hot gas go up from the source of ignition, they mix with cold air that comes into convection flow. Consequently, when the height of the room increases, to start thermal or smoke detector, width of ignition source or fire load should also increase. To some moment, this effect can be compensated using fire detectors with greater sensitivity. Consequently it leads to rise for detector price.

Usually, to protect any room, smoke or thermal detectors are placed at maximally acceptable distance between them. In the standard LVS CEN/TS 54-14 it is 5 m between thermal detectors and 7.5m between smoke detectors [1], but some local places can be protected with additional detectors. For example, systems with linear thermal detectors are suitable for protection of energy equipment or cable networks. In this case detectors should be placed as close as possible to the place where overheating or fire can appear.

Effectiveness of automatic fire detection system can be affected by obstacles between thermal or smoke detectors and products of burning. It is very important for detectors not to be places too close to warm air flow obstacles. At the junction of a wall and a ceiling there is so-called “empty space” where detection of smoke or warmth cannot be effective. While detecting carbon monoxide, the effectiveness can be lower if gas is transferred with the help of diffusion.

As smoke and hot gas spread horizontally, parallel to the ceiling, there is a petrifaction layer close to the ceiling. It excludes the possibility to place thermal and smoke detectors so, that sensitive element of a detector could be placed at one level with ceiling. This restriction can have less importance in case of aspiration system, as the system actively absorbs air samples.

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Dynamic lighting system for workplaces at northern latitudes

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Keywords **– dynamic lighting, spectrum, color temperature, indoor lighting, workplace ergonomics.**

I. Introduction

In this article the author analyzes relevant quality parameters of ergonomic lighting systems and formed a model for an ideal dynamic indoor lighting system. Based on the literature review [1], [2] and author's previous research the following parameters are considered essential in developing ergonomic lighting systems: 1) full spectrum, 2) high color temperature, 3) flicker-free, 4) sufficient illuminance level, 5) glare-free, 6) uniformly lit and 7) no electromagnetic disturbances. The essence of dynamic lighting deals mostly with the first two parameters.

In developing the dynamic lighting system fit to northern latitudes, the author sees it necessary that such lighting system's spectrum and color temperature follow the same parameters of natural daylight in the corresponding geographical region. As for example, when observing spectrum and color temperature throughout the year and day in south-European latitudes they have a great difference to those observed in northern Europe. The latter region is where the study was performed and the current model produced for. The author presents the findings from the literature and argues the necessity of each parameter to be included in the system.

In addition to examining the light characteristics of the natural daylight this study provides an overview of the typical modern indoor lighting systems. The parameters of these indoor lighting systems are compared to those of a natural daylight. The author brings forward the characteristics of the modern indoor lighting most problematic in regard to the ergonomic aspects of lighting.

The aim of this study is to develop a model for an indoor ergonomic lighting system that would best match the afore-mentioned parameters and match the natural daylight.

II. Method

In order to develop an ergonomic lighting system model the author performed 1) a literature analysis and 2) a series of measurements. The goal of measurements was to record the characteristics of natural daylight throughout the six month period from winter solstice to summer solstice – a period from when the sun is at its lowest and to when at it's highest. In average, two measurements were done per month, recording the sunlight spectrum, color temperature, illuminance level and UV-radiation output. Additionally on-site air temperature and relative humidity level were recorded. To perform the task the instrumentation included lux-meter, optical spectrometer, UV-meter, infrared thermometer and a PC to record the data.

The literature analysis mapped what health effects and cognitive effects are known from afore-mentioned lighting parameters. The purpose of the literature analysis was to support the proposed model with research data.

Taking into account the literature findings and the measurements' analysis the author formed an ergonomic lighting system model.

III. Results

The natural daylight measurements were conducted in the latitude of 59 degrees (city of Tallinn). Figure 1 displays solar noon spectrum measurements of the sun in 1) in the winter and 2) in the summer. A spectrum of the compact fluorescent light bulb (CFL) is added for a reference. The difference in between the two seasons is obvious and highlighted in grey. The difference from a regular CFL, most common in nowadays European indoor environments, is even clearer.

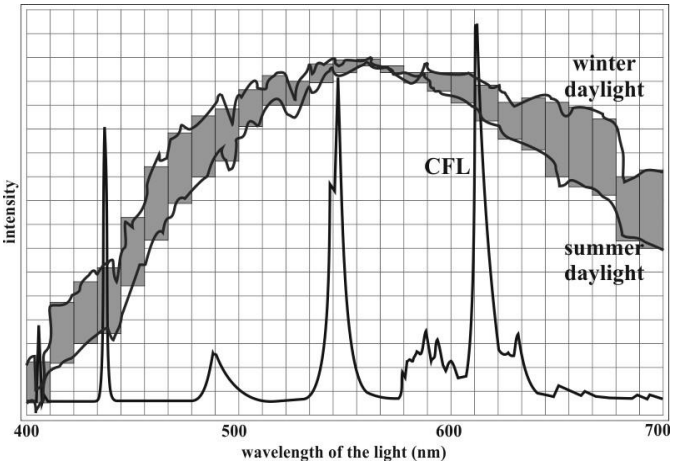

Fig. 1. The author's measurements for the spectrum of the summer sun, the winter sun and the CFL.

The author forms a model of a dynamic and ergonomic indoor lighting the essence of which is to as closely as possible to follow the daylight spectrum of the corresponding time of the year. Next to following the seasonal spectrum the model prescribes a spectrum also for the course of the day. The basic principle behind the day spectra variance follows the findings of the literature – having a yellowish tone at the evening, bluish at noon and reddish by the end of the day. The described color tone is likely unnoticeable by the eye but does affect the circadian rhythms of the human body, telling when it's time to be active and when it's time to prepare to rest. .

IV. Conclusions and Discussion

In this article the author formed a model for dynamic indoor lighting system that best matches the natural daylight characteristics. The author argued why this model would suit the human in the work environment better than majority of the lighting system in use at present time. This article provides a theoretical basis, grounded with instrumental measurements for the future studies in developing and analyzing the benefits of such dynamic lighting systems that match natural daylight characteristics.

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Exposure from electromagnetic fields at modern office workplaces and their risk management

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Keywords **– electromagnetic fields, occupational exposure, Wi-Fi, wireless networking, risk management.**

I. Introduction

This study focuses on computer workplaces in modern office environments. Electromagnetic fields (EMF) present at computer workstations are measured to determine the occupational exposure from this risk factor. The study will give an overview of exposure levels of different office environments and workplace settings. Settings include working on desktop and laptop computers, also encompassing surrounding office equipment such as copiers, printers etc. Especially the high frequency electromagnetic radiation from mobile phones and wireless networks has become a topic of controversy in most modern countries in the recent years. European workers have shown concern in regard to such exposure as whether the applications that utilize the microwave radiation are safe to their health. The authors tackle this issue by analyzing the results obtained from the on-site measurements in regard to the European safety limits and recent research findings suggesting much lower safety limits.

This study contributes to the scientific body of knowledge by pointing out the electromagnetic "nuisances" in modern technogenic office environment, taking into account the rapid development of information technology in the past few years that has greatly diversified the use of IT-equipment in workplaces. A large increase has taken place in the use of laptop and netbook computers, also increasingly more work is being performed with the use of the tablet PCs and smartphones. All of these IT-newcomers contribute to the ambient electromagnetic fields, increasing the workers' electromagnetic exposure. The spread of IT-devices and wireless networks has raised the EMFs to the levels unprecedented in the history of mankind.

The European leaders have called for thorough studies on the EMF levels in modern work and living environments [1], [2]. Several studies have also indicated that exposure limits meant to guard European workers' and general population's health might indeed be outdated and need for revision [3].

The novelty of the authors' approach is using 14 points measurement protocol to create a detailed map of the worker's exposure to the EMFs. Standard measurements, where only one point is recorded, might miss significant exposure data. Also by detecting in which body parts the exposure is greatest allows better analysis in regard to adverse health symptoms.

At the latter chapter the authors discuss risk management of occupational exposure to EMFs. Different work methods and computer workstation set-ups to minimize worker's exposure to the EMFs are analyzed. A comparison is made along the measurement data to estimate an exposure dose that can be avoided by using proper set-ups.

II. Method

Three main regions, where modern office appliances operate, are all measured: Low frequencies, Medium frequencies and High frequencies. Low frequencies (LF) measurements encompass power grid frequency electromagnetic fields – appliances operating on frequencies of 50Hz and it is harmonics (usually up to 2000Hz). Medium frequencies (MF) encompass 2-100kHz frequencies operated widely by switching power supplies. A special attention is paid on to high frequency (HF) (800-3000MHz) range of the electromagnetic spectrum that covers the wireless applications such as wireless network (Wi-Fi, 3G) and other mobile communications (i.e. GSM repeaters placed on the buildings etc.).

The position of the worker's body is used as the measurement location. To provide a comprehensive picture of the worker's EMF exposure several points along the imaginary torso, head and limbs are measured (altogether 14 points). For each point the measurements are done using 1) LF-MF field strength meter and 2) HF meter. In LF's and MF's the magnetic field and electric field are measured independently.

III. Results

Altogether 32 workplaces were measured. The results indicate a great variance of EMFs along the workplaces – from about 10 to 650 V/m in case of electric fields. Upon the inspection the authors concluded the variance to be dependent upon the set-up and diversity of the computer hardware used by the worker. The strongest EMFs were measured where laptop computers without external monitor nor keyboard, mouse were used along with the wireless network (Wi-Fi).

IV. Conclusions and Discussion

Comparison of the measurement results to European legislation (directive 2004/40/EC) shows that workplaces are indeed within the safety limits.

The authors see the precautionary principle adopted by the European legislators indeed necessary in the development of future legislation, both on the European and national level, as the scientific body of knowledge is lack of abundance in studies of long-term effects from the electromagnetic fields. Also the indirect health effects must be studied whereas the current EMF legislation only considers direct effects. Therefore the authors conclude that considering the multitude of the EMF sources present at the modern workplaces and the uncertainty regarding some of their effects discussed, it is recommended to minimize the EMF exposure.

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Fire resistance evaluation of reinforced concrete structures

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Keywords **– fire resistance, concrete structures, injector, pre-aeration, sprinkler**

The study of fire resistance of reinforced concrete structures of buildings is today an urgent task. Effective static work at normal temperatures can lead to unpredictable results in case of fire [1]. Therefore, reinforced concrete structures need a reliable support of their sustainable operation in fire effects. Due to time-dependent thermal conductivity in case of fire, the calculation using the simplified calculation methods is difficult to maintain.

Modern buildings and facilities must meet the safety requirements for the entire period of their operation. The requirements of fire safety are most important and laid at the design stage of buildings. Without looking at serious steps to reduce the number of fires made in the last decade, the number of fires is still high. Undoubtedly, the measures taken to contain and eliminate the fire arose, such as automatic detection and extinguishing fires, largely reduces the risk of fire impacts on buildings. However, they are dependent on many factors, such as the stability of energy supply, reliability, communication lines and automation systems, and more. All this causes the probability of failure of these systems and, consequently, buildings and structures must be resistant to the possible effects of fire.

Resistance to fire all over the world called the fire resistance. For optimum regulation of the indicator there is the concept of "fire resistance rate" - as the stability of structures exposed to fire, the rated thermal power. Fire resistance of building structures, as shown by numerous studies, is highly dependent on the ability of design to burn and change their strength and deformation characteristics under fire conditions.

Reinforced concrete, as a non-combustible composite material has a relatively high fire resistance. Destruction of concrete structures in fire and, consequently, the onset of fire resistance, is mainly due to reaching the yield stress in the reinforcement, which in most cases occurs at a temperature valve 400...500°C or more. Thus, the fire resistance of reinforced concrete structures is largely determined by fitting warm-up time to critical values - that is the subject of thermal calculations.

This can be made by means of simulation of structures under fire in the computer-aided design. The adequacy of the modeling environment can be confirmed by comparison with experimental data on fire. This process is conveniently carried out in three stages: model validation materials (concrete, rebar), model checking of simple structural elements (beams, columns, trusses), model checking frame systems.

For lightweight aggregate slabs 120 mm thick subjected to standard fire exposure from below, the smallest deviation (within 20%) is observed for all methods within 40 mm from the heated surface and the importance of fire exposure time of more than 60 minutes. For all calculation methods are typical deviation of about 80% of initial values for the time of fire exposure. Apparently, this is due to too low temperature value of heated sample surface. The values for the calculation methods [2, 3] give a deviation of 60 ... 80% for the unheated side of the overlap, while the calculation with the use of CAD ANSYS gives the deviation of not more than 50% only in the initial stages of fire exposure, subsequently, after 90 minutes, these deviations not exceed 5%

Based on a complex comparative studies, the authors developed a technique for modeling time-dependent thermal conductivity in case of fire in computer-aided design. The simulation results can be used to organize the numerical experiments and, therefore, to develop a simplified calculation methods (for example, based on the method of limiting equilibrium) for use in concrete construction system.

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Multi-step Evolution of Radiation Dust Under Gravitation in the Pollution Prediction Problems

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Abstract **–** The article proposes the basis for calculation of the evolution in time and space of one of the most important factors damage radiation accidents - radioactive dust. It was proved that the decontamination of areas contaminated by radioactive dust should be carried out in several stages. If the first stage is cleaning the surface, which quickly removes large dust particles, then the second stage should be to clean the air of very small particles since these particles are most dangerous to the respiratory tract. Quantitative limits of the three modes of evolution of radioactive dust in the gravitational field are determined and influence of the boundary condition was considered. The equations that give the description of the evolution of dust particles of arbitrary size were derived.

Keywords –environmental impact, accident, radioactive dust, sedimentation.

The task of improving the accuracy of prognostic assessments of radiation characteristics of the radioactive contamination of military equipment, the environment and doses to personnel and the population is among the most important tasks in the field of radiation safety [1-3]. Therefore, the solution of such problems requires the original equations of motion, taking into account the behavior of particles at all time scales and distances. This approach allows a consistent conclusion of approximate equations, which are then used to solve specific problems. At the same time taking full account of approximations performed to evaluate the accuracy of the results.

Consider the radioactive dust, as a system of particles suspended in air, non-interacting with each other. Then, the motion of a single particle is described by Langevin equation [4]:

$$M\frac{\partial v}{\partial t} = -bv - Mg + \rho_0 Vg + f_{st}. \qquad (1)$$

Here the first term is the force of friction, the second and third terms are defined by the presence of gravitational field, they account the force of gravity and the Archimedes force. The value $M = \rho V$ is particle mass, $V = 4\pi R^3/3$ is volume, R is radius, and ρ is density of the particles, the value of g = 9.8 m/c^2 is gravity acceleration near Earth's surface, and ρ_0 is density of air. The last term describes the contribution of random collisions of molecules of air and particle represented as a random force. A solution of this equation [5] gives a complete picture of the evolution of dust in the gravitational field of view of diffusion.

The typical dependencies on the height at certain points in time are presented in Figures 1, 2 and 3. In these figures one can observe how physically different mechanisms determine the evolution of the system depending on the size of the particles.

In the case of very small particles (Fig.1) we observe just diffusion relaxation with almost immovable center of gravity.

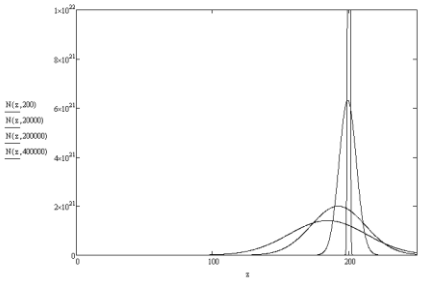

Fig. 1. Spatial distribution at different times for the small sizes of dust

In the case of very big particles one can observe the falling in a gravitational field with a small spreading (see Fig. 2)

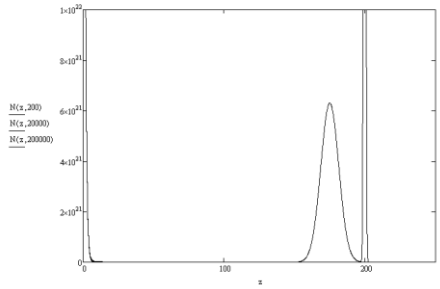

Fig. 2. Spatial distribution at different times for the large sizes of dust

Finally, in the case of particles with intermediate sizes one can observe the simultaneous action of diffusion and falling.

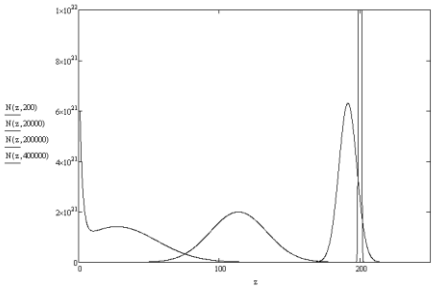

Fig. 3. Spatial distribution at different times for the medium sizes of dust

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Simulation of Two-Phase Flow in the Diffuser with Foam Sprinklers Pre-Aeration Extinguishing Agent

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***Keywords*– fire extinguishing systems, foam, injector, pre-aeration, sprinkler.**

At the present time to obtain a low multiplicity of foam at automated foam extinguishing systems the most widely used (up to 90% of the total foam sprinklers), universal foam sprinklers low multiplicity. A promising way to improve the efficiency of foam sprinklers low gas saturation is the multiplicity of the extinguishing agent. So far, the task of creating domestic sprinkler with pre-aeration, the extinguishing agent for automatic foam fire extinguishing systems is not implemented. In this connection it is interesting to study the mechanics of fluid motion in these sprinklers.

A theoretical study of fluid motion in a vertical injector. We use the method proposed in [1].

We use the theorem of conservation of momentum. We define the forces acting on an elementary section of the cone included between the sections S_x and $S_x + \Delta x$, as well as their projections onto the axis O_x, passing along the axis of the diffuser.

Gas content φ is given by (1, 2):

$$\varphi(x_0,t_0)=\frac{1}{\Delta t}\int_{t_0}^{t_0+\Delta t}\varphi'(x_0,t_0)dt\ , \qquad (1)$$

where $\varphi'(x_0, t_0)$ − fraction of the area S_{x0}, occupied by the gas fraction at time t; $\Delta t >> 1/n_{sr}$ (n_{sr} - the average rate of passage of the gaseous fraction of the individual entities through the cross section S_{x0}).

For the elementary section of the diffuser made between sections of S_x and $S_x + \Delta x$ ($\Delta x << 1$, where Δx is replaced by dx), we write the momentum conservation law. Given that for a continuous function

$$\int_x^{x+\Delta x} f(\xi)d\xi = f(x)dx\ , \qquad (2)$$

(Up to the members of the 2nd order), neglecting terms of order of magnitude greater than unity, we write:

$$\begin{aligned} &g\cdot\pi\cdot tg^2\frac{\alpha}{2}\cdot x^2\left[\left(\rho_g-\rho\right)\cdot\varphi+\rho\right]dx-2\cdot\pi\cdot tg\frac{\alpha}{2}x\cdot\tau dx+\\ &+2\cdot\pi\cdot tg^2\frac{\alpha}{2}\cdot x\cdot\sigma dx-\pi\cdot tg^2\frac{\alpha}{2}\left(x^2\frac{\partial p}{\partial x}dx+2\cdot x\cdot pdx\right)=\\ &=\left(W+dW\right)\cdot\left(\nu+d\nu\right)+\left(W_g+dW_g\right)\cdot\left(\nu_g+d\nu_g\right)-W\cdot\nu-\\ &-W_g\cdot\nu_g \end{aligned} \qquad (3)$$

where W, W_g - massive spending, respectively, liquid and gaseous phases; ν, ν_g - velocity, respectively, liquid and gaseous phases.

To this add the equation of continuity equation, which in this case takes the following form:

$$\begin{aligned} &\pi\cdot tg^2\frac{\alpha}{2}\cdot\left\{x^2\cdot\frac{\partial}{\partial t}\cdot\left[\rho_g\cdot\varphi+(1-\varphi)\cdot\rho\ \right]+\right.\\ &\left.+\frac{\partial}{\partial x}\left[x^2\cdot\rho_g\cdot\varphi\cdot\vartheta_g+x^2\cdot\rho\cdot(1-\varphi)\cdot\vartheta\right]\right\}=0 \end{aligned} \qquad (4)$$

where ρ, ρ_g - respectively, the density of liquid and gaseous phases; α - cone angle of the diffuser; τ - shear stress at the wall of the diffuser; σ – normal stresses on the wall of the diffuser. p − pressure perpendicular to the O_x-axis sections. W, W_g - massive spending, respectively, liquid and gaseous phases; ν, ν_g - velocity, respectively, liquid and gaseous phases.

The system of differential equations (3), (4) describes the motion of two-phase flow in the diffuser for aeration injectors fire extinguisher sprinkler in low multiplicity. The solution of this system will determine the necessary hydrodynamic parameters and geometric characteristics of the injector-aerator.

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Assessment of work environment hazards during shale oil handling

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***Keywords* – shale oil, toxicity of chemicals, workplace air, influence on health.**

I. Introduction

Estonian oil shale is the main national commodity in the country. Oil shale has been extracted for centuries. It was discovered in the North of Estonia more than 200 years ago. At the present time the Estonian government invests to the use of oil shale in the form of oil. It is used as boiler fuel in houses, might be also used in cars, vessels and other applications are possible.

The current paper describes the investigations in Tallinn University of Technology in chemical de-composition and combination of hazardous gaseous phase during production and handling of shale oil.

II. The Aim of The Study

The aim of the study was to determine the toxicity and concentration of hazardous gaseous components in the work environment and to work out the matrix for connections between the toxic components' concentrations and possible health damages.

III. Material And Methods

Two types of medium fraction fuels were investigated: shale oil and petroleum-based.

Chromatography of gases was used as the main determination method while a lot of complex organic compounds are created in the production and handling processes of shale oil. A common combination is gas chromatography-mass spectrometry (GC-MS). In this technique, a gas chromatograph is used to separate different compounds. This stream of separated compounds is fed online into the ion source, a metallic filament to which voltage is applied. This filament emits electrons which ionize the compounds. The ions can then further fragment, yielding predictable patterns. Ions and fragments pass into the mass spectrometer's analyzer and are eventually detected.

In the preliminary stage of investigation chemicals in the workplace air were measured with Dräger-Accuro Gas Detection express method using the pump and indicator tubes for determining the concentration of different gaseous components: benzene (C_6H_6), phenols (C_6H_5-OH), toluene and o-xylene (C_8H_{10}).

In the theoretical part of the study the vapour pressure of air contaminants (benzene, xylene, toluene, phenol) on temperatures (25- 70^0C) was calculated. The Engler distillation was used for the determination of the amount of vapour phase in the same temperatures. The toxicity of the substances was determined using toxicology databases (TOXNET, ECOTOX, TOXSEEK etc.).

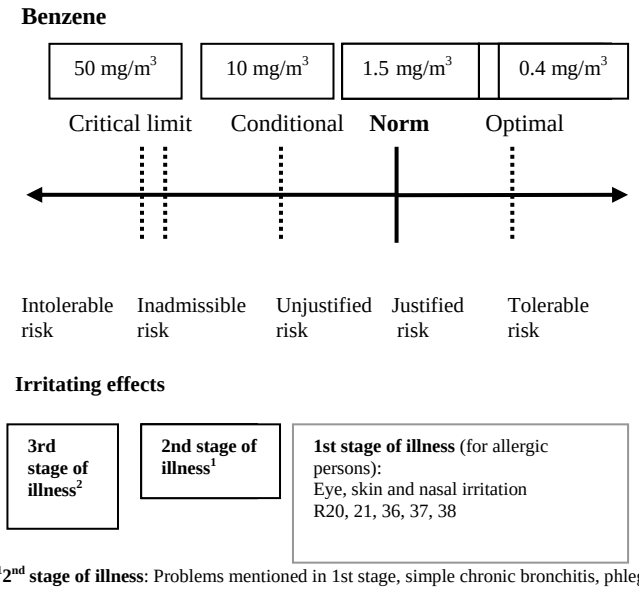
IV. Results

The most hazardous component in the work area is benzene (Table 1), the concentration in the worker's breathing zone was 3.2 mg/ m^3 (exposure limit= 1.5 mg/ m^3). Benzene is carcinogenic and it has to be removed from the work environment. Benzene was found both in petroleum-based fuel and shale oil fuel. The other chemicals found in the work environment (using the shale oil based fuel) over the limits were phenols. The petroleum-based fuel gave high concentration for xylene, toluene and phenols. So the shale oil fuel is more safe for use. The sulphur containing components were not found in the medium fraction of shale oil. The risk assessment of benzene is shown in Fig.1. The irritating effects are given in the Fig.1, but the substance (benzene) has also the neurotoxic and carcinogenic effects. The other measured substances (xylene, toluene, phenols) are not carcinogenic, but cause upper pulmonary irritations and the risk assessment model has been worked out for all chemicals found in the air of the work environment.

TABLE I

Concentrations and exposure limits of different Chemicals from fuels in the air of the work environment

Fuel	Chemicals, ppm; U=10…30%	Chemicals, mg/m^3	Exposure limit, mg/m^3
Individual boiler (petroleum-based fuel)	benzene- 1.0 toluene- 300.0 xylene- 60.0 phenol- 20.0	3.2 1128.0 260.4 76.0	1.5 192.0 200.0 8.0
Commercial Boiler (shale oil fuel)	benzene- 1.0 toluene- 6.0 xylene- 8.0 phenol- 9.0	3.2 23.0 35.0 34.0	1.5 192.0 200.0 8.0



[1] **2nd stage of illness**: Problems mentioned in 1st stage, simple chronic bronchitis, phlegm, chest pain, upper pulmonary irritations, extrinsic allergic alveolitis, skin diseases
R23, 24, 25, 33, 34, 40, 43, 48, 62, 63, 64

[2] **3rd stage of illness:** Problems mentioned in 1st and 2nd stage, chronic cough, decline in lung function, asthma, severe skin diseases, stable severe damages
R26, 27, 35, 39, 41, 42, 45, 49, 60, 61, 65

Fig. 1. Five-step simple/flexible risk assessment method used for benzene as a carcinogenic component in the air of the work environment using the shale oil as fuel (R- risk phrases).

Trend of air pollution during electric arc welding and oxyacetylene cutting

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Keywords **– air, pollution, electric arc welding, oxyacetylene cutting.**

I. INTRODUCTION

The purpose of this work is to assess the risk of air pollution with substances released during electric arc welding and oxyacetylene cutting. The main tasks, which shall be solved to achieve that purpose include: 1. Selection of a method for studying pollution arising from fire works, which allows application of an active experiment; 2. Carrying out experimental research; 3. Risk assessment; 4. Analysis and assessment of obtained results.

II. EXPOSITION

The method of physical modelling is applied for the solution of the first task. The method of the active experiment is applied which enables direct identification of parameters of critical situations. The following input factors of actions, which may incur risk of pollution are adopted: a) environment of distribution of risk effects; b) type of fire-catching material; c) surface density of the material on the floor ;d) additional processing of the flammable material by soaking with diesel fuel and gasoline; e) position toward the source. Output parameters of critical situations are firing of materials and air pollution from their burning. Criteria for assessment of the risk of air pollution include: 1) type of pollutant, 2) imissions, 3) probability P_K for pollution within the range $E[K] \pm \sigma(K)$, where $E[K]$ is the average value of concentration of pollution, and $\sigma(K)$ -mean quadratic deviation; 4) number of exceeding N of the maximum concentration limits; 5) probability Pnp for exceeding the maximum concentration limits within the range $E[N] \pm \sigma(N)$, where $E[N]$ is the average number of exceedings, and $\sigma(N)$-mean quadratic deviation; 6) time Tnp of exceeding of maximum concentration limits; 7) probability Pnp_T of the time of exceeding within the range $E[T] \pm \sigma(T)$, where $E[T]$ is the average value of time Тпр of exceeding, and $\sigma(T)$ - quadratic mean deviation. Probability $P_{K,}$ characterizes the content of pollutant in air, and Pnp and Pnp_T determine the degree of criticality. Risk *Rzam* is established by multiplying Pnp and Pnp_T . It is a complex criterion of pollution. Probabilities $P_{K,}$ Pnp , Pnp_T are determined by verifying the hypothesis for the statistical law of distribution.

Analysis of the results shows a number of clearly outlined trends. Concentration of pollutants and time of exceeding of maximum concentration limits are distributed according to laws for continuous random values – normal and Weibull. The number of exceeding is subject to the laws of discontinued random values - Poisson and binomial. Uncertainty, assessed through dispersion, quadratic mean deviation, variation ratio, is highest for pollution with carbon dioxide and dust. It is lowest for nitric oxide. Concerning number of exceeding and their duration, great dispersion of results is established, respectively uncertainty within statistical meaning. There is significant difference in the values of parameters of the normal law and the Weibull's law, which are established for concentrations. Anomalies are observed concerning nitric oxide, where they are much bigger compared to other pollutants. Outlined trends are confirmed also by average value and mode. Differential risks unite the average values and dispersion. Regardless of the subjective effect in selecting the scope, the introduced criteria $P_{K,}$ Pnp , Pnp_T are more objective than using the absolute values of concentrations. The same is noted for complex risk *Rzam*. It combines concentrations, number of exceeding and their duration. Comparative analysis shows that trends in change of differential risks Pnp и Pnp_T are preserved. It is explained with the fact that it is a product of them and relative share of the higher value has effect because it is a multiplier. Generally it appears that pollution with nitric oxide during electric-arc welding and oxyacetylene cutting features highest degree of risk. On second position is pollution with carbon oxide during electric-arc welding, followed by pollution with dust during abrasive cutting. As to other pollutants *Rzam* changes from 0,1771 to 0,5832. Regardless of the small range of variation the criterion has great sensitivity and resolving ability.

III. CONCLUSION

The paper proposes that the method of physical modelling is applied for assessment of risk of air pollution during fire works. Air pollution is measured in different points in the space of distribution of pollutants within the range of the modelling system. Colorimetric method is applied to measure the concentrations of carbon dioxide, carbon oxide, acrolein, nitrogen oxide and acetylene. Dust concentration is measured by gravimetric method. These methods enable accurate practical measuring to a sufficient extent. Risk assessment is made by a new method. It is based on determination of the laws of distribution of exceedings of maximum concentration limits. Then probabilities of occurrence of changes within the specified ranges around the average value are established. In the same way the ignition time is handled. The complex risk is a product of probabilities for the number of exceedings of the maximum concentration limits and their duration. Analysis of results show that the applied criteria for risk assessment reflect objectively levels, variations and dynamics of pollution. Uncertainty in terms of statistics is reflected. It also important that the method of physical modelling allows carrying out a wide range of planned experiments which otherwise would be impossible in normal production conditions.

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Diagnostic of transboundary environmental security

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Keywords **– environment, diagnostic, risk, security, border zone.**

I. INTRODUCTION

Transboundary hazards is a criterion of environmental security in border zone. It is a distinguishing mark, a property of the quality of production systems and economical activities. It changes in the course of time and has environmental hazard character. The risk is an indicator of environmental hazards. Therefore risk is not only a criterion of security, but also object of diagnostic.

II. EXPOSITION

The subject of this diagnostic is hazards of subjective and objective type, occurring in production systems of border economical activities. They characterize the problem of this diagnostic – risk and common relations between components of production systems and surrounding environment in border zone. The object of the diagnostic are the production systems in border zone, which have exactly specified functions. The basic requirements, which can be formulated for that diagnostic, are: a) objectivity; b) pragmatics; c) universality regarding its application in various systems; d) implementation to different phases of production processes and the life cycle of products; e) coordination with the state-of-the-art achievements in environmental security and known natural laws; f) experimental check ability and provability; g) limitation and reality of assumptions; h) logic. The well-argued and adopted morphological model of criticality [1,3] of production systems environmental treats it as an process in the course of time. The basic stages of the diagnostic are:

I Stage - Formalizing environmental hazards which aims at describing hazards sufficiently enough. It is a basis for developing and undertaking protective actions and for establishing information system. Therefore the following tasks must be performed: 1) Determination of the production system, formulation of system borders, input factors and output parameters, having influence on controllable and uncontrollable parameters; 2) Defining goals and tasks, specifying structure, common and private functions of production equipment; 3) Structuring of technological machines, apparatuses and equipment, decomposition and reporting of material, power and informational interaction between components on one side and on the other side the interaction with a man-operator, with people, elements of nature, etc. 4) Systematization of contact positions of environmental objects of influence with the sources of hazardous factors, respectively their imissions and emissions; 5) Descriptive model of hazards; 6) Formulation of environmental security requirements.

II Stage - Analysis of environmental hazards which aims at establishing the characteristics of hazard indicators, respectively current hazardous situations. To achieve that aim the diagnostic applies empirical research and modeling of hazards. Empirical researches must be carried out according to preliminary established: a) Research program – type of research; specification of indicators; principles, methods and approaches to performance; place, term and order; required means and personnel; b) Research methods – purpose; assessment and condition criteria; input factors and output parameters; methods of measuring; equipment and furnishing; research plan; sequence of performance; normative level; duration; number of observations and volume of sample; methods of processing of results and presentation form. We explain and create in practice statistical models; theoretical information models; logical models; models of subjective danger; physical models; semiotic models [1,2,3]. c) Results of analysis serve for formation of information database, which is a basis for approval of a reasonable concept for making safe the production systems. For that reason it is connected with the conceptual phase of design and also with a united block for risk assessment and decision-making.

III Stage- Classification of hazards aims at determining the class of the task that should be solved. Thus classification signs are defined, based on which environmental hazards are classified and rated by events, actions and damages.

IV Stage – Synthesis of environmental security includes three groups of methods – protective, corrective and compensating actions. Protective methods aim at preventing and reducing hazardous events – sources, risk factors and their emissions. Corrective actions aim at limiting emissions of risk factors along the channels of distribution, of space and time co-existence of the objects of influence and emissions. Compensating actions apply in order to limit damages that already have occurred – physical, chemical, biological. Risk assessment at this stage is final and is accompanied by the application of the method “costs-benefits”, which is the basic principle of the universally adopted approach ARAL. The conclusion for the optimal solution is based on it.

V. Stage - Information assurance.

III. CONCLUSION

In general the diagnostic of transboundary environmental security has cyclic character. It allows operational and stage-by-stage return to previous solutions and iterative search of improved solutions. Combining the diagnostic with the methods of design of production processes in economical activities in border zone allows applying constructive solutions and complete technological design of production systems of economical activities. The application of the presented diagnostic in different productions [1,2,3] has proven its efficiency.

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Economic System of Evaluating Effectiveness of Fire Protection Taking Into Consideration Use of Mobile Robots

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Keywords **– fire protection, economic effectiveness, mobile robots, scientific research, tracked vehicles.**

I. INTRODUCTION

One of state security directions is its fire security. Rising in level, reduction of fire risks to socially acceptable level, reduction of the number of the dead and the injured in the result of fires, as well as reduction of damage from fires is achieved by using new technologies, such as mobile fire robots.

Fire robots can be divided into mobile and stationary.

There are no normative documents elaborated for mobile robots. The reason of it is the novelty of this trend: it is not clear what constructional schemes of these robots are the most effective for fire-fighting, how these robots can be used in emergency focus, what is the economic effect from their use. Research in this field should be started with calculation of economic effectiveness.

II. GENERAL PART

Calculation of economic effectiveness of fire protection system is used for performing such kinds of calculations [1]:

1) preliminary calculation of economic effectiveness, preparing annual and prospective plans as well as substantiating the variants of new technical technical solutions in the sphere of fire protection formation;

2) calculation of prospective economic effectiveness, fulfilling technical scientific works, as well as on the preparation stage of technical tasks, technical project and workpapers;

3) calculation of actual economic effectiveness, introducing the results of scientific research, starting line production of technology, as well as certifying technology to the highest quality degree.

Effectiveness of use of mobile robots has been discussed in [1-2]**.** The case with using mobile robot reduces time, before starting fire extinguishing. Besides, informational awareness of behavior of fire is considerably improved because of usage of measuring instruments of robots.

Use of mobile robots also increases informational time of fire fighting process. In case of fire brigade starting from fire station, primary information comes from an operator. On their way the head of the brigade reviews the documentation about the object of extinguishing and upon arrival to the place of fire he performs examination of the place, survey of eyewitness, as well as reconnaissance.

In case of using mobile robots identification of the fire and examination of it is performed simultaneously. Primary means of fire extinguishing being available, immediate localisation of fire is possible. With the help of a robot it is possible to perform monitoring of fire process during reconnaissance, but during extinguishing robots can be used in the most dangerous places.

Effectiveness of the use of mobile robots depends directly on their constructional perfection and fitness to conditions of operation. Basically, mobile robots with tracked movers are used in fire fighting. That is why the research of tracked vehicles and their movers is topical.

Review and analysis of scientific technical works on the functioning of tracked vehicles and of patent literature about the construction of their movers marked the ways of improving the construction of mobile fire robots. Constructive examples of increasing the effectiveness of use can be using modular configuration or multisectionness of a machine. It allows effectively use the power of a power plant in transitional movement regimes (acceleration, deceleration) and hard operation conditions: low bearing capacity of soil, balking. Use of elastic elements in sprockets reduces dynamic load in transmission, improves smoothness of machine motion. Application of rubber steel mounting reduces their wear and improves the precision of interaction of elements „track – traction sprocket". Vibration ramming of soil in tracked vehicle movement gauge rises its passability.

Rising the level of fire security, reduction of fire risks to socially acceptable level, reduction of the number of the dead and the injures in the result of fire, as well as reduction of damage from fires is achieved by using new technologies, such as mobile fire robots.

Effectiveness of the use of mobile fire robots must also consider their economic effectiveness. To increase it, scientific research is necessary.

To assure good results in scientific research of this field, trends are defined and ways of research are marked. The result of such research is creation of experimental prototype of fire robot.

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National Economy and Entrepreneurship

International Business, Logistics, Customs and Taxes

The Role of Export Credit Guarantees in the Improvement of Business Environment in the European Union

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Keywords **– business environment, European Union, export credit guarantees, export.**

Nowadays along with the global economic crisis and its consequences export promotion has become a one of the key measures to encourage global economic development. Global economic crisis has especially developed an idea of state support for exporters in the European Union (EU). The EU is interested to support and encourage export of each of its member states because it contributes to the development of the EU and facilitates business environment.

The aim of this research is to study the existing export credit guarantees system in the EU, to identify its advantages and drawbacks as well as to elaborate the solution for its improvement. The authors have applied analytical and graphical methods to process and investigate the available information, as well as applied economic mathematical and statistical methods, quantitative and qualitative methods for statistical data analysis.

There exists a variety of political and commercial risks in export markets which exporters are facing in transactions with foreign buyers. Due to the decreasing consumer demand a sharp trading volume decline began in 2007 [1;2]. As a result, a plenty of enterprises representing various branches dropped in liquidity which led to an increase of precaution from credit institutions and insurance companies as well as to the decrease of commercial transactions' financing. At this time most of the countries increased state support to exporters by introducing export credit guarantees. Export credit guarantees in the EU are provided for cover of risks only for transactions to heightened risk countries. Currently, export credit guarantees in the EU are not provided nor to the EU member states nor to a number of member states of the Organization for Economic Co-operation and Development (OECD). Export credit guarantees to these countries were available to companies but only from 1 July 2010 to 31 December 2010. However, currently this option is no longer available which hampers the development of export credit guarantees [3].

At the moment a number of the EU member states are facing serious economic and financial problems. As a result they have become a heightened risk export markets, therefore it is highly desirable to provide export credit guarantees in order to help promoting export to these countries.

In the article the authors have elaborated the model for the argumentation to provide export credit guarantees to crisis-affected EU countries demonstrating a range of benefits the export credit guarantees bring to the EU economy (see Figure 4). The model may be used as a reasoned justification for the negotiations with the European Commission to widen the geography of the export credit guarantees availability. As it is shown in the Figure 1, the model consists of six stages. It shows the benefits the availability of the export credit guarantees to the EU countries would bring to the entire EU.

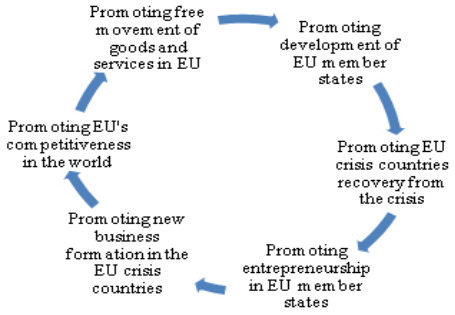

Fig. 1 Model of benefits of resuming of the availability of export credit guarantees to the EU countries

Firstly, over the last years Greece, Ireland, Italy, Portugal and Spain have become high-risk countries which has made export to these countries unpredictable. If export credit guarantees are available to high-risk developing countries (the third countries) then this possibility should also be available to the high-risk EU countries. The availability of export credit guarantees to the EU countries would foster the development of the export credit guarantee receiving companies encouraging the development of the crisis countries as well as their recovery from the economic crisis as entrepreneurship in these countries is to be facilitated. That would also encourage formation of new businesses in crisis countries.

Secondly, it is recommended to the EC to remove the prohibition of export credit guarantees to the EU crisis countries because that would stimulate their exports. In addition, these countries would be able to encourage their economies by exporting with each other. Consequently, exports of a crisis country as well as the development of other crisis affected countries could be promoted. In addition, the EU would benefit from it as as most of the crisis countries have received loans and financial support from the EU, and the resuming of export credit guarantees could stimulate the debt repayment. Moreover, cancellation of the export credit guarantees prohibition would bring benefits to the entire EU – the EU's competitiveness in world would be improved.

As a result of the investigation, the authors concluded that the resuming of the availability of export credit guarantees is highly desirable for helping the EU crisis countries to recover from the financial and economic problems and promote the development of the entire EU.

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Unification of Public-Use Railway Infrastructure Charging

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Railway infrastructure charges, discounts, increased cost.

I. Introduction

The displacement of global maritime traffic to railway causes a challenge on the development of a coherent charging system [1]. The purpose of this document is to research of the clear and single public-use railway infrastructure charging algorithm based on the work defined equality principle.

II. Equality principle

The principle of equal charging entails the same price for work in equal circumstances and the different price if the circumstances can differ [2]. Proposals for differential charging application criteria are worked out.

III. Charging system

Proposed charging system consists of three components – the basic price, reimbursement of costs spent in national transport policy implementation, charge differentiation tools which provide public-use railway infrastructure manager's guidelines.

A. Basic Price

Full cost pricing is suggested as the best pricing system. Basic price have a multi-part charging structure: marginal costs, operating charges covers routine maintenance and renewing which varies between train categories depending on the different function assurance and premium price if market allows this.

B. National Transport Policy Implementation

The main requirements for the charge differentiation are the prevention of cross-subsidies on the one hand and speculation in attracting government funding on the other hand as well as ensure effective policy decisions [3].

The infrastructure charge discount for politically significant rail services were formulated as charge reducing up to the marginal cost level, covering the difference from the state budget:

$$A_g = \frac{(I_p + I_g) - (I_f + I_f * U) * V}{I_p} \times 100 - 100, \quad (1)$$

where A_g is discount for politically significant rail services (%);

I_p is expenditure basis excluding the cost of providing subsidized transport policy (currency unit);

I_g is costs of providing subsidized transport policy (currency unit);

I_f are marginal costs of expenditure basis (currency unit on carriage unit);

U is premium price if market allows this (%);

V is planned amount of carriage to provide subsidized transport policy (carriage unit).

C. Differential charging to provide infrastructure manager's guidelines

Based on the work defined equality principle the tools for infrastructure charge differentiation were formulated as follows:

Increased infrastructure charge to provide for carriers' liability for railway infrastructure network problems in case of congestion due to technical non-compliance of operational activities:

$$P_v = \frac{J_p}{J_f} \times 100 - 100, \quad (2)$$

where P_v is increased charge to provide for carriers' liability for network problems (%);

J_p is scheduled capacity (daily load);

J_f is actual capacity (daily load).

- Discount on infrastructure charges as the liability of manager for network problems.

$$A_v = \frac{J_p}{J_f} \times 100 - 100, \quad (3)$$

where A_v is discount on charges as the liability of manager for network problems (%);

J_p is scheduled capacity (daily load);

J_f is actual capacity (daily load).

- Other charge differentiation can take into account several factors such as congestion, scarcity, performance, environmental impacts and so on. Thus charge should be equal to the social cost of expected unfavorable action and can only be applied when the net is effectively used.

IV. Conclusion

Unification of public-use railway infrastructure charging can be implemented using modal charging system, where basic price should be calculated on the similar principles, but each state and manager policies can differ.

V

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Export, industrial productivity and international competitiveness: the case of Latvia

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Keywords **– export, foreign trade, industry, efficiency, productivity, international competitiveness.**

I. INTRODUCTION

Export is one of the key driving forces in any economy nowadays. It is admitted that globalized world economy stimulates productivity and efficiency in sectoral and national level. The aim of the paper is to analyse and estimate the exiting relations between exports of goods and services and labour productivity. The main focus is on Latvia's economy, however in order to perform international comparison and reveal existence of regional or global trends the statistical data on neighboring countries as Estonia and Lithuania were used, as well the data on several European Union countries (as Austria, Slovakia etc.). The input-output data and analysis were used as the most appropriate and truthful source of information and research method. However, in order to perform general econometric analysis of existing relations in the economy, the statistical data of national accounts have been used. The paper tests the stated hypothesis that higher export activity (real export of goods and services; ratio of exports to gross national product (GDP)) leads to higher productivity in producing country (in Latvia).

II. REVIEW OF LITERATURE

Industrial efficiency and productivity taking into account the impact on sales (including foreign trade) analysed under input-output analysis have been performed by various authors. However, the authors focused on so diverse aspects (offshoring, natural disasters, transport etc.) and it can be observed that there are no reports on study that examines the relations and economic conditions as they are observed in Latvia (sharp economic growth for years followed by one of the fastest economic recessions; sharp and stable recovery of exporting activity after economic crisis etc.).

III. METHOD

In the study, the econometric and statistical methods were used as well principles of input-output (IO) analysis. The following indicators were computed on the basis of National Accounts (NA) and IO table data and analysed: labour productivity, ratio of value added of unit spent for labour and labour input coefficient.

IV. DATA AND RESULTS

In the research, two IO tables were used – of 2004, and 2007 (at current prices, national currency), as well as annual time-series of NA indicators (at current prices and at constant prices (volume), euro) and auxiliary indicators to NA (as labour productivity, real labour productivity per hour worked) (2000-2011) (at constant prices (volume)). Economic activity was analysed according to level of sectoral disaggregation of NACE classification Rev.1.1 (as IO tables) and Rev.2 (as latest NA data). As economic performance of Latvia is frequently compared with Estonia and Lithuania, the international comparison is performed according to the methodology and data of IO tables of these countries. The data source was *Eurostat* data base – IO tables [1]; National Accounts aggregates and employment by 60 branch (NACE Rev1.1), auxiliary indicators to National Accounts [2].

The results of relations analysis show that there is a strong correlation: a) between labour productivity (per employee; EU-27=100) (lab_prod) and real exports (coefficients of correlation (R^2=0.96); and b) between real labour productivity per hour worked in euros (r_lab_prod) and real exports (R^2=0.82) (See Fig.).

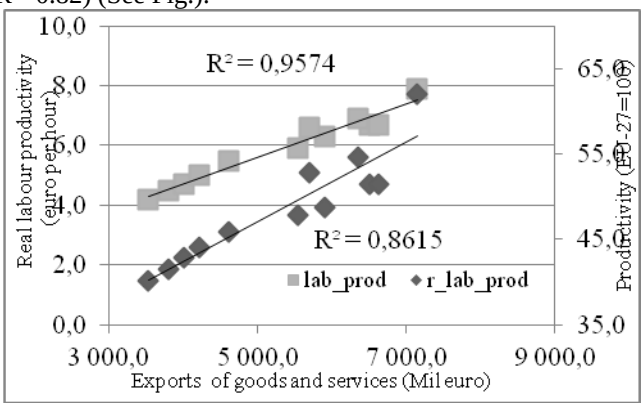

Fig. Labour productivity, real labour productivity and exports.

The analysis of IO tables data shows that labour input coefficients fluctuate significantly amid various branches in the economy - industry it is from 0.10 (Manufacture of basic metals) to 0.26 (Manufacture of wearing apparel). Though, the values of ratio of value added per unit spent on labour also vary among branches (the highest values in industry are in Energy sector, Manufacture of furniture, Manufacture of wearing apparel).CONCLUSIONS

The findings show that real export has doubled in 2011 since 2000 - from 3.5 to 7.2 billion euros. At the same time, the ratio of exports to GDP has also increased significantly – from 41.9% to 59.3%. Such a notable increase of export volume (both in absolute and relative figures) indicates the Latvia's economy is more focusing on foreign market rather than domestic. The increase of exports is accompanied by increase of productivity. However, the increase of productivity is lower. In 2011, in Latvia, labour productivity was 62.1% of the average of EU-27 (in 2000, 40.1%). However the real labour productivity per hour worked has increased by 88.1%. Sectoral analysis on the basis of data of input-output tables (examing productivity, labour input etc.) gives more precise and feasible results, especially when industrial activity is researched as technologies in branches are very diverse.

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Modeling perspectives, status and development of international lending in Ukraine

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***Keywords* – External debt, international credit, international financial institutions, project portfolio, credit risk.**

I. INTRODUCTION

One of the important scientific and practical problems faced by the financial science and of a need of an immediate resolution, is an urgent need to develop the science-based concepts and effective strategy of Ukraine's cooperation with international financial organizations. The difficulty in the way of financial stabilization and economic growth in Ukraine is largely due to the lack of financial resources.

I. INTERNATIONAL LENDING STATE

The global financial crisis affecting the economic recession in Ukraine caused an increase of state needs in borrowing resources. The main share in the gross external debt is short- and long-term international loans, which are distributed between four main sectors: public sector, organs of monetary (OM), banks and other sectors. So, on 01.01.2012 more than a half of the volume of the external debt is obligation on loans − 61.8% from the gross amount and a share of trade credit liabilities (payable accounts), which in 2011 increased from 11.8 to 14.0%.

Despite challenging times for the economy of Ukraine, obligation debt runs on time and in full and the solvency of Ukraine in the future is expected to remain at a level sufficient to meet all debt obligations.

II. COOPERATION WITH INTERNATIONAL FINANCIAL ORGANIZATIONS

In order to fulfill the tasks of the national economy modernizing and further structural reforms, defined by the President of Ukraine in the Economic Reform Program for 2010 − 2014 [1], Government carries out the work aimed at increasing cooperation with international financial institutions, increase the inflow of international technical assistance.

According to the Ministry of Economic Development and Trade for the entire period of cooperation Ukraine granted resources from International Bank for Reconstruction and Development (IBRD) amounting to $ 7.27 billion USD to fund 116 projects; from the European Bank for Reconstruction and Development (EBRD) amounting about $ 9.5 billion USD to implement 281 projects (65% used in the private sector); from European Investment Bank (EIB) − the amount of $ 1.7 billion USD for 7 projects; from International Finance Corporation (IFC) − the amount of $ 1.7 billion USD for 63 projects; from Black Sea Trade and Development Bank (BSTDB) − $ 0.260 billion USD for 13 projects (See Fig. 4) [2].

This could improve the structure and portfolio quality of international financial institutions (IFIs), especially the World Bank, by project portfolio reorientation from social and humanitarian sphere for the realization of profit and revenue-generating investment projects to modernize the infrastructure. So, today 88% of the current project portfolio is oriented to support the real economy, in particular for the modernization of transport (47%), energy (38%) and municipal infrastructure (3%).

III. MODELING INTERNATIONAL LENDING INFLUENCE ON THE ECONOMIC STATUS OF UKRAINE

The management purpose of external debt is to provide the economic development of the country through foreign loans while avoiding macroeconomic difficulties and problems of payment balance in future.

In the context of this, an attempt to determine the relationship of the economic situation in the country and the amount of external borrowing was made. As a result, a model of relationship between the volume of international lending (in) and state (Deficit/surplus) of Government budget (x1), the official exchange rate USD / UAH (x2), official reserve assets of the National Bank of Ukraine (x3) was created and the model was specified:

$$y = -50306.66 - 0.05x_1 + 103.27x_2 + 1.58x_3 \quad (1)$$

To investigate the influence of the volumes of external loans on the economic situation in Ukraine in 2012 the appropriate models are being constructed.

The results show that for all other equal conditions the Ukrainian economy will have positive effects on increased lending by international financial organizations. Thus, the growth can occur in nominal incomes of the population of Ukraine by 0.73%, nominal GDP by 0.63%, investments in fixed assets by 2.86%, revenues of the State Budget of Ukraine by 9.33% and expenditures − by 9.77 %. However, the increasing of consumer price index by 3.92% to 108.52% can have the negative effect. However this indicator is not critical, that's why Ukraine should continue to develop cooperation in the field of external loans.

IV. CONCLUSIONS

As practice shows the continuation of Ukraine cooperation with international financial institutions is appropriate and justified. However, to improve the efficiency of foreign loans in Ukraine it is necessary the further improvement of involvement, use and repayment of loans, limits and phasing out of foreign loans to cover the budget deficit when the deficit is not formed by investment expanding, ensuring unrelated nature of loans that the loans stimulate domestic production and are not used to import goods, etc. To do this, first of all, a management system of borrowings in Ukraine must be developed and implemented, and the first step in this development should be the Strategy of borrowing, which must be based on the state programs of social and economic development of Ukraine.

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Transit chain analysis

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Keywords – Transit, transit operations system analysis, synergetic effect.

I. THE EFFECTIVENESS OF A TRANSIT SYSTEM

The geographical position and geopolitical situation in Latvia lead to conclusions that the sphere of transit logistical services will be one of priority directions of Latvian economy development now and in the very near future.

It is important and interesting to make system analysis of transit operations, and to develop the special device of the analysis and transit operations efficiency improvement.

The main task of the research is working out of transit services system efficiency general indicators.

Using this tool we are going to create an effective system of cargo transportation by different transport types through the terminals construction for combined transportation based on the existing infrastructure of railroads, railroads development and converting to logistics centres. The implementation of these objectives will increase the role of transport freight units, improve the quality of the transport process and reduce operating costs. It helps us in integration increasing of various types of cargo transportation by transport chains creating between the different kinds of transport, loading operations and logistics services.

Transport hubs should work as connecting links between different transportation types to improve the efficiency and competitiveness of intermodal solutions, as well as between transportations and other logistics operations. There is one approach to efficient transport hub model creating, which is very successful in the countries of the European Union, - the logistic centres creating.

II. ANALYSIS OF FACTORS INFLUENCING TRANSIT SYSTEM

To define the main indicators influencing a transit system, firstly the major factors influencing that system were defined. The external factors influencing the system were analyzed.

An external environment is divided into two parts:

1. Macro environment - includes the study of different environmental components influence, such as: development of the economy; legal regulation and control; political processes; the natural environment and resources; social and cultural components of society; technical, scientific and technological development of society; infrastructure, etc.
2. Microenvironment - includes the study of the environmental components influence such as: buyers; suppliers; competitors; labour market.

Only essential changes of external environment can entail changes of the enterprise logistic structure or a transit chain. The external factor can serve as the initiator of necessity of transformations. This factor can be not the most significant for the given enterprise. A combination of the importance and capacity of this external factor is most important.

Factor analysis starts from a differential analysis of the economic and political situation. The second set of issues which need to be investigated is the transport and logistics sector's specific conditions in the region where the logistics centre is placed. Special study should focus on cargo flows in the region, which are also important for international transportation and logistic centres within the main traffic routes and networks.

There are factors which help to develop of each other and cooperate, i.e. improvement of one factor (positive development) will develop other factors, and positively influence to the development of a transit chain.

And there are also factors, which can bring a dissonance conflicting with other factors.

TABLE I

FACTORS INFLUENCING TRANSIT SYSTEM

develop and cooperate (synergetic effect "+")	dissonance and conflict (synergetic effect "-")
The level of economic development in the country	The political situation (the level of legislative basis development, the interest of the ruling parties in the logistics development in the country)
Road infrastructure development, as well as the existence of rail, marine and air routes	Natural environment, climate
The level of warehouses, technological parks (ensuring the required number of warehouse space in the right places and their quality, extra services, customs) development	The state of the labour market. It means, because of the lack of qualified personnel, the demographic factor may contradict in some cases other factors influence.
Technical, scientific and technological development (new programmes introduction to accelerate the movement of material flows in transit net)	New transport corridors development out of the State
The economic situation in countries that are major suppliers of transit goods	Competitors' transit services market development
The economic situation in countries that are major consumers of transit goods	
New transport corridors development inside the State	

Thus, the actions influencing system as a whole by the first group of factors will introduce synergetic effect in the transit system.

The second clashing group of factors will weaken system. And, as well as the first group of factors they will give synergetic effect but with a negative sign «-».

The analytical procedures' results making analysis within the framework of the synergistic approach is to identify the causes of system's significant indicators unusual deviations from trend. If unusual deviations are above the acceptable level, the cause must be investigated. Knowing the nature of unusual variances, we can efficiently manage risks, make weighted and correct economic decisions.

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Application of the risk-based approach to audit and internal control system

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Keywords **– risk management, internal control system, audit risk, risk-based approach.**

I. Introduction

The study is devoted to the application of risk-based approaches in audit and internal control system (AICS) as well as to determination of common and distinctive features of both aspects. The topicality of the study lies in uncertainty circumstances which exist in the entrepreneurial activities from the beginning the problem of diminishing these circumstances and managing them efficiently still remains urgent for entrepreneurs. The research sums up theoretical base in connection with risk management methodology and international audit standards requirements. The authors present methodological summary of reducing risk management and audit risk determining both control systems significance and relevance. The object of the research is directed to risk-based approach in audit and internal control system. The subject of the research is the application of risk based approach in audit and internal control system.

II. Risk-based control

To provide stability, reliability and security of entrepreneurial activities a device which could reduce uncertainty and increase trust in an operating enterprise is needed. To obtain information testifying to the application of risk based approaches in audit the study embodies international audit standards requirements which make it possible for auditor to ensure that reduction of audit risk level should reach an acceptable low level.

Audit risk models include 3 constituent parts: detection risk, inherent risk and control risk. By combining two latter risks it is possible to define significant non-compliances risk which can be recognized according to international audit standards as a risk that is created out of mutual closely connected risks.

Having two aspects in entrepreneurial activities and their control, which determine the necessity of risk management in legislation and desire to provide long-term operation for an enterprise it is necessary to compare them in order to define common and distinctive features. This approach demonstrates that the auditor's clients are likely to reduce an inherent risk by implementing internal control procedures to detect and prevent possible and emerging non-compliances [1].

Audit risk-forming structure (see Fig.1).

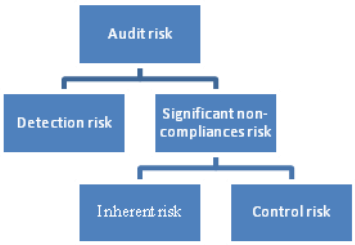

Fig. 1. Risks of auditors' work [2].

Considering the analytical procedure of evaluation system from the practical point of view which is envisaged to be introduced into audit practice by ISA 315 [2], the authors came to the conclusion that the procedure involving methodology is directed to risk factors identification and evaluation according to definite criteria which provide qualitative implementation of process, enhancing auditors reputation and rendering perfect services.

Summing the AICS definitions, mentioned in the theoretical framework, the authors express the necessity for risk management mechanism, enabling to implement multilateral functions. Therefore modern risk management deserves priority for it considers risks not only as factors of possible threats and of loss forecasting system but also as probability of optimistic scenarios encouraging implementation and emergence of new business aspect at an enterprise.

As a result, risk subjects should carry out any possible changes reflecting business and market risk. That is why these changes should be open so that they improve risk management and the gained benefits justify any costs [3].

In both cases of the application of risk-based approaches risk is linked to gaining information when making decisions. Risk subjects should understand business activities environment to present objectively existing risks and predict those with potential impact on an enterprise.

Thus, both the auditor and the risk manager should bear in mind that without directly influencing risk factors anyone else existing risk can indirectly affect enterprise activities or preparation of financial statements. Risk management is the combination of two main controls of AICS – administrative and accounting. That is why accounting control system should incorporate methodology of reducing audit risk level which provides objectivity of AICS.

III. Conclusions

In the authors' opinion, enterprise risk management (ERM) is the mechanism for business activities protection aimed at increasing enterprise value and long term operation. This mechanism includes all organizational management intelligence and it needs continuity principle realization not to make "downtime" based on outdated information.

In its turn, final conclusions testify to the fact that risk management based on competence requires the application of the approach involving a system-thinking principle aimed at promoting long-term increase of efficiency (objective approach).

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Knowledge and cultural in tourism organization management

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Keywords **– international tourism, tourism organization, intercultural knowledge, management.**

I. Introduction

International tourism, as highly globalized industry, over past decades has employed diverse opportunities, proposed by changing global international tourism business environment. Market and customer profile changes have stimulated need to analyze more carefully management of international tourism organizations. Contemporary international tourism management deserves comprehensive understanding of cultural knowledge factors in management. Results of a quantitative research demonstrate importance of intercultural competences in management of international tourism organization and sales of a particular tourism organization product.

II. Knowledge in Tourism Management

Knowledge has become a catchword in contemporary management studies and it is often considered as key factor for organization success in producing and selling its products or services [1]. Content of required knowledge differs from sector to sector, even knowledge management principles remains the same. Employees and their knowledge has become most important asset of any organization and various management theories attempts to formulate strategies and theories playing around it.

At the same time, service sector, where tacit knowledge is of a special importance, more than any other admits importance of knowledge in effective management and business development. International tourism is not an exception and efficient management of a contemporary tourism organization requires diverse, comprehensive knowledge [2;3].

International tourism, which historically has emerged as Western society privilege, recently is experiencing major changes due to transforming emerging markets, increasing number of international travelers. This requires tourism organizations to supplement constantly their existing knowledge of their core markets and eventual future markets. Among various directly management related knowledge, international tourism is very dependent on cultural differences as any international tourism model experiences meet of different cultures through purchase and experience of tourism product. Even tourism organizations can be proud of their knowledge, international tourist, using classical, tourism organization produced tourism products face not only well package and organized products but also destination products. In this perspective, understanding of cultural differences becomes especially important and is related to various aspects. Among first to be mentioned is tourism product and destination product quality assessment by international visitors. However tourism product and destination product quality assessment is very closely linked to successful organization performance and eventual business development. At the same time, tourism organizations, selling their products to their customers, are also expected to understand cultural differences of customers, originating from different markets. Understanding of cultural differences may play crucial role in proper delivery of service, avoiding fake service expectations, which may result in eventual complaints on tourism.

III. Information Delivery Quality Assessment

Aim of this article is to disclose partial results of quantitative research where purpose has been to identify and to asses, international tourism organization's performance in communication to its customers on particular product, its specifics. 502 questionnaires were collected and analyzed during high season of tourism in 2011. In order to verify stability of results, research continues also in 2012.

Guests participating in guaranteed escorted tours have been asked various questions, aiming to identify importance of cultural factors in quality assessment of tourism organization product. Particular article demonstrates results of cultural differences according to questions proposed by guests on following two statements:

- Does the information provided by travel agent before tour corresponds to service received during tour?
- Did tour program in travel agent where tour was booked catalogue/web site correspond to the program received?

For both questions according to Likert scale 5 answer options have been proposed, varying between completely and do not correspond. Respecting differences of visitors, they were prepared and distributed in 5 different languages according to core markets of particular product. Totally 2160 questionnaires have been distributed among guests, originating from 22 different countries. Hoofstede model of cultural differences has been taken as basis to analyze differences originating from cultural factors.

Obtained results of quantitative research contributed sufficient basis for further research, supporting need to understand origins of differences and importance of intercultural communication in management of an international tourism organization and in sales of tourism organization product in particular. Results demonstrate differences in perceptions of tourism product and insight of it and encourage the need to respect intercultural competences as a crucial knowledge in management of international tourism organization.

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Inbound Tourism and Sectoral Development in Latvia

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Keywords **– economic development, export, tourism demand.**

I. Introduction

Statistics and empirical studies show that export positively influences economic growth. Moreover, diversified export decreases growth volatility. Tourism is considered as important part of export in many studies and much attention is paid to the evaluation of tourism influence on economic development, which is evaluated within a macro-economic system. However, in Latvia such studies are mostly focused on a particular area or are based on qualitative methods. The aim of the paper is to identify the linkage of tourism and sectoral development in Latvia and to substantiate the choice of tourism demand indicator most suitable for modeling. Time period of analysis was mainly 2000 – 2011.

II. Export Diversification in Latvia

At the macro level, two main diversification directions are diversification by countries and by groups of products and services. Diversification by countries is usually gradual and long-term process, however, if the need for new markets is urgent, significant changes can occur in relatively short time. Such situation was seen in Latvia in late 1990's, when export share to CIS countries reduced from 38.2% in 1995 to 8.7% in 2000, but the share of EU-15 countries increased from 44.0% to 64.6% in respective years [1]. After the EU enlargement in 2004, grew the importance of the new member states.

Diversification by groups of goods and services depends more of the ability of companies to improve existing products and services and provide new ones. In 2000 two commodity and service sections were dominating – wood and articles of wood and transportation. In 2011 the share of leading products sections decreased, while the share of other sections has mostly increased. Still, there are sections, which can further facilitate diversification of export, one of them – tourism.

III. Methodology of Tourism Impact Analysis

The first stage of analysis implies the choice of the most appropriate tourism indicator. As the most popular statistical measure of tourism demand in different studies, tourist arrivals is used, followed by tourist expenditure, tourism revenues, employment, import and export in aggregated or disaggregated form [2]. For correlation analysis in the case of Latvia two indicators were used – tourist arrivals and travel export. These indicators are correlated to the real value added in industries, which are more exposed to tourists – transportation and storage (H, according to NACE Rev.2), accommodation and food service activities (I) and arts, entertainment and recreation (R). Indicator with a stronger correlation with value added was chosen for further analysis.

In the second stage of analysis the chosen tourism demand indicator is correlated to the real value added of 17 industries (NACE classification, rev. 2). Based on the results, industries are divided in 3 groups. In this study correlation coefficient value above 0.9 indicates on strong correlation.

The third stage of analysis implies calculation of real value added in the second group of industries, in case trends of 2000 – 2008 continued also in 2009 – 2011.

IV. Impact of Tourism on Sectoral Development in Latvia

In the first stage of analysis travel export was chosen as a tourist demand indicator.

The second stage of analysis showed that all industries can be categorized in three groups:

- Industries, which are closely related to travel export for the whole sample – mining and utilities (BDE), trade (G), transportation and storage (H), accommodation and food service activities (I), financial and insurance activities (K), real estate activities (L), professional and scientific and technical activities (M).
- Industries, which are closely related to travel export in 2000 – 2008, but afterwards there is a shift in trend – construction (F), information and communication (J), administrative and support service activities (N), public administration and defence (O), education (P) and arts, entertainment and recreation (R).
- Industries with comparatively week relation to travel export – agriculture (A), manufacturing (C), health care (Q) and other service activities (S).

The results of the third stage indicated that, if there were not significant structural changes in 2009 – 2011, then the real value added would be by almost 5% points lower in 2009 (value added decreased by -15.6%) and would increase by 1.4% in 2010 (rather than decrease by -0.5%), however in 2011 increase rate would be a bit lower (5.3% instead of 5.5%). As a result the value added in 2011 would be 7.7% higher in 2011 than it is now.

V. Conclusions

Export growth is an important factor for the economic growth in Latvia. There are several potential ways for export diversification, one includes also tourism, which currently is one of the smallest segments in the structure of export of goods and services.In case of Latvia, travel export is the most suitable indicator of inbound tourism, as both annual, quarterly and monthly data are available and their relation to sectoral development is closer (in terms of correlation coefficient). Real value added of several industries develop in line with travel export, in other industries there is a shift in trends as less inbound travelers are interested in tourism in Latvia in recent years.

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Just in Time and Sequence Logistics Challenges for the Automotive Enterprises in the Eastern Europe Countries

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Keywords: **Automotive manufacturers, suppliers, accurate deliveries, OEM, OES.**

The purpose of the paper is to provide analysis of the significant differences and relevant trends taking place in the supply chain methodology designed for the automotive industry manufacturers with an emphasis on the emerging CIS market as well as just in time delivery challenges for OEM and OES companies. Automotive companies which are intending to invest into the production in the CIS countries, to follow not only the sparkling opportunities of the new "gold mine" markets, but really to carefully analyze where should the production be located, what kind of production phases will be in use, how the customs procedures will be organized and monitored, relations with the municipal and governing institution, personnel, etc. [1;2;3] The last mile delivery planning problem is also very significant for automotive enterprises.

The first question, the authors of this paper would like to disclose is – „What are the main reasons of such a phenomenal interest from automotive sector towards such a volatile and at some poin „dangerously explosive" market as CIS?

The main reason is - CIS region still has a low private car ownership per capita (40% of EU average) and majority of cars are older than EU average. Peoples' mobility is predicted to grow, leading to a higher demand for vehicles. The same situation is in the commercial and public transport sectors.

Another reason of such a great interest in cooperation from international and local OEM and OES sides - is the new regulatory environment in Russia, Belorussia, Kazakhstan, Uzbekistan and Ukraine which is leading to the numerous waves of localization and partnerships of global Russian and CIS automotive companies. The majority of such technological co-operations are organized as joint ventures or holding companies, located in special economic zones (SEZ) or automotive clusters.

The location of the automotive production base is also playing a crucial role, in the modeling of the supply chain as well. Location determines construction fundamentals of the physical inbound flows of materials and components needed for the production, and outbound flows devoted to the distribution of the buld-up vehicles and after sales components to the final consumption markets.

It is very significant to provide accurate last mile deliveries for OEM and OES companies.

It is possible to use only the *micro-elements method* to improve route planning in cities with intensive and unstable traffic. To explain it we may investigate the following example. The micro-elements method is very useful to solve the logistic problems for the small-cargo physical distribution control. The time of delivery consists of the two basic positions: time of driving and time of loading/unloading. The specialist's task is to consider these elements for the particular route. It is possible to plan the driving time precisely, if we use the following approach for solving the routing problem.

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Latvian Companies' Entry Model in the Market of France

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***Key words*- international trade, external market, the market of France, entry model, Latvian producers.**

I. PURPOSE

The purpose of the research is to study the theoretical entry modes in external markets and to come forward with a model for Latvian companies so that they might successfully enter in the market of France. The research is urgent because at the current economic situation Latvian companies should seriously consider entering new markets.

II. TASKS

The tasks of the research are the following:

1. To describe theoretical aspects of international trade and possible entry modes in external markets.

2. To analyse socioeconomic situation in France and Latvian companies' potentialities in the market of France.

3. To come forward with a personalised entry model for Latvian companies so that they might successfully enter the market of France.

In order to prepare a successful research project the author used qualitative and quantitative research methods. The qualitative research methods used in this paper are in-depth interviews in Latvia as well as in France, focus group discussions and participant observation. The research is divided into three parts where the first one analyses theoretical aspects of International sales and other activities in external markets, the second part is an overview and evaluation of Latvian companies activities in the market of France as well as its socioeconomic data analysis, but the third part of the research outlines Latvian companies' entry model in the market of France and there are a comment of four reviewers-industry experts.

III. RESULTS

Latvian companies should use their own know-how to create a product with high added-value based on Latvia's natural and competitive advantage. Latvian companies may be successful in the market of France when selling product with a Scandinavian quality at Eastern Europe's price. For an efficient way to enter in the market of France author has worked out an entry model. It consists of 12 steps which are divided into 4 categories.

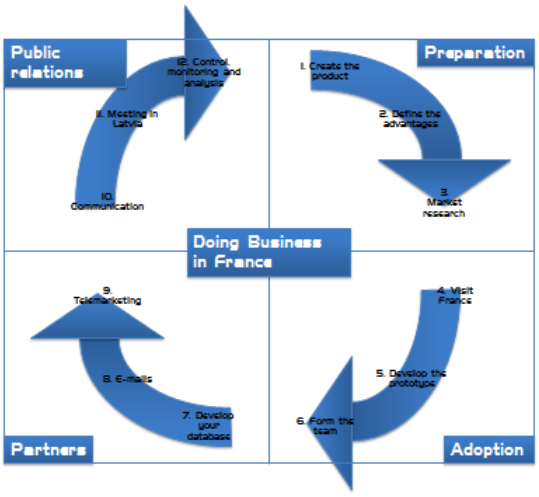

Fig.1. Latvian companies' entry model in the market of France

IV. CONCLUSIONS

The main conclusions apply to Latvian companies which should use export as an entry mode and a personalised entry model composed of 12 steps described in the research. Taking into account specific information about economic, political and social situation in France and its own characteristics described within this research may be important. When considering the entry in the market of France Latvian companies should pay attention on long-term business relationships and subordinate their strategy in this way.

The research was developed under the supervisor's Dr., prof. Tatjana Volkova control.

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The peculiarities of foreign direct investment intensification policy

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***Keywords* – foreign direct investment, TUI policy, incentives, China, Canada, Ireland.**

I. Introduction

The attraction of foreign direct investments (hereinafter – FDI) more and more often is understandable as the sign of successfully developing country. Furthermore, FDI serves as one of the external sources of funding, which is particularly important for the developing countries. The flows of international capital are determined by various factors. However, the government's political decisions play one of the major roles in the attracting FDI. Anyway, the government which is willing to increase the quantity and the quality of FDI flows should acquire the country's economic management skills. The intensification policy of FDI is feasible to implement successfully by following good practices of the high economy countries [1]. The article analyses the determinants of foreign direct investments, addresses the problem of attracting targeted FDI and highlights the incentives which constitute the FDI policy. However, it is noticed that the governments in number of the countries seek to attract FDI at any price. The article seeks to define the aspects of successfully implemented FDI policy.

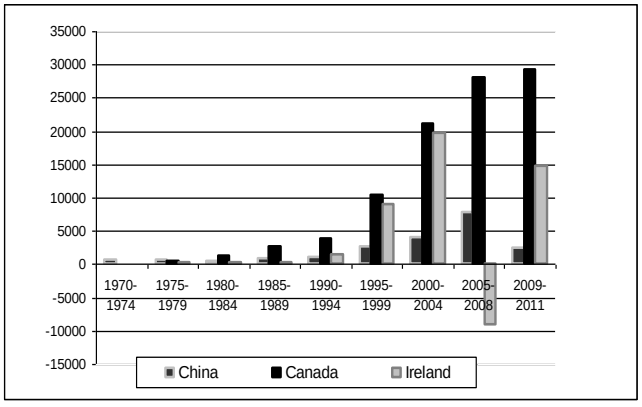
The article is divided into three parts. The first part explores the theoretical aspects of employing FDI policy (f.v.). The second part analyses good practice cases. In order to determine, the significance of bilateral FDI flows on the development of the host country, the gravity model is used. The third part discusses empirical results.

A. Case study

Ireland, Canada and China have been chosen as the countries of good example of FDI policy [2]. These countries are not selected accidentally. Ireland is the first country successfully implemented FDI policy (table 1 f.v.). It employs purely liberal FDI policy which covers all business sectors. Comparing to China, Ireland increased its FDI flows gradually [3].

FIGURE I

Dynamics of inward foreign direct investment in US dollars per capita



As continuously emerging economy, China stands out from the rest of the countries. China being politically closed country employs all possible FDI incentives. Meanwhile, Canada attracts FDI implementing conservative and regulatory FDI policy.

II. Empirical research

The survey covers the relationships between the factors influencing inward FDI on Canada, China (particularly Hong Kong region) and Ireland during the period of 1970–2011. The study is based on the World Bank, International monetary fund and UNCTAD statistical data. The examination is based on the main driving forces of FDI, which were analysed in the theoretical part of the paper.

$$y(FDI) = f(GDP; IN; MS; OP) \quad (1)$$

A dependent factor is the inward FDI, which is expressed in relation to a market size (MS), investments in attracting FDI (IN), market openness, population. It is assumed that the dependent variable is the inward FDI per capita. Market size is expressed as the GDP per capita in U.S. dollars, market openness is measured as the ratio of export and import.

TABLE II

Correlation results

Country	GDP	IN	MS	OP	R	R^2
Ireland	0,928	0,967*	0,418	0,589	0,999	0,998
Canada	0,456	0,999*	0,339	0,750	0,999	0,999
China	0,833*	0,967*	0,833	0,866	0,999	0,998

*p>0,05

The empirical analysis reveals that there is a strong positive relationship between inward FDI and investments in attracting foreign capital. However, other results are controversial.

III. Conclusions

In China's case a strong positive relationship between FDI and other determinants gives evidence that the growth of an economy is highly dependent on foreign capital. Meanwhile, Canada attracting tremendous FDI flows stays at least dependent on MNCs. Lower than average relationship between FDI flows and the openness of the country shows that Ireland attracts horizontal FDI. A strong positive relationship between investments in FDI and FDI flows and a weak positive relationship between FDI flows and market size indicates that Ireland being small market country successfully implemented FDI policy. The analysis of three cases proves that success to attract FDI is the dependent on the government's ability to employ FDI policy.

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EU enlargement analysis with system dynamic method

Valerijs Skribans (*Riga Technical University*)

Keywords **– EU integration, system dynamics, GDP, employment, debt, international trade, investments.**

I. Introduction

After formation of the European Union (EU) enough time has passed to make conclusions, as to what member countries gained from the accession to the Union. The EU has definite advantages: free trade, free movement of labour force and capital. Participation in the union involves other Member States' support during the times of economic difficulties. Despite the advantages, the crisis in 2008 underscored the union's problems: some states do not fulfill the basic financial and economic conditions, some try to improve their internal well-being at the expense of others. These conditions have highlighted the actuality of the study; they require defining functioning economic models of EU, as well as defining the differences and similarities of these models.

In the paper researched problem is related to economic evaluation of EU member states, as well as development of a functioning EU economy system dynamic model.

Paper's novelty elements are related both to quantitative evaluation of the impact of political - economic union formation on its member states' economies and the functioning EU economy model development with system dynamics method. At the present, union formation process is topical not only for EU countries; the integration processes take place worldwide: CIS, etc. Paper's results could be used in planning union, regional public policies, economics, as well as for academic and scientific purposes.

The research objects are EU economical integration and EU economy functioning model development. The research subject is the changes of EU member states' economies, which have occurred as a result of EU enlargement.

Paper's aim is to develop EU economy functioning system dynamic model, taking into account the EU countries' main economic indicator changes since the EU enlargement. To achieve this aim, the following tasks are set: 1) to analyze the GDP dynamics of the EU countries, 2) to analyze employment level dynamics of the EU countries, 3) to analyze public debt dynamics of the EU countries, 4) to analyze foreign trade dynamics of the EU countries, 5) to analyze investment dynamics of the EU countries, 6) to analyze scientific literature and previous experience in EU model development with system dynamics method, 7) to develop a conceptual scheme of EU economy system dynamic model, 8) to develop a conceptual scheme of model of a new EU member state's economic integration in the EU, 9) to develop a system dynamic flow - stock model for a new member state's economic integration in the EU, 10) to test developed flow - stock model.

The study will use traditional mathematical, statistical and economic analysis methods, such as data grouping, comparison, average level and trends detection, regression method, as well as visual analysis (graphical) method. Main research method is system dynamics.

The system dynamics method is chosen taking into account EU specifics – rapid changes in the economy, in these circumstances econometric methods do not operate correctly, and the system method specifics – it allows to combine analytical reasoning and mathematical, statistical calculations. It is the study limitation.

As the information base of study the European Community's, Eurostat data are used. Some materials are taken from experts, news agencies, newspapers and the Internet. Methodological basis of research is based on the world top scientist's works on the international economic theory - MacConell C. and S. Brue, system dynamics - Sterman J., Yamaguchi K., Wheat D., Chevalley_T. [1;2]

The study focuses on the EU expansion in 2004, and its results; it is the limitation of the paper.

In the paper both developed model and its results are shown. Model is tested only for one EU country, the new EU member - Latvia. It is the study limitation.

The model was tested in several set of experiments. The most likely scenario for the Latvia's economy integration into the EU show labour force reducing in close future, that leads to wages increase and consumption decrease. As a result decrease in output will happen. Increasing wages would not only reduce production, but also substitute production with import. This expected increase of import will be compensated by diminishing of import, which will be related to reduction of consumption in the country. Therefore, the import remains unchanged, at steady state. EU subsidies will contribute to industrial development, despite of increase in labor force cost. Production will exceed consumption, there can be over-production in the system and inventories increase. This could mean that EU subsidies have limited effectiveness. After a certain stage, to encourage business development in Latvia would be useless. Deeper crisis will be caused by the lack of demand. Production without the sales market is useless.

Results of the paper show failure of the mechanism of EU operations. The available mechanism contradicts EU principles; it does not promote the cohesion in European Union, but quite opposite - leads to solving problems of well-developed EU countries at the expense of developing countries. In the given conditions the example of Latvia shows that there is no possibility to overcome the system crisis. These circumstances specify necessity of changes in EU internal migratory policy, changes in principles of developing countries' support in EU, and changes in distribution of EU means, taking into account internal migration.

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Efficiency of Corporate Income Tax Reliefs for the Investment Promotion in Latvia

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***Keywords* – tax reliefs, investments, corporate income tax.**

I. Introduction

Corporate income tax (CIT) is generally seen as one of the main obstacles to investments, but the revenue from CIT are important to the governments. Therefore to get expected positive externalities from investments, broadly are used different tax reliefs aimed at particular investment activities, sectors or regions, maintaining higher standard tax rate.

In Latvia statutory CIT rate is low – flat 15%, and existing tax reliefs decrease implicit tax rate even below 10% showing their importance.

The aim of the paper is to look at theoretical justification for CIT reliefs, analyse effectiveness of existing CIT reliefs to promote investments in Latvia and make recommendation to improve it. Author proposes set of criteria appropriate to evaluate CIT investments related reliefs in Latvia.

II. Theoretical considerations

Corporate income tax (CIT) is common in the most tax systems in the world. As all taxes also CIT brings some distortions to the economy. It taxes corporate profit and so directly affects investment decisions and capital flows by influencing after-tax rates of return on investment. Corporate income tax is also on the frontline of the international tax competition, as capital is the most mobile production factor.

CIT in many countries is important source of revenue, and governments are not ready to lose it by abolishing CIT in favour of potential investments. Especially as empirical evidence suggests that effectively managed public expenditure (e.g. education, infrastructure etc.) and rule of law could more than compensate this tax burden. Investors are ready also to accept higher taxes if risk/return opportunities are more attractive. [1, 105-108] In the presence of economic rents, it may be possible to levy high capital taxes. Important however is to distinguish the types of rents. Only firm-specific rents are subject to full tax competition. In taxation of location-specific rents more important is that taxes are proportional to the rent. [2, 319-320]

Rate of corporate income tax however is declining throughout the world and particularly in the European Union. This could be explained by the growing role of mobile capital flows in global economy and tax competition for them. To limit negative fiscal consequences could be used different tax reliefs that offer smaller payments to particular activities, but do not influence the rest of tax base.

One of the main goal introducing tax reliefs is to produce incentives to attract investments to boost economic growth. But often it is done under pressure of international tax competition to limit outflow of investments. Other broad group of tax reliefs are those where governments are expecting positive externalities by stimulating specific investments. Examples could be incentives for R&D expenditures or incentives to invest in particular regions or sectors.

CIT reliefs are widely used as a tool to boost investment and so increase output, improve competitive position of country especially in the future, but they could have also short term consequences as investment spending is important component of GDP.

However it is important to stress that tax rate is only one of the factors influencing investment decisions

III. Investment related CIT reliefs in Latvia

Latvian corporate income tax rate 15% is one the lowest in the EU. The law contain 23 tax reliefs, thus decreasing considerable effective tax rate. According to the calculation of the European Commission the implicit tax rate (ITR) on business income of corporations in Latvia in 2010 was even 4.1%, but average ITR since 2004 was 8.3%. [3, 261]

Nine of CIT reliefs are attributable to the promotion of investments. Additionally six tax reliefs are aimed to support specific industries.

IV. Effectiveness

Overall CIT burden in Latvia is low and competitive in the region. This is confirmed by historical investment flows and regional comparisons. Increasing number of tax reliefs however is adding more administrative burden on business.

Tax reliefs oriented on specific investment activities, sectors or regions however do not show satisfactory results. Main reasons for this are associated with relief's design and poor link with other economic policies, introduction of new tax incentives were often based on exaggerated expectations.

The fiscal cost of these investment and sector oriented tax reliefs reached 120 mln in 2010[1], 94 mln lats in 2009, and 128 mln lats in 2008, which corresponds to 0.94% of GDP, 0.72% of GDP and 0.8% of GDP respectively. These figures are high when compared with CIT revenues.

V. Recommendations

The existing CIT system with the main overall investment incentives should be maintained. Other more targeted tax reliefs however are recommended to examine and change or remove if found necessary. The suggested criteria for such examination are – type of taxable rent, existence of positive externality, appropriate design and potential for tax planning, costs in revenue forgone, administrative burden (for both corporations and tax authorities).

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Application of immovable property tax in the european union member states

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Keywords **– European Union Member States, immovable property tax, revenues, burden.**

I. INTRODUCTION

There is no single tax establishment system within the European Union Member States. Every country shall develop its own model which is based on such factors as the number and breakdown of population; cultural, economic and social structure; the administrative system; and the number and scrupulosity of taxpayers. The European Union Member States have rather different tax systems, and thus, the tax rates vary among the Member States. According to the EU legal and regulatory enactments, no restrictions have been set to the Member States for the application of immovable property tax.

The research topicality and choice is based upon the relatively small number of scientific studies on the application of immovable property tax in the EU Member States.

The research **aim**: to analyse the competitiveness indicators, tax burden and peculiarities for the application of immovable property tax in the European Union Member States.

The following **tasks** were undertaken to achieve the aim:

1) to compare the competitiveness indicators of the EU Member States with the tax burden;

2) to study peculiarities for the application of immovable property tax in the EU Member States;

3) to compare the immovable property tax revenues and tax burden in the EU Member States.

II. COMPARISON OF TAX BURDEN AND COMPETITIVENESS INDICATORS OF THE EUROPEAN UNION MEMBER STATES

Tax burden determination is one of the key state tax policy indicators. It is a generally accepted opinion that business tax burden is an essential factor affecting decision-making of enterprises when choosing their place of registration and legal address. The role of this factor is essentially significant within the EU context upon free capital movement. The state competitiveness indicator is of the same significance. The analysis of the EU tax burden and competitiveness indicators for the year 2010 allow concluding that the countries having higher tax burden (Denmark with the total tax-to-GDP ratio of 47.6% in 2010 took the 5th position in terms of world competitiveness) are ranked higher also in terms of competitiveness, while the countries having lower tax burden (Latvia with the total tax-to-GDP ratio of 27.3% in 2010 took the 68th position in terms of world competitiveness) are ranked in much lower positions in terms of competitiveness [1,2].

III. PECULIARITIES FOR APPLICATION OF IMMOVABLE PROPERTY TAX IN THE EUROPEAN UNION MEMBER STATES

Immovable property tax rate, the procedure for setting the tax rate and taxable items significantly vary among the European Union Member States. The immovable property tax is set consistent with the state policy, priorities and other factors. There are countries where immovable property tax is levied only upon land (Estonia) or buildings (Germany, Sweden etc.). There are countries where immovable property tax is levied both upon land and buildings (Denmark, Latvia etc.). In most cases, the property value is determined applying a mass valuation method and not the individual one. Immovable property tax is levied through the application of two types of interest rates – fixed (rates are determined by the state governmental authorities – it is a fixed interest rate deviated from the taxable value) and variable (local government plans the immovable property tax rate following the expected budget expenditure and the amount of taxable base). Several cases are observed when a local government has a wide authority to set tax rates (the Netherlands); however, generally legislative enactments determine the minimum and maximum tax rate. There are countries where the immovable property tax rates are expressed in terms of money against square metres of immovable property (Poland, the Czech Republic etc.) [3].

IV. COMPARISON OF IMMOVABLE PROPERTY TAX REVENUES AND TAX BURDEN IN THE EUROPEAN UNION MEMBER STATES

In 2010, the immovable property tax revenue-to-GDP ratio in the European Union Member States ranged between 0.4% (Estonia, the Czech Republic, Slovakia) and 4.2% (the UK). In 2010, the immovable property tax revenues in the European Union were 1.3% of GDP on average. However, the juxtaposition of Latvia and the average EU level demonstrates that the share of immovable property tax in Latvia is 0.4% lower than in the EU on average. In 2010, immovable property tax revenues accounted for 0.9% of GDP in Latvia [1].

CONCLUSION

After studying and analysing the information summarised from different sources, the authors conclude that the European Union Member States have no single approach for taxation of immovable property. The EU Member States apply various basic principles for tax imposition. One of the basic reasons for disparities is that tax systems in the European Union have developed in various time periods responding to different economic growth stages in individual countries and different events in the national economies of these countries.

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National Economy and Entrepreneurship

National and Regional Economics

Innovation in Latvian Economy

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Keywords **– innovation, human capital, competitiveness, sustainable development, productivity.**

I. INTRODUCTION

Innovation is becoming the brightest feature of the modern economy. Quite recently this name seemed exotic, unknown and incomprehensible even among professionals; yet both the innovation itself and its concept are rapidly pervading the world. In Latvia, a paradoxical situation has formed with a positive attitude and support for innovative processes being shown in society in general, though in reality only a small part of the entrepreneurs can be regarded as innovative or the ones undertaking innovative entrepreneurship. In the new economic model, the innovation is to become one of the main factors for creation and promotion of competitiveness. It is the innovative development which is able to increase the productivity and the return from the resources used within the working process; or to decrease the costs of production or provision of service.

The aim of the present article is to provide a new insight on such economic concepts as innovation, human capital, sustainable development and productivity; to show how the role of innovation changes in different stages of economic cycle, and how it influences national economy.

To reach the goal the following tasks were set: to characterize the role of innovation and human capital in economic development, to highlight the role of innovation and education to increase the productivity and in sustainable economic development.

The following research methodology was used: logically constructive approach – for making judgments and result analysis; synthesis method - to combine the elements of a single system; social research methods – to obtain the primary information and to carry out its verification.

II. THE ROLE OF INNOVATION AND HUMAN CAPITAL IN ECONOMY

It was the research on human capital, which substantiated that knowledge and competences are a vital source for economic development and welfare. Educated and healthy inhabitants form national wealth; therefore investment in human capital is justified and necessary. Only educated inhabitants are able to create new ideas, to turn them into innovation and apply them successfully in entrepreneurship.

It is the depression stage when economy in ready for the transition to new base innovations; within this stage the base innovation clusters are formed. During lengthy economic crisis, companies turn from the profit maximization strategy (used in prosperity stage) to the relative risk decrease strategy. While the existing production and technologies provide significant profit, the inclination of companies to introduce innovation is small as the innovations are always associated with risk. Yet, when the economy suffers lengthy crisis and the opportunities in the traditional areas deteriorate, innovative risk is no longer an insuperable obstacle as any other investment projects can turn out to be even riskier. This allows for the conclusion that the most of base innovations – products are created during lengthy and hard depression. This means that it is the innovation, which converts the downturn of the economic conjuncture into its upturn; creating its fluctuation.

Innovation is also one of the main factors helping to increase the productivity and to promote sustainable development. For this to be true, the state needs a certain scientific potential, which is able to create new products and technology. As well, there should be entrepreneurs interested in introducing them into production, and well-educated labour force able to implement all this into practice.

III. INNOVATION IN LATVIA

The innovation development in Latvia is characterized by following data: according to the summary innovation index, Latvia takes the 27th place among the 27 EU countries. Especially pronounced back-lag is in such parameters as the contribution of the private sector in financing innovation, absolutely insufficient inter-connection between particular parts of innovative chain, especially between science and entrepreneurship, low economic efficiency etc. One of the factors directly influencing the current situation in Latvia is the low public and private investment in research and development. The total R&D funding in 2004 was only 0.42% of GDP, in 2005 – 0.56%, in 2007 – 0.59%, in 2008 – 0.61%, in 2009 – 0.46%, and in 2010 – 0.50%. For comparison, in 2007 the funding for research and development in average was 1.84%. The strategy "Europe 2020" includes the target to increase this indicator to 3% by 2020, while Latvia has planned only 1.5%.

IV. HUMAN CAPITAL IN LATVIA (EDUCATION COMPONENT)

Latvia holds a deep-rooted view that it is a country with highly qualified and educated labour force, but is it really true? Though the literacy level of adults is high, the education quality has several deficiencies, e.g. insufficient knowledge in exact sciences, which is clearly experienced in universities that cannot rectify all mistakes created by schooling. As a result, the national economy does not receive all needed specialists with the required level of knowledge. The number of new scientists and total employment in science are still unsatisfactory.

V. INNOVATION AND PRODUCTIVITY

So far in Latvia the main competitiveness factors have been relatively cheap labour force and low overall expenses. Sadly it is to be concluded that such competitive factors are not sustainable, which was comprehensively substantiated by M. Porter in the works written in the last century. Many of the "Asian Tigers" used to exploit the cheap labour force at a time, yet in successful combination with modern technologies. This, again, leads us back to the influence of innovation on productivity and national economy in general.

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Effective management of residential real estate in European countries and Russia

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Keywords **- management of residential real estate management companies, apartment buildings, housing and communal services.**

There are no legislative restrictions on the activities of management companies and individual managers who work under contracts with homeowners in most European countries. In some cases, managers need a license, certification provided for in other works and services in the field of housing management [1]. In Russia, in order to reduce bureaucratic red tape and reduce state regulation in the framework of administrative reform, it was decided to abandon the licensing of activities in this area. In 2007, the Federal Law № 315 from 01.12.2007 "On the self-regulatory organizations" to form a self-regulatory organizations. This will allow management companies, has entered into these organizations, to increase the financial responsibility for providing poor service, and their liability for damage to common property home will be insured. The Institute will encourage the creation of self-regulation of professional standards, to cleanse the market of services from unscrupulous participants.

As a rule, the market itself generates requirements for management companies, failure of which makes the company uncompetitive. First of all, this applies to insurance of the Criminal Code and its civil liability arises if the wrong control actions resulted in harm to the client-owner. Liability insurance managers developed in most European countries. It is strange that this effective management tool is not used against the backdrop of numerous accidents on the house engineer networks in almost all villages of the country, which lead to the actual material and moral damage in Russia.

Of great importance is training in housing management. In the West, a lot of the polytechnics provide a basic education that enables the graduate to start working manager. In addition, the professional community managers do offer a variety of educational courses - both basic and advanced training designed for working managers who provide significant knowledge and practical skills. For example, in Hungary the law "On homeowners associations" establishes that the governing condominiums may be only those persons who received the appropriate training. Since 1999 the country received a state license taught courses in the field of "managing the condominium" and "managing real estate." [2] In Russia today, a catastrophic lack of professionalism of managers structure of housing and communal services. Accepted the situation of inadequate management decisions lead to a permanent system crashes, and the enormous costs of time, and most importantly - budget resources to eliminate them!

To control the critical infrastructure of cities in Western countries, distributed forms of attracting private sector through concessions. Note, adopted in 2005 the Federal Law № 115-FZ of July 21, 2005 "On Concession Agreements", practically does not work (except for a number of examples related to the disposal of municipal solid waste). This suggests that the law is far from perfect, and what is now the executive power does not guarantee business in the long term (30-50 years) return on investment.

The major component of the management of residential real estate in Europe, as elsewhere, are information technology. Collection and processing of information, interaction with consumers and communal power structures is automatic. The whole process of personal interaction between customer and service provider can pass through the Internet or other resources. Recognizing the importance of information in the urban sector, regional and municipal authorities in Russia, however, funds from their budgets virtually isolated, and private management companies, who feel themselves as "temporary worker" divide the profit from business activities in completely different directions. The backwardness in this area is observed even in St. Petersburg, not to mention other financial unsecured regions of Russia.

The experience abroad a positive experience in managing residential real estate complex being introduced to the Russian reality, since in addition to the above issues should be noted that the opacity of the sphere, irresponsible and corrupt officials. These problems make it difficult to process the transfer of European experience in Russia. However, widespread and consistent implementation of European experience in municipal practice - is the most important task of the Russian authorities at all three levels.

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Assessment of Human Resources Management policy issues in Public Administration of Latvia

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***Keywords* – strategic HRM, public administration, employee motivation.**

I. Introduction

The latest researches on the future of work scenarios emphasize change of Human Resource (HR) management role in the light of future economic trends such as globalization, developments in Technology at Work and changes in the labour market i.e. ageing population.

Since the world of work is changing rapidly, organizational performance will be very much influenced by strategic HRM. This will be one of the challenges also in the Public Administration. OECD policy brief shows that new problems and changing labour market, as much as new management ideas, have driven the main trends in public employment modernization in the past two decades.

Therefore one of the key challenges for the HR function will be to link the organisation's resources to meet the demands of globalisation in this respect, and vice versa. Extending this line of thought, how a rethinking occurs of the design and innovation needs within workplace communication and engagement approaches and philosophies will be a key part of the intergenerational people transformation challenges that lay ahead (P.Wilson 2010).

New problems and a changing labour market, as much as new management ideas, have driven the main trends in public employment modernisation in the past two decades. However, the actions taken to date have tended to be adaptations of particular employment instruments to meet specific problems. OECD survey concludes that it is important to give more attention to the increasing knowledge and skill demands of modern government, and increasing difficulty of government in attracting and keeping high quality staff. This requires introduction of new ways of work styles and methods in public administration.

In the situation when great emphasis is placed on effectiveness of public administration it is important to estimate current strengths and weaknesses of Human Resources Development in Public Administration of Latvia, as well as to assess whether HRD activities ensure strategic perspective in the light of rapid changes in economy and labour market as well as with pressure of society for small and effective public administration.

According to Chanzi Bao et al. it has been widely accepted that HR policies make as direct and positive impact on firm performance. This issue is still not so evident in the light of public administration, but according to Chanda et al. there are various measures which define organizational performance through non-financial measures such as employee productivity, quality level of product and services, customers satisfaction on the product and services provided, level of employee satisfaction and employee turnover rate. Since one of the factors influencing organization performance is employee satisfaction and motivation then purpose of this article is to assess level of satisfaction of public employees with current HRM policy planning and implementation as well as with the working environment in the public institution.

II. Methodology and data analysis

To assess Public Administration HRM policy and its results in Latvia the paper will provide answers to following questions:

1) How public employees assess Public Administration HRM policy;
2) How public employees are satisfied with the working environment in the respective public institution;
3) Which factors are influencing positively and negatively employee satisfaction with work in the respective institution;
4) How public employees are estimating development of such new ways of working as teleworking in public administration.

A combination of qualitative and quantitative methods was applied. Results are based and described according to literature review and survey of public employees. The survey of 1253 public officials in Latvia was done using an internet questionnaire. Survey shows that 96% of the respondents have worked in the public administration more than a year, 77% - more than 4 years, 60% - more than 7 years. Similar results refer to the time worked in the current institution. It allows us to consider the respondents of this survey to be well experienced in the state administration work organization. The average age of respondents was 39.5 years. For female respondents the average age was 39.7 years (in total 951) and 39.3 years for male respondents (in total 297). For 5 respondents data were not available.

To assess employee attitude and satisfaction a Likert-type scale ranging from 1 (well below) to 5 (well above) was applied.

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Models of efficient investment management in Latvian aquaculture sector

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Keywords **– European Fisheries Funds, aquaculture sector, Cohesion policy, regional development, regions.**

I. Introduction

Since year 2004, when the funding of the European Fisheries Fund had become available to Latvia, return of public investments of full value has not been gained. To date the studies carried out in Latvia in the aquaculture field are poor and provide only general analysis of the situation. In the paper it is intended to explore, analyze and evaluate the return of the invested in the field of aquaculture means viewing in details 5 main spheres of activity: 1) Investments in aquaculture companies. 2) Water environment activities. 3) Aquaculture animals' disease restriction. 4) Fishing in the inland-waters. 5) Processing and marketing of the fishing and aquaculture products.

Simultaneously there are active discussions about the principles pursuant to which the funding of the European Fisheries Fund should be appropriated for, which activities need bigger investments and how to ensure optimal and efficient application of the appropriated means, however, at the moment in Latvia there are no scientific and economic grounds for solving the problem. In order to facilitate the social and economic growth of regions of Latvia, sustainable development of the territories significant for aquaculture and increase in the amount of human resources in the territories, to improve life quality in the territories significant for aquaculture simultaneously maintaining the biological diversity, competitiveness of the aquaculture field should be increased by enhancing added value of the aquaculture production.

Development of efficient management of investments in the field of aquaculture of Latvia will increase effectiveness of resource using and competitiveness of the field, wherewith it will facilitate social and economic development of the country's regions, and development of economics of Latvia overall.

The EU aquaculture has come to contradictions of strategic development; increase in its production has almost stopped. It is predicted that sustainable aquaculture and efficient productivity will be ensured by the new Fisheries Consultative Council and the reformed financial support mechanism – European Maritime Affairs and Fisheries Fund emphasizing the latest technologies and persisting in firm environment protection and product safety requirements. In the project of European Maritime Affairs and Fisheries Fund in general support for aquaculture using in order to improve life quality is promised, which in the circumstances of Latvia can be gainfully related to environment and landscapes' protection, fisheries as supplementary farm application, fishing and rural tourism development and solving employment problems. However, some concerns arise regarding the expressed in the project of European Maritime Affairs and Fisheries Fund information about interruption of support to traditional aquaculture directions, including fish-breeding farms.

Aquaculture of Latvia from 2004 till 2011 generally developed in a positive direction: production capacity, productivity and number of produced commodity products increased, irrespective of the drop in production sales.

The made investments in the sector of aquaculture have facilitated increase in number of aquaculture companies within the period from 2010 till 2012 – increasing on average per 35 companies within a year [1]. Increase in the number of aquaculture companies has brought an increase in the amount of employees in the aquaculture companies – on average per 10 people a year [2]. In the sector of aquaculture there were mostly men who were occupied. The carried out public contributions have facilitated improvement of financial indicators of aquaculture companies.

The main mass of commodity products in year 2011 was given by open ponds - 89,72%, which in the local circumstances are mostly suitable for carp-like fish breeding. In the natural water flow basins were acquired 6,14% of aquaculture production, but in the recirculation systems – 4,14% of aquaculture production [3].

In 2011 in the composition of market production mainly dominated carps constituting 449,7 tons (82,42%) of the total amount of production sales. In their turn, crucian carp, pike, trout, cat fish and sturgeon constituted 54,3 tons (9,95%) of the total volume of the aquaculture production market sales. The smallest amount built up the rest fish and crawfish (tilapia, ide, sander, perch, grass carp, tench, crawfish, bighead, etc.) - 41,6 tons (7,62%) of the total volume of production sales [3].

Evaluating the events of FCC we must admit that significant investments have been made in the companies of aquaculture, support to traditional fish-breeding farms, fish products processing and environment measures has been provided, however the corresponding return is not yet visible in the efficiency and productivity of the whole sector. Partly we can explain it by the overall economic crisis, partly - by imperfections in the Fisheries Action Program planning and management (several goals and tasks are abortively defined, objective and open project expert examination with no manufacturers' organizations involved, statistical calculation is not arranged, there is no licensing of aquaculture companies which could help in selection of support applicants and results evaluation).

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Factors of the business-processes re-engineering in the knowledge-driven economy

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Key words: **creative potential, cognitive science, business-process, the system approach, cognitive reengineering, cognitive management, reengineering, self-learning organization, creativity.**

I. INTRODUCTION

Success (or failure) of any organization depends not only on the quality of goods manufactured and services rendered, but also the speed on innovation applied. Modern organizations require new ideas, approaches, viewpoints and hence – open-minded people ready to embark on that.

Creative potential of employees becomes the major pulling power for successful development of an organization, its efficiency pillar and stairway to achievement of strategic goals.

II. MAIN TEXT

Re-engineering of business processes within the organization is based on the use and development of the creative potential of the employees.

Management of creativity can be arranged as a separate business-process or be integrated into general business processes of an organization. They may be linked to the human resources management, that can be achieved via quality management (knowledge, creativity) or via quantitative measures.

Re-engineering involves massive transformation in the corporate culture of an organization, not only in its corporate structure. Dominating corporate values should mirror the efficiency of the business processes. [2]. Employees must be convinced that they work for their clients, not their immediate supervisors that should be reflected by the remuneration policy since this is the key factor which transfer corporate values to the staff. It should be understood that introduction of new processes will fail in case these values remain the same.

Contemporary re-engineering differs from the concept of the 1990s as it has been influenced by cognitology, which is defined as science that covers cognitive processes and consciousness, and the processes of interaction between perception, understanding, modification, imagination and reflection and self-education as well as modeling of artificial intellectual systems on the basis of the analytical, synthetic and synergy concepts. Informational, cybernetic, systematic and synergetic approaches are the methodological cornerstone of this approach. [1].

Development of cognitology is going into such “irrational” fields as intuition and creativity. Business practice shows that there are many situations in which spontaneous decision are made, and subsequent consideration of such decisions reveals that positive outcome can be achieved even without thorough consideration and having a chaotic influx of data.

Understanding of the fact that competition has migrated from competition for natural resources to competition for intellectual resources has led to evolvement of the cognitive management concept.

Cognitive management is a systematic process management which concentrates on identification of knowledge, accumulation and distribution of data within an organization for efficiency purposes.

Information technologies assume a new role in the re-engineering process: they transform from being a mere instrument of innovation into the basis for the organization’s evolution, because even the most sophisticated IT background will render null and void without a significant change in the employee competence (responsibilities and authorities) and capabilities (skill, perks, etc).

III. CONCLUSIONS

This new approach would be centred around state-of-the-art IT and technological solutions. It is essential to ensure the development of knowledge management concept alongside cognitive approach of human behaviour since that turns out to be the most sought-after instrument for modernization and innovation, ensuring full-scale use and application of human creative potential.

It is the cognitive re-engineering that meets all of the above requirements. Its key priority is to creat a self-learning organization, that will resemble an organization that creates, acquires, transfers and uses knowledge and know-hows and is capable of duly reacting and proactive responding to the challenges of the business environment

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GDP and lending behavior: empirical evidence for Latvia

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Keywords **– Monetary transmission mechanisms, bank lending, GDP.**

I. INTRODUCTION

This paper investigates how lending responds to monetary policy and GDP shocks. Sustainable economic development is based on the favorable and stable business environment that promotes business competitiveness. Commercial banks have a significantly important role on the growth and successful functioning of the state economy. Development of any industry is not possible without the raised debt capital, which most popular forms are bank loans and leases. Commercial banks facilitate the capital flow from the less efficient sectors of the economy and businesses to more competitive industries and enterprises.

L.Gambacorta and P.E.Mistrulli investigated the existence of cross-sectional differences in the response of lending to monetary policy and GDB shocks owing to a different degree of bank capitalization in Italy. They indicate that all theories, which explain how bank capital could influence the propagation of economic shocks, suggest the existence of market imperfections that modify the standard results of the Modigliani and Miller theorem. Broadly speaking, if capital markets were perfect, a bank would always be able to raise funds (debt or equity) in order to finance lending opportunities and its level of capital would have no role [2].

The paper uses a unique dataset of quarterly data for Latvian banks over the period 2000-2010. The principle results of analysis provides evidence about the leading and influencing factors in GDP shocks and banks issued loans mutual relations.

II. METHODS AND DATA USED

Research is based on macroeconomic data of output (GDP) in Latvia and data on outstanding loans, which were obtained from Latvian Central Statistics Bureau and Finance and Capital Market Commission. The methods of the research are systematical, logical and comparative analysis and statistical methods (correlogram analysis, statistical model analysis).

III. RESEARCH RESULTS

Quarterly data from 2000 to 2010 about outstanding loans in Latvia and data about the GDP were used in statistical analysis. Previous research [7] shows that there are some causality effects between loans issued and output. This effect is significant (at the level of 95% probability) in Lithuania, though at the aggregate level these causalities were not significant in other Baltic countries including Latvia. The research indicated that the strongest influence there were in such sectors as wholesale and retail, construction and operations with real estate.

Next step in our analysis is to evaluate the amount of these effects. We will look at the aggregate level to get the overall understanding about connection between loans and GDP. Correlograms were used to evaluate the effect of auto correlation; results show that both GDP and the amount of outstanding loans depends strongly on their value in the previous quarter because partial correlation with lag 1 is has a spike, but autocorrelation values decrease and this decrease is close to exponential decrease.
Based on the information that GDP value depends on its value in previous period, following model was built:

$$\ln(GDP_t) = 3.8796 + 0.7072\ln(GDP_{t-1}) + 0.0338\ln(loan_{t-1})$$
$$(0.017)\quad (0.001)\qquad\qquad (0.780)$$

In this equation there are shown the results for the simple model to display relationships between GDP and loans for the case of Latvia. The R^2 for this model is 67%. Connection between loans and GDP is positive (if loans increase by 1%, GDP in next period increase by 4%), but this coefficient is not significant, so further research at more disaggregated level is needed to test the relations between some sectors of economics and loans influencing them.

IV. CONCLUSIONS

Analysis of correlograms shows that in Latvia value of GDP and outstanding loans depend strongly on their value in the previous period, so the models showing the impact of the value of loans and previous value of GDP were created. Coefficient describing the impact of lagged GDP value is significant, but coefficients showing the impact of loans were not significant in any of the examined countries, though they were positive suggesting that increase in the loans possibly could be a factor that influences the increase in GDP.

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Territory Development Index – overrated for some territories, undervalued – for other?

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Keywords **– Demographic burden, Territory Development Index, Regional development.**

I. Introduction

Territory Development Index (TDI) was developed by Latvia Statistics institute in 2000, and with definite weight coefficients it sums standardized values of statistics indicators which characterize development of territories in Latvia. This index shows how the territory has developed during respective year in comparison with the average parameter of the state social and economic development level.

TDI values for planning regions and districts and cities of the republic are calculated differently therefore they cannot be compared for different administrative classifications. In order to calculate TDI for districts and cities following parameters are used: unemployment rate, amount of individual income tax per one inhabitant, level of demographic burden and changes in the number of permanent residents within last five years.

The article particularly reviews the indicator of demographic burden included in the calculation of the index, pointing out that it can't be valued as a factor which encumber territorial development. Therefore example for alternative Territory Development Index calculation is proposed and changes in district development evaluation are reflected.

II. Territory Development Index calculation and usage

Territory Development Index is used for territory comparison and decision making about financial resource allocation. It is also used in processing of state support program for regional development, various fund support differentiation, territory comparison and especially for determination of supportable territories.

Considering wide usage of TDI, it is important to comprehend the methodology of TDI calculation and how sensitive it is to small changes in indicator calculation. As the index is used quite widely and it is related to planning and finances, it must be carefully examined and it must describe real level of development in different territories, as well as to show the potential of respective territory development.

Up to now TDI methodology disadvantages have been already discussed by several authors (more details can be found in the clause II A). V.Vesperis (8) points out that demographic burden is an indicator which can initiate discussions, and it is incorrectly to consider larger proportion of children among inhabitants as the factor which diminishes development.

This article proposes adjusted TDI calculation method by dividing demographic burden into „bad" – inhabitants who are over working age, and into „good" – inhabitants before working age. Following formula is used in calculations:

$$TAI_i^* = 0.3 \cdot IIN_i - 0.3 \cdot U_i + 0.2 \cdot IEDZ_i - 0.1 \cdot P_i + 0.1 \cdot B_i \quad (3)$$

where TAI_i^* – adjusted TDI for respective territory,

IIN_i – amount of individual income tax per one inhabitant,

U_i – unemployment rate,

$IEDZ_i$ – changes in the number of permanent residents within last five years,

P_i – part of demographic burden level from inhabitants over working age,

B_i – part of demographic burden level from inhabitants before working age.

III. Result comparison of current and adjusted territory development index

In order to evaluate influence of modified methodology and estimation of Territory Development Index, author analyzed district ranking due to original and adjusted index values. In compliance with the estimation of their development, districts were divided in four groups („leaders", „almost leaders", „below average", „the weakest"). By the division of demographic burden into „positive" (from children and youth as inhabitants before working age) and „negative" (from inhabitants over working age), 24% of districts have changed their belonging to those four big groups – 13 districts show weaker development trends than it was estimated initially, but other 13 show higher development.

III. Conclusions and suggestions

Methodology of TDI estimation is sensitive against different changes in its calculation. Usage of results of this index in strategic decision making and financing decisions and the need for the support of some districts can be undervalued, so they can get less support than those territories with comparatively faster development or which has higher development potential.

Author suggests evaluating part about demographic burden included in Territory Development Index. It is necessary to divide those two different inhabitant groups (children and pensioners) separately. Author suggests to keep current methodology for the information about inhabitants over working age and to leave influence of demographic burden with negative sign, but the part of demographic burden from inhabitants up to working age must be estimated as the factor which positively characterizes development.

Considering that TDI is used in decision making process, which essentially influences further development of different territories, author calls upon discussions and possibilities to improve methodology for the calculation of this index, by paying special attention to the part about demographic burden, which can't be unambiguously estimated as the factor which gives negative influence on the development.

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Pricing Mechanism in the Changeable Modern Latvian Business Environment

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Keywords **– pricing, factors influencing pricing, price – setting principles, pricing model.**

I. Introduction

Latvian market is characterized by changing prices with a strong upward trend. Though the scientific literature increasingly accentuates the science-based price-setting, Latvian enterprises have little experience in this field and this important and complex process is given undeservedly little attention. Pricing contains a huge potential, implementation of which can ensure the increase in the company's operational efficiency and gaining the competitive advantage.

The objective of the research is to elaborate the basic principles of the price-setting concept that would be applicable in Latvian companies in the changeable modern economic conditions.

To reach the objective there will be characterized the nature of the price-setting process, establishing the main elements and stages, analyzed the price-setting practices in Latvian enterprises, based on the opinion of the entrepreneurs and experts.

Research methodology, will be used: logically constructive approach - making judgments and results analysis; synthesis method - to combine the elements of a single system; social research methods – to obtain the primary information and to carry out its verification.

II. The Nature of the Modern Price-Setting Process

Pricing is no longer a purely economic challenge to be addressed through studies of market elasticity. It's a challenge that can't be solved by lowering prices until customers make a purchase. And it's a challenge can't be solved by allocating costs and adding markups. Rather, pricing today must focus on value exchange. Combined, the marketing orientation of the firm and the economic understanding of value exchange provide the foundation for developing insights required for executive decision making in pricing strategy. Executives can structure pricing challenges into one of four types: price setting, price discounting, price structure, and overall pricing strategy.

Pricing has come a long way, and it is time for executives to grasp this modern understanding to improve the results of their decisions.

Shared-value pricing is a nascent and evolving strategy, and some experiments will surely fail. But given the fundamental shifts in consumers' power and expectations, customers will have dwindling patience for antagonistic pricing. There are five pricing principles that every business could profitably adopt:

1) Focus on relationships, not on transactions;
2) Be proactive;
3) Put a premium on flexibility;
4) Promote transparency;
5) Manage the market's standards for fairness.

To maximize the effectiveness of pricing cues, retailers should implement them systematically. Ongoing measurement should be an essential part of any retailer's use of pricing cues. In fact, measurements should begin even before a pricing cue strategy is implemented to help determine which items should receive the cues and how many should be used. Following implementation, testing should focus on monitoring the cues' effectiveness. There are three important concerns tend to be overlooked. First, marketers often fail to consider the long-run impact of the cues. Second, retail marketers tend to focus more on customers' perceptions of price than on their perceptions of quality. Finally, even when marketers have such data under their noses, they too often fail to act. They need to both disseminate what is learned and change business policies.

Retailers must manage pricing cues in the same way that they manage quality.

It's incredibly important to truly listen to your customers, and to act based upon their input. Pricing problems evolve into price problems, and cumbersome systems that make doing business unnecessarily difficult are sure to anger and frustrates customers. Business success today demands that companies commit to fixing the weak links in the chains that connect them to their customer. Also changing as the economy recovers is the focus from cost to market-based issues.

III. Price-Setting Principles in Latvian Enterprises

Latvian entrepreneurs carry out pricing mostly by themselves. Usually it is done by the owner – the manager of the company. Pricing is based on expenses. Though entrepreneurs try to combine principles (by estimating demand, consumer needs, and competitors' prices), surcharge is created in line with the trends existing in the branch and with the focus on the average level there (therefore more important become specifics of operation). Pricing in the companies is organized in a relatively simple way, without paying much attention to it.

The experts evaluate Latvian price changeability as rapid and often unpredictable, and point out that the main conditions for price-setting are expenses, based on the expense principle or the combination of several principles. As the main price-setting influencing factors are mentioned production expenses and purchasing power.

IV. Modern Pricing Concept for Latvian Enterprises

There should be noted three priorities connected with the price management organization in a company:

1) The support of the tom-management within the process of price-setting;
2) Clearly defined process and responsibility;
3) Systematic analysis of the competitors' prices.

The pricing requires complex models.

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Reconsidering Labour Force Training to Enhance Innovation for Economic Development

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Keywords **– labour force, training, skills, institutional mechanisms, innovation.**

I. INTRODUCTION

Economic development today greatly depends on skilled and 'innovation capable' labour force, and this may require new approaches to labour force training, since the fast technological development continuously causes skills' shortage and skills' mismatch. This is not an easy task. Also the President of the European Commission J.M Barroso, when discussing 'what's wrong in Europe', has pointed to the weakness of public education and innovation systems [1]. According to our observation, today much emphasis is being put on the training of skilled and 'innovation capable' labour force at higher level. At the same time, not so much attention has been paid to the training of 'innovation capable' labour force in the vocational training system. This is partly rooted in the traditional approaches, where the higher education system and the vocational training system have been functioning relatively separately. However, today, when the technological processes require highly skilled and 'innovation capable' labour force at all levels, new approaches and an enhanced dialogue have to be considered for strengthening the link between the two (training) systems.

II. RESEARCH APPROACH

The research is aimed at studying the attitudes of relevant stakeholders towards the success of the training of 'innovation capable' labour force, as well as towards possible change of institutional approaches to address challenges in the training of modern labour force. Academic research on this has been conducted worldwide, like on political aspects of innovation [1], where the positive transformational power of public innovation policies have been examined – policy framework and identification of issues that governments and businesses support as innovation policies; on development of the National Innovation System (NIS) concepts [2], where it has been analysed how the formal body of codified NIS knowledge is being produced, developed and spread, and how it is being used; on transformation of university roles in regional technological and economic development [3]. To do the empirical research on above indicated issues, textual analysis and empirical analysis has been carried out. By the textual analysis the current policy and academic discourse regarding our research problem has been discussed. By the empirical study the opinions of relevant stakeholders regarding the respective research problems have been analysed. The target group for the empirical study were high and medium level public administrators in education and research, as well as research experts from various research institutions.

[1] Innovation Priorities for Europe. Presentation by J.M.Barroso to the European Council of 4 February, 2011.

For the implementation of the empirical research, a questionnaire was developed and experts were asked relevant questions to evaluate the current situation. Before the expert survey the questionnaire was tested among proved professionals in the above mentioned fields. Evaluations had to be made in scale 1 – 10, where 1: fully disagree; 10: fully agree. Based on the material obtained by the questionnaire, the primary analysis of the opinions of the various target groups has been conducted and the results compared. Qualitative analysis has been complemented by quantitative analysis through applying the indicators of central tendency or location (arithmetic mean, mode, median), as well as indicators of variability (variance, standard deviation, standard error of mean, range, etc.). This has enabled us to draw conclusions regarding the research problem based on which further practical recommendations for possible steps in policy making could be prepared and taken.

III. THE EMPIRICAL DATA ANALYSIS

Regarding the empirical study, the focus of the research has been on the analysis and comparison of the opinions of experts regarding the training of 'innovation capable' labour force at the higher and vocational education systems, as well as on the need to establish closer links between the two systems. Analysis of answers have been presented regarding the research specific questions/ statements: 1) Labour force with higher education (within the range of competence) is well prepared for the implementation of innovation (are innovation capable); 2) Labour force with vocational secondary education (within the range of competence) is well prepared for the implementation of innovation (are innovation capable); 3) Closer links between the higher education system and vocational training system would promote the implementation of innovation.

IV. CONCLUSIONS AND RECOMMENDATIONS

Our analysis shows that traditional approaches to the training of labour force still prevail, with relatively little emphasis on the need for a more comprehensive approach towards the training of 'innovation capable' labour force at all levels. Closer links between the higher education and vocational training systems is not being viewed as crucial in the training. The same refers, as our previous research shows, to the existing institutional mechanisms, e.g., the relatively reserved attitude towards the Branch Expert Councils that aim at addressing the challenges of training of labour force at all levels. This presents new challenges for further research on the causes and dynamics of the prevailing opinions.

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Civilization determinants of competitiveness of national economy

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Keyword **- competitiveness, competitiveness of national economy, determinants of competitiveness, civilization, civilization determinants of competitiveness.**

I. Introduction

The contradictory effects of globalization, which is manifested in the growing disproportions and asymmetries of the world economy, increasing of international competition, attract the attention of theorists, politicians, and economists to the factors, which determine the competitiveness of national economies.

II. General Information

The conceptual appliances and approaches to the understanding the essence of the term “competitiveness” in globalization conditions were analyzed.

The determinants of national economy’s competitiveness were systematized.

The civilization determinants of national economy’s competitiveness were defined.

It was set that the main civilization determinants of competitiveness of national economy were: identity and relationship to a particular religion; attitude towards life (value of life), friendship, family, freedom, labour, resources, time, property and wealth (poverty), power; the propensity to risk and change (related to risk and change); the level of tolerance.

In addition, it was found that all countries could be divided according to their belonging to a particular models and submodels of civilization, which determined their features of development.

Models of civilization is a set of most general relatively static current and / or latent signs of civilizations, which define its most important common features and development potential, and most fully distinguish them from other civilizations.

Submodels of civilization are the civilization-specific groups of countries which act as structural elements of civilization, and are characterized by similar conditions of ontogeny (individual development).

It was proposed scientific and methodical approach to test hypotheses about the influence of civilization factors on the level of competitiveness of national economies, which includes five steps: 1) studying the characteristics that define the identity of a particular models and submodels of civilization; 2) grouping the countries by primary and secondary criteria; 3) determining the distinctive features of the "cultural core" of the various models and submodels of civilization; 4) determining the relationship between of countries of particular models and submodel of civilization and their features and results; 5) determining the vector of influence of civilization determinants on the parameters of development and competitiveness of national economies.

It was figured out that there was 95-99% of probability of dependence between certain model and submodel of civilization of a country and its economic development and therefore competitiveness.

III. Summary

Thereby, civilization determinants influence the competitiveness of national economy. Countries model of civilization as socio-economic systems of higher level of aggregation should be considered both as a force that promotes progress, ensuring the formation of competitiveness advantages and high competitiveness of national economy and as a force that stimulate a progress, resulting in the formation of competitive disadvantages and reduces the competitiveness of national economy.

Consideration of civilization determinants in assessing the competitiveness of national economies will help: to more fully understand the sources, factors and mechanism of formation and to provide competitive advantages at the level of national economy, to identify the main trends and prospects for transformation processes, to develop an effective strategy for economic growth and competitiveness.

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Employee Ownership Model for Latvia

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***Keywords* – employee ownership, employee ownership model, employee stocks, financial participation.**

I. Introduction

Former experience of employee ownership (EO) in Latvia is related to privatisation period when property rights transfered from state to private ownership. Nowadays still the issue of EO is topical in many companies (e.g., JSC "Latvijas Finieris", JSC "SAF Tehnika", and others).

EO models are common in developed countries and most of them have taxation benefits. Conversely in Latvia the regulation of EO is insufficient and existing taxation regime impedes the use of EO for enterprises. Lack of information and understanding about EO in all levels (state, entrepreneurs and employees) is another barrier for EO use.

Thus the research questions are: would the impact of EO give the same result in Latvia as in other countries; what are the barriers of EO in Latvia; what is the best EO model for Latvian enterprises?

II. Theoretical Background

Employee ownership is a type of financial participation that anticipates granting enterprise stocks to employees directly or indirectly (e.g., using stock options).

There are several definitions of EO that reveal it from different perspectives. For example, scientists of the National Center of Employee Ownership (USA) define employee ownership as *an organizational arrangement in wich there remains a clear separation between managers and workers, where shares of ownership are not necessarily distributed equally, and where a significant proportion of the people who work in the firm, regardless of hierarhical level, or whether compensated by salary or hourly pay, possess ownership in the employing organization* [1]. This definition is being concentrated on details of EO plan but not the esence of it. Furthermore the authors of the Model plan have developed contrary conditions (suggestions) for EO plan, such as voluntary participation; equality; clear rules; regularity and succession of EO plan; providing complete information for employees; setting clear boundary between regular pay and EO pay; etc [2].

The author of this digest has summarized the main advantages of EO that are widely discussed in literature, such as improvement of employee motivation, productivity, employment stability, solution of principal – agent problem, increase of competitiveness, long term savings and additional income for employees, etc.

III. Research Methods

The research is based on two methods:

1) Qualitative survey (interview of experts), and
2) Contentanalysis of Model plan, case study of EO in *Fachglas Wernberg GmbH* (Germany), PEPPER report and legislative documents of Latvia regarding EO.

IV. Research Results

The main results of research are that Latvia's entrepreneurs need to have an option to introduce EO corresponding to world's best practice. It would help to adjust and balance labour payments, regulate consumption, counterbalance economic fluctuations, motivate people to work in particular organisation and achieve the best results.

Main problems and risks associated with EO are *free rider problem* (f.v.) and risks of stock price fluctuations, lack of diversification and risk to lose both stocks and job.

Due to survey results there are four steps (state level) of implementing EO in Latvia:

1) Employers'request to set regulation for EO;
2) Development of EO legislation;
3) Introduction of tax advantages for EO;
4) Informing the society about EO.

V. Employee ownership Model for Latvia

The legal regulation that needs update is regarding EO plans (e.g., stock option definition and regulation), an option to issue employee stocks with voting rights and to set tax benefits that would be equal with benefits for other long-term savings for employees.

Before introduction of EO model in an enterprise there are tasks to be done: situation analysis (to make sure that EO is needed); target identification (to set the EO plan); and EO plan development (see Table I).

TABLE I

EO plan implementation

	Action	Result
Preparation tasks	**Situation analysis**: Investigation of legal basis; Ascertainment of employers'interests regarding EO; Ascertainment of employees'interests regarding EO.	Decision about implementation of EO (or not)
	Target identification: Employers'targets; Employees'targets.	Selection of EO plan
Implementation of EO plan	Development of participation criteria; Setting the amount of resources and their origin; Selection of stock valuation method; Setting the terms of EO plan; Determination of procedure of informing employees.	EO model in an enterprise

VI. Conclusions

The goal of the paper was to develop a model of employee ownership implementation in Latvia. It contains tasks to be done in government level and practical recommendations for enterprises willing to introduce EO.

The author of this digest has developed a theoretical basis for further research and practical approbation.

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Participation of Ukraine in the decision of world food safety problems

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Keywords **– development strategy, global agricultural infrastructure, world food safety.**

I. Introduction

In the era of globalization the task of ensuring world food safety takes an important place among the global problems of humanity. A large number of international organizations and individual countries are taking part in the solving the problem of famine.

II. General Information

Theoretical frameworks of the management of food safety were analyzed. The essence of definition for "World Food Safety" was specified as conditions, when each person has an access to a safety food in an amount sufficient to be active. Impossibility of achieving a high level of world food safety by only increasing agricultural areas was justified. Importance of individual states (with significant agricultural, innovative, geopolitical potentials) for solution of the problem of world food safety was established.

Tendencies for demand and supply on the world market of agricultural products including FAO Food Price Index were established; the reliability of predictions for FAO in relation to prices and trade volumes was estimated; the state of the world's food supply was studied, also the features of the distribution of food in certain regions were analyzed. A methodological approach for evaluating the level of world food security was proposed.

Factors that affect world food safety were set, among which objective and geopolitical ones were distinguished.

The main functions of international organizations dealing with the problems of famine were determined; deficiencies in their work were revealed; methods for improving their efficiency were proposed. The activities of international organizations were critically analyzed (United Nations, Food and Agriculture Organization of the United Nations (FAO), Committee on World Food Security, International Labour Organization (ILO), World Health Organization (WHO), World Bank).

The programs of international organizations, carried out to increase the level of world food safety including United Nations Millennium Development Goals, activity of separate countries and personalities, executed to eliminate the famine, were analyzed.

It was proved that national policies in this particular field as well as activities of large agricultural enterprises play significant role in providing a high level of world food safety/.

Directions of participation of Ukrainian enterprises in ensuring of world food safety were defined, including increase of shipments of agricultural products to world market, forming the infrastructure for storage of food supplies, creation of hubs for freights of agricultural products.

III. Summary

Thereby, the participation of Ukrainian agricultural enterprises and the transformation of state policy will significantly increase the level of world food safety by means of existing basic competitive advantages of agricultural complex of Ukraine (vast agricultural potential, including availability of land resources of the highest quality).

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European Monetary Union and its compliance with the Optimum currency area criteria

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***Keywords* – Optimum currency area (OCA) theory, OCA criteria, European Monetary Union (EMU), euro zone.**

I. INTRODUCTION

EMU is a result of serious and long-term integration processes. European monetary integration has both positive and negative aspects, which is evidenced by the member states' achievements and modern economic and financial problems. The aim of the paper is to analyze euro area's level of compliance with OCA criteria based on the OCA theory guidelines to help understand the basic problems of euro area's functioning.

II. CRITERIA OF OPTIMUM CURRENCY AREA THEORY

It is possible to distinguish two main directions in the OCA theory. The first direction focuses on the analysis of economic characteristics or economic indicators, which are significant in choosing the participants of an OCA. The second approach is based on the study of the monetary integration's costs and benefits. Using a number of criteria it is possible to define whether a group of countries / regions form an OCA.

The accomplishment of the labor mobility criteria can contribute to the automatic stabilization of the monetary union that has been affected by asymmetric shocks (Mundell). If there is unemployment in one country and inflation in another, it is possible to resolve the imbalance by labor force overflow between the countries. High diversification of production and consumption in the member states' currency area reduces the probability of asymmetric shocks (Kenen). Countries with a large degree of economic openness are inclined to use the fixed exchange-rate regime that positively affects price stability, which in turn helps to prevent asymmetric shocks' consequences with fewer costs (McKinnon).

High degree of financial markets' integration reduces negative effects of asymmetric shocks, because even small changes in interest rates can balance the movement of capital between member states (Ingram). Price and wage flexibility is one of the government's instruments in the fight against asymmetric shocks. It is used because it reduces the likelihood of consequences being connected with long-term unemployment in one country and long-term inflation in another (Friedman). High convergence of inflation rates creates more sustainable conditions for functioning of the economy, helping to deal with asymmetric shocks faster (Fleming).

High degree of political integration contributes to a rapid and coordinated decision-making process and ensures the stability of the currency area, which helps to fight asymmetric shocks (Ishiyama). Accomplishment of the homogenous preference criteria implies that the currency area members need to work towards a common solution on how to solve asymmetric shock consequences (Baldwin Wyplosz). [1] The degree of accomplishment of the criterion of solidarity against nationalism contributes to a more stable fight against asymmetric shocks. This criterion also states that OCA member states have to be tolerant and show solidarity to other currency area members (Baldwin Wyplosz).

III. EUROPEAN MONETARY UNION COMPLIANCE WITH THE OCA CRITERIA

EMU compliance with the OCA criteria was researched using the information published by European Commission, European Central Bank and Eurostat.

Labor freedom index measures indicate that labor migration rate in the euro area is at low level, which is influenced by different cultures, traditions, different welfare systems and other factors. Degree of openness of the euro area is at a high level, based on the high average indicator from export and import quota. According to production and consumption analysis, the euro area is diversified at an average level, as indicated by the gross value added distribution between sectors. The greatest contribution is made by the services sector, particularly the financial sphere.

Abolition of capital movement restrictions, new financial innovations, new opportunities for risk diversification, foreign asset amount, M3 cash mass growth, high rates of financial freedom index in the euro area – all these contributed to better allocation of resources in the euro area, which in turn stimulated greater integration.

The degree of inflation convergence in the euro area is on an intermediate level because only Germany, Austria and the Netherlands have managed to keep inflation within defined limits during EMU existence. Taking into account the comparison of changes in the minimum wage against the inflation rate changes, the criteria of price and wage flexibility in the euro area is on an average level.

Euro area member states do not have consensus on economic and financial policy planning and implementation, which indicates a low level of political integration, homogenous benefits and level of solidarity against nationalism.

The degree of accomplishment of the majority of euro area's optimality criteria is at low or medium level. For that reason the euro zone cannot be considered an optimal one. After the evaluation of the strong and weak sides of the euro area, its development potential, and taking into account its existing problems and risks, it was concluded that there are a number of destabilizing factors present in the euro zone. This means that the fight of the euro zone with the financial crisis will be long, with big changes in the economic, financial, political and institutional fields.

It is also possible to use efficiency and innovation rate in EMU member states and diversification indicators of export partners as additional criteria for the evaluation of the currency area's optimality.

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Asymmetric development under European integration: Social aspect

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Keywords: **European integration, EU new member states, social cohesion, Gini index, human development index**

Overall social progress and increasing social cohesion are among the top priorities of the European Union [1]. The aims of reaching greater social cohesion and reducing poverty were set in the Lisbon strategy and the Europe 2020 strategy [2]. The achieved results, however, remain contradictory at inter-country as well as at intra-country levels.

I. Disparities in per capita income and consumption

The gap between the most rich ("core") and most poor ("periphery") countries constituting now the EU-27 has hardly narrowed since the mid-1990s, if measured by GDP per capita index. Quite stable degree of disparities in per capita GDP is proved by high value of coefficient of variation (between 0.49 and 0.44 during 1995 – 2011). Actual individual consumption (ACI) index shows less dispersion among countries than GDP per capita. Nonetheless, the disparities remain impressive and prove greater than those between the republics of the former Soviet Union in the 1970s – 1980s. Statistical data and results of author's calculations supporting these conclusions are presented in Tables 1 and 2 (f.v.).

In Latvia, the aim of reaching the EU average level of GDP per capita in nearest 20-25 years had been declared in official government documents at least since the beginning of the 2000s. Unfortunately, more than a decade later, in draft of the new National development strategy, reaching of this aim proves again postponed to the same 20 years perspective.

Among painful consequences of the gap from rich countries, increasing emigration from the EU periphery states and regions has emerged, leading to their actual depopulation.

II. Human development index: consistent gains?

Since the early 1990s, when the centralized economic system was overthrown in the ex-communist Central- and East European countries, substantial fluctuations of human development index (HDI) can be observed in these countries. As concerns HDI comparative levels, the EU new member states are in better position than in terms of per capita incomes. This is first of all due to quite good indices of education and public health. On the whole, progress can be noticed in the above-mentioned countries. Except Bulgaria and Romania, they have managed to move to the category of countries with very high HDI (qualified as developed countries). As demonstrated in Table 3 (f.v.), their places in the recent rankings lie between the 21st and the 55th in the world. However, it remains disputable to what an extent this progress was a result of the EU membership.

III. Gini index: medium-term fluctuations and their factors

As concerns social cohesion, a measure of income inequality is Gini index. This index, analysed in historical retrospective in the East European countries – new EU member states – proves not diminishing. Moreover, as Table 4 (f.v.) shows, the income inequality tended to grow since the early 1990s in most of these countries. The Baltic states, besides comparatively low GDP per capita, were being steadily distinguished by the greatest values of Gini index (up to 0.36 – 0.37 and above) which meant the highest degree of inequality in income distribution among the EU new member states [13]. This index appeared high in comparison with the late 1990s data of the advanced West- and North European countries (Table 5, f.v.). In addition, inequality in income distribution at regional level within particular countries remained, at least in Latvia, even more impressive and did not tend to decline.

A more detailed analysis of the Gini Index dynamics will be undertaken by the author aimed at verifying some theoretical hypotheses. Namely, relationships between changes in the Gini index, overall level of economic development and economic growth rates were explored (Table 6, f.v., and Figure 1, f.v.).

Therefore, most of the EU new member states face a perspective to remain a poor periphery of Europe for an uncertain period of time. Economic growth was followed in these countries rather by increasing overall inequality in income distribution as well as of regional inequality. It seems that economic policies in these countries did not favour the low-income groups of population. Only few of the countries in question seem to have managed to somewhat reduce income inequality.

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Kesearch of factorial analysis evaluation in current assets costs

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Keywords **– assessment of financial reports, current assets, factorial index analysis.**

I. INTRODUCTION

In order to assess the financial condicion of the company, it is important to analize the current assets ant its expenditure. As the company attempts to become competitive in modern market conditions, the formation of new methodology of expenditure may help to acquire new competitive advantages. The modeling methodology of expenditure of current assets does not exist neither in Lithuania or abroad. However, such modeling ant its application would improve and accelerate the evaluation methods of expenditure by applying not only simple, but also mathematical models. And such attitude towards the accounting of the companies is quite new and has not been analyzed in the scientific literature at all. Therefore the main objective of this scientific research is the usage of such econometric statistical models as factorial analysis in the financial analysis of the companies or its separate areas, for example in the expenditure accounting of current assets.

II. USAGE OF THE METHOD OF FACTORIAL ANALYSIS OF EXPENDITURE OF CURRENT ASSETS

It is not completely clear, how to distribute the current assets in the company, and there are no methods, which would allow showing, how the company‘s manager could make the management of the current assets in the company effective. At present the mathematical modeling of the expenditure of current assets is not widely spread because it is not clear, which mathematical method could be applied for evaluation of expenditure of the company‘s current assets. The expenditure of current assets may be defined as the process and the method of factorial-index analysis can be applied for this process, its cognition and identification.

The factorial index analysis is the method, which is defined in the theory of economical statistics in the following way: the research of resulting changes that determines the influence of particular factors on the index being analyzed. Gregoriuo, G. N., Pascalau, R. (2010) present general characteristics of this method and define its role in the economic-statistical researches. Now we will restrict ourselves simply by stating that this method is closely related to another „slippery“, complicated and multi-spectral problem that is generally called economics indexes. Using the first evaluation, the factorial index analysis is the branch of this problem that has aquired independent development. Martišius S., Kėdaitis V. (2010) distinguish the important role of the method in case of researches of determined relations.

In order to receive the desired result and understand, how to apply the index of factorial analysis for evaluation of expenditure of current assets, the model has to be formed. When the model is supplemented with the qualitative and quantitative components ant the calculations are done, the new index is received.

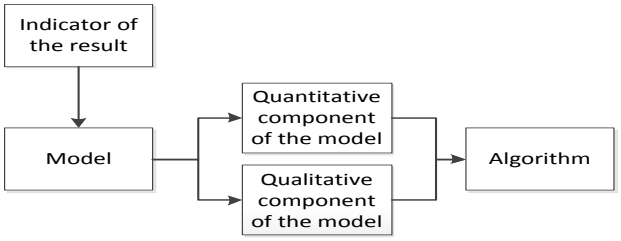

Fig. 1. Scheme of calculation methods of factorial index analysis

Such modeling with regard to the cause-consequence and using the method of factorial index analysis allows solving such principal tasks as: 1) determination of resulting index of changed factors in the relative expression; 2) determination of resulting index changed factors in the absolute expression. Finally the indexes in algorithm are formed as the partial of factor indexes, which show the interactions between the factors and impact expressed in the relative expression.

In order to apply the form of factorial index analysis, the following may be noted and marked in the calculation procedure of the index of expenditure of current assets.

$$M = m * q \quad (1)$$

Such a written and market formula becomes the model of full form of the multiplicative type. The latter is composed form two variables or factors, thus following this formula, it is possible to see the possibility to use and apply practically the method of factorial index analysis.

$$\overline{m} = \frac{\sum m_i q_i}{\sum q_i} \quad (2)$$

In the next stage of model formation we will use the already discussed dependency of multiplicative type that links M, m and q. Thus we have the model of multiplicative type of two factors. If the data of current and basic period are known, such model may be analyzed by distinguishing two directions of calculations.

To summarize, it is possible to state that the total increasing speed of generalizing index defining the rationality of expenditure is formed by two factors: 1) change of the rationality-generalizing index; and 2) structural changes in structural formations. The influence of these factors is defined when the indexes of constant composition and structural changes are calculated.

Thus the formed model will allow evaluating the effectiveness of analysis of usage of current assets. Besides it will be possible to decide not only on the usage of present current assets, but also about the effectiveness of the conducted activity or management, and it may be used by scientists, managers of the companies, or any other interested person.

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Level of competitiveness of depressed regions in Bulgaria

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Keywords **– competitiveness, depressed regions, problems, Bulgaria, Regional competitiveness index.**

I. Introduction

The regional development is one of EU's policies toward to decreasing imbalance between regions within member states and between regions in whole EU. The evaluation of level competitiveness is one of the ways to identification of regional differences and problems.

II. The aim and Object of research

The aim of this research is to analyze the level of competitiveness in depressed regions in Bulgaria. The depressed region is a part of territory which is characterized with low level and ineffective production, high level of structural unemployment, mono structural economy, lack of investment etc.

The object of the study are regions, classified as level NUTS 3, according to EU legislation, where is more than 1 local administrative unit (LAU 1, according EU legislation) define as depressed territory. In Bulgaria NUTS 3 level is named *'districts'* but in the text both *'region'* and *'district'* will be used as synonyms.

The depressed areas in Bulgaria are 65 municipalities from 256 municipalities in Bulgaria or 25,4% from LAU 1. The depressed areas are located in all 6 statistical regions and in 23 from the 28 districts in the country (82,1%). The total territory of these areas is 28 185 km^2 or 25,4% from total territory of Bulgaria. There live 1,36 million people (18,5%) in 67 from 257 towns in Bulgaria (26,1%).

The level of competitiveness is estimated through the regional competitiveness index composed by 10 indicators.

III. The used methods

The regional competitiveness index, used in the research, is calculated as distance from each district, as a point of N-dimensional space with coordinates which definite by the values of indicators for the studied district, to the hypothetical district which coordinates are definite by the best values of used indicators for all districts. The index is calculated by 10 indicators published at the website of the National Statistical Institute in Bulgaria in the section for regional statistical data. The indicators concern: firstly, the market size measured by indicators of population density, natural growth and turnover per capita; secondly, the quantity and quality labour resources, respectively, measured by the rate of employed persons, the share of working-age population with higher education and the share of the population using the Internet; thirdly, the competitiveness of the economy, determined by the expenditure on acquisition on tangible fixed assets, foreign direct investment, productivity and gross domestic expenditure on research and development activity per a person engaged in research and development. The indicators are selected by level of significance for regional economy. A part of them are very sensibility from changes in the economic situation. This for example are the expenditure on acquisition on tangible fixed assets, foreign direct investment and etc.

IV. Results and Discussions

The research presents results for the regional competitiveness index in Bulgaria from 2005 to 2010. They show that:

The main influences on the regional competitiveness index have: expenditure on acquisition on tangible fixed assets; foreign direct investment in non-financial enterprises; turnover per capita and population density per squared km.

The influence of natural growth of population increases.

The area and the population of depressed territories in district have no considerable effect on regional competitiveness index which shows the leading role of these territories in economy of the district. If the administrative centre of a district is defined as depressed then regional competitiveness index is high which means a district with low competitiveness nevertheless will be of the relative share of the depressed territories (for example Kardzhali (28th place in 2010 at 29,1% depressed territories); Vidin (27th place at 36,9%), Montana (26th place at 47,1%), Targovishte (22nd at 59,5%), Kyustendil (20th at 82,2%)). Districts with relative high share of depressed territories but with administrative centres defined as *'centre of growth'* are more competitive (Sofia (5th place at 62,4%); Stara Zagora (6th place at 29,7%); Plovdiv (4th place at 18,3%).

V. Conclusion

The results for the level of competitiveness of depressed region in Bulgaria show that for its increase a purposive regional policy toward: stimulating of investments in researches and inventions; increasing of the companies competitiveness; improving of effectiveness and efficiency in using of EU funds; encouraging of the foreign direct investment in districts by flexible tax policy, building and improving of the infrastructure and etc is necessary.

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Application of determinate factor analysis in municipal performance indicators analysis

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Keywords **– municipality, factor analysis, municipal financial equalization fund, subsidy.**

I. Information, its significance and methods of processing in economical analysis

Successful and effective operation of organization depends on decisions, made in various administrative levels. Quality of decision-making, in turn, depends on such factors as decision-makers knowledge, experience and intuition. An important role has also information, available for decision maker, i.e. – informative support for selection of alternative. Significance of information increases due to more rapid changes in the internal and external environment of organization. So it is a topical to define what qualitative information is and how to attain it. Of decision maker point of view, there are very relevant to receive processed information i.e. that have already been analyzed and allows draw explicit conclusions about the situation and the factors influencing it.

Quality information is:

1. correct ("true");
2. complete;
3. user-friendly;
4. accurate and reliable;
5. visible and well lit;
6. timely and prompt;
7. at the right place;
8. adequate (adequate for purpose and useful).

Classically, for information processing are used a number of logical information processing techniques – comparison, the relative and average values, data display in graphical and a table format, grouping, balance method, intuition and experience.

Factor analysis is a methodology for conducting a complex and systematic exploration and determination of factor influence on the resulting indicator. This means that the analysis of the information and situation is made much more thoroughly. Determinate factor analysis is used in cases where the factors and the resulting indicator have a functional relationship. There are several techniques to determine the impact (direction and amount) of each factor on the resulting indicator:

1. Method of progressive substitution.
2. Method of absolute difference.
3. Method of relative difference.
4. Method of proportional sharing and partial participation.
5. Integral method.
6. Logarithmic method

II. Application of determinate factor analysis in municipal performance indicators analysis

Analyzing the budgets (which are the main financial document for municipalities), mostly are used only information processing techniques (e.g., calculated plan relative values, relative values of intensity and comparison, average values etc.). However, while analyzing municipal operations, it can be concluded that each of municipal activities (not just the budget items) indicator is formation of multiple, often complex combination of factors influences. Part of factors the municipality can affect, but there is also a part of the external factors that the municipality cannot influence directly. These include, for example, social and economical environmental indicators, that municipality can partly affect by the promotion of public welfare level rise (promoting entrepreneurship, public health, culture and education, etc.). This group also includes the overall situation in the country (e.g., population and financial situation of other municipalities), as well as legal provisions (e.g. sharing the revenue from taxies, the procedure of taxation and calculating taxies, the tax rates, discounts, etc.). For example, amount of the subsidy from the municipal financial equalization fund in municipal budget is affected by local characteristic features and performance, as well as by a variety of external factors. So, in order to fully assess, for example, changes in amount of county municipality revenue subsidy receivable from municipal financial equalization fund (in the year 2012 in comparison with year 2011), it is necessary to determinate the impact of each factor. Calculation of the factors influence can be made if the model of appropriate performance indicator is drawn up (see formula 4)

$$U_i = 0{,}95 \cdot (0{,}53 \cdot (0{,}47542264 \cdot \frac{a_i}{A_2} + 0{,}13895868 \cdot \frac{b_i}{B_2} + \\ + 0{,}25686492 \cdot \frac{c_i}{C_2} + 0{,}12875376 \cdot \frac{d_i}{D_2}) \cdot K) - VI_i \qquad (4)$$

Due to the complexity of the model type, factors influence can be calculated only by using the progressive substitution method, i.e. – by replacing factor volume (one by one) from rate in year 2011 to rate in year 2012. In such way, indicator (amount of subsidy of municipal budget equalization fund) of year 2011, conventional indicators and indicator of year 2012 can be calculated. So, it is possible to determine the direction of the impact of each factor (i.e. increase or decrease the amount of subsidy) and the volume of effect (the amount by which factor led to a subsidy change). This, more depth approach to the analysis for indicators of municipalities, allows assess the influence of factors mainly with the aim to, through the planning, focus on the most important factors and measures of improvement. In addition, by planning operations and analyzing factors changes trends, it is also possible to compile forecasts of indicators.

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Smart Work Centre – possibility to increase economical development in Balvi municipality

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Keywords **– Regional Competitiveness Index, telework, smart work, smart work centre.**

I. Introduction

Nowadays the rapid growth of information and communication technologies allows successfully to change the existing traditional management to more flexible form of job – telework. The main goal of the research is to define advantages and disadvantages of telework and Smart Work Centers (SWC) and to evaluate main problematic development spheres in Balvi municipality. Research methods are analysis and synthesis, quantitative data analysis, comparison, graphical methods. The survey about telework is going on for further research.

II. Concept of telework

Definitions of telework rely on 3 main concepts: organization, location and technology. More than 60% of these definitions are based on a combination of at least two of these concepts. Since remote work and the use of new technology imply organizational changes, telework may be defined as work carried out in a location, where, remote from central offices or production facilities, the worker has no personal contact with co-workers there, but is able to communicate with them using new technology. Within this broad definition, telework may be performed „on-line" or „off-line", it may be organized individually or collectively, it may constitute all or part of the workers' job and it may be carried out by self-employed workers or by employees.

III. Advantages and disadvantages of SWC

The smart work centre (SWC) is an office or some room near the worker living place, where the employee or group of employees have their own working place, they are provided with the necessary technologies. Employers offer flexible and appropriate work conditions for their employees. The main advantage of smart work centers is their nearness to workers living place, in the result of this the transportation costs have decreased and productivity has increased. The SWC is flexible concept with multiple applications, depending on the user groups that are being catered.

SWC provides many kinds of activities and services. The SWC gives people a choice, so instead of making the stressful and time-consuming journey into the central office every morning, they can go to a place much closer to home where they can concentrate on their tasks, meet other people, drink coffee and do nearly all of the things they would normally do at their place of work.

Most of the people who use SWC do not use them every day. They might use the centre only one or two days each week, and on the other days they might go to their usual workplace, or attend meetings with clients or colleagues. In some cases they might use the centre for half a day – or just a couple of hours.

IV. Economical development of Balvi municipality

The economical development of Balvi municipality, in comparison with other municipalities of Latgale statistical region, has been evaluated using Territory Development Index (TDI), as well as formula of Regional Competitiveness Index (RCI) and method of its calculation, developed by the author.

Balvi municipality is rather competitive municipality in comparison with other municipalities of Latgale region. The best performance was in such areas like migration balance, which in 2010 was positive, as well as the Personal income tax revenues per person were rather high (181,7 LVL in 2010).

But the biggest problem was the high level of unemployment – 17,1% in 2009 and 18,8% in 2010.

By use of development level / trend matrix the development currently ensuring and decreasing, and also development potentially facilitating and hindering factors in Balvi municipality were find out.

V. Conclusions and suggestions

Every kind of telework (from home or from outside of home) has its own advantages and disadvantages for employees and also for employers. To choose this modern form of working it is necessary carefully to evaluate them.

If employee or employer will choose the telework in smart work center, they will have extra advantages, because several disadvantages compared to work at home are eliminated.

The main problematic spheres in Balvi municipality are high level of unemployment and comparatively small amount of population, which continues to decrease. Also the natural increase trend is negative. The solution might be establishing of SWC in Balvi municipality. In such center the rooms, working places, modern technologies to do telework are available. Dynamic and creative environment in the SWC open up new opportunities to make new contacts and cooperation among employees and employers, which had worked at home till now.

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Problems and development prospects of educational system in Latvia

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Keywords – education, system, reform, knowledge, labour.

I. Introduction

Human knowledge and skills now become a key factor in economic development. Education and science are major directions of application of material and intellectual resources to ensure economic, social and cultural development of the particular country.

II. Importance of education in today

Currently education at all levels are becoming mass so that its maintenance requires more and more financial resources.

The world experience explicitly proves that science and higher-level university education ensuring both versatility and in-depth studies of processes is the basis for the development of high technologies and culture.

In a longer perspective this issue is related with global processes. Of course, also in the new conditions there will be the demand for semi-skilled (low-paid) labour alongside with highly qualified (well-paid) labour. The issue of what jobs inhabitants will be able to perform in the future is to be addressed already today. Therefore, the long-term perspectives of both production and employment of population are related with knowledge. Education and science are the necessary prerequisites for successful integration into globalization processes.

III. Education System and situation in Latvia

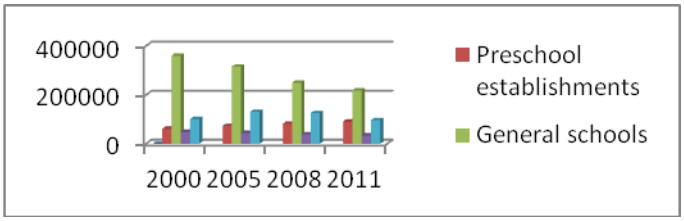
After regaining independence the Latvian education system faces a number of issues: reform, the quality of education level, financial weaknesses, etc.

The education reform was undertaken after restoration of independence in Latvia. However, despite a number of positive changes, the reforms so far have not produced the expected positive effect. The quality of the reforms was affected by several objective and subjective factors: insufficient financing, the desire to, at any price, to approach western standards, departmental interests, a desire to acquire political capital etc. Therefore the reforms were frequently undertaken for the sake of the reforms themselves, without serious substantiation and systemic approach. Changes were introduced in separate elements of the system, without coordinating them with other elements. Thus in many cases reforms were only imitation – names, external attributes and their forms were changed, without addressing the content and quality of the results of education.

Educational process is made possible through the functioning of the education system incorporating several elements (stages) – pre-school education, primary, secondary and tertiary education. Changes (reforms) in one of these stages trigger changes in the consecutive ones. These consequences may be either positive or negative. They may improve or aggravate the overall situation. In any case they call for changes in the higher consecutive stage.

Secondary education is the platform for tertiary education. The reform launched in the early 90s, the transfer to the elective subjects principle has seriously undermined secondary education in Latvia. In most cases in secondary schools preference was not given to exact science and natural science subjects. After a few years of unsuccessful implementation of the reform education policy makers tried to rectify the situation, namely, they developed the so-called programme education concept, which created humanities and exact sciences focused schools and programmes.

The analysis of the data of the number education in different levels of education system (see fig.1), we see that the number of students decreases, which is closely related of the demographic situation in Latvia.



I. Fig. Enrolment by type of school [2]

It has to be outlined that school education is lacking professional orientation, which creates adaptation problems for first year students in the professional work field. Pupils often lack sufficient motivation to continue education.

There is no doubt that an individual's need for education can be fostered not only by external socio-economic or political factors and incentives, but also by internal motifs and requirements. Most frequently persons mention the following factors encouraging them to acquire and continue education: the need of self-expression with regard to both general and professional competence; requirement for increasing the level of self-respect and self-esteem; the requirement for self-assurance; awareness of education as an asset in society [1].

At present the fast changes have been happening in economics and society of Latvia and as a result the discussion about education, especially higher education, has become very important. Exactly the higher schools are the guarantee of the development of economy in the state because the high schools prepare high qualified labour for a governmental sector and private sector. Therefore, it is necessary for academic staff of higher schools to upgrade their competences in the various areas, so the academic staff is the most valuable resource.

Nowadays in education it is relevant how a person can perceive and use the result of education, not the content of education itself. It means that high self-esteem, ability to work in a team, argumentation skills and ability to express opinion are more relevant than the scope of theoretical knowledge mastered but which the particular individual cannot or is unable to practically apply.

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Urban development trends in Latvia

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Keywords – city, urban development, sustainable development

I. Introduction

The last century marks a major urban development and urbanization trends around the world, because during this period, most of the world's population for their accommodation have chosen the city rather than in the countryside. Today, more than 50 per cent of the planet's 7 billion people have chosen to live in towns and cities than in villages and countryside. Consequently, one of the most pressing issues not only in the world, but also in Latvia is the role of the city on economic development.

II. Urban formation on the territory of present-day Latvia

In the second half of the 13th century in the current territory of Latvia, developed crafts and trade, creating the first villages and cities. Part of the site evolved in ancient settlement center site as Riga and Cesis. Later new localities such as Ventspils, Jelgava and Piltene emerged.

The villages and towns were mostly formed in the vicinity of the castles that settled German immigrants and local craftsmen and traders who traded between the Western and Eastern Europe, tried to control the trade routes leading through Latvia to Eastern Europe (3).

III. Urban evolution after the 19th century

Cities of Latvia rapidly developed in the beginning of the 20th century. During this period, Riga city became the third largest city in Russian Empire. In 1913 the population of Riga reached 500 000 however only 40% of the inhabitants of Riga were Latvians. During this period, in Latvia cities began rapid residential and industrial construction. Up to 1913 approximately 2 000 residential buildings were erected in Riga (3).

Urban infrastructure was developed and improved; water supply system was expanded, parks formed social and cultural institutions established. Riga Tram Company began installation of an electric tram and developed the first tram line. After inclusion of Latvian in the Union of Soviet Socialist Republics (USSR), the country underwent rapid changes; almost all of the production was taken over by the State. In the cities nationalization of businesses and homes began, in the countryside farms were merged and underwent massive collectivization, and as a result individual farms were eliminated. Latvia adopted Soviet industrialization and agricultural collectivization policies developed in the last century until 1980s (1). Increased urban population, developed certain branches of industry, however, underdevelopment compared to the West remained, especially in terms of environmental protection and quality of life. In the second half of the eighties due to a number of different political and economic conditions various changes started in Latvia and as a result Latvia regained its independence.

Since Latvia's independence in 1991, the economy has changed. In the early nineties economic structure was dominated by agriculture and industry, but in 2001, 70% of Latvia's gross domestic product (GDP) accounted for the services sector.

Now industry's share in GDP is very low. Hence the importance of change in population structure of cities and the country as a whole. Most goods and services are produced in Riga and its surroundings and it is more than 55% of the total production volume of Latvia GDP. From the 2000th to 2006 GDP, which binds to Riga has increased more than twice, and was over 6 billion lats (see Table I).

TABLE I
Gross domestic product in Latvia cities*(1)

	2000		2006	
	Total, in thousands lats	In total, the proportion of percent	Total, in thousands lats	In total, the proportion of percent
Riga	2 633 965	55,4	6 174 398	55,3
Daugavpils	145 145	3,1	398 183	3,6
Jelgava	99 818	2,1	258 625	2,3
Jurmala	67 164	1,4	136 918	1,2
Liepaja	175 379	3,7	391 629	3,5
Rezekne	53 586	1,1	177 896	1,6
Ventspils	245 120	5,2	303 745	2,7

All the others cities participation has been small on Riga background. Jelgava is left unchanged, Daugavpils and Rezekne - slightly increased, but Jurmala, Liepaja and Ventspils have declined.

IV. The future development of Latvia cities

Latvia as a whole is in beneficial conditions for balanced and sustainable development (2) because the cities are located evenly throughout the country. The cities in the future will become a major economic power, which will focus more on production resources. Cities in Latvia will develop successfully if the next few years create urban systems that are the best way to ensure sustainable economic and social development of the whole territory of Latvia.

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*Due to the transition to the statistical classification of economic activities in the new version of the 2007 GDP estimate by Latvian cities are not made.

Application of methods to assess public finance sustainability in Latvia

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Keywords **– sustainability, public finances, population ageing, intertemporal budget constraint, implicit and explicit liabilities.**

I. Introduction

Sustainability of public finances has a major role in economic growth in the long run. Sustainable public finances imply stable and predictable fiscal policy, as well as government solvency. This, in turn, allows attracting financial resources, including investments.

The main purpose of this paper is to examine theoretical framework of fiscal sustainability, analyze assessment methods and determine methods, which can be used in Latvia's case.

II. Theoretical framework

Scientific literature offers various definitions on sustainability of public finances with one common feature: government debt, which can be thought as a central indicator in assessment of sustainability of public finances.

Theoretically significant concept is intertemporal budget constraint, on which theoretical framework of sustainability of public finances is built. According to intertemporal budget constraint public finances are sustainable, when present value of future primary surpluses is equal or greater than the present level of government debt.

However, government debt is not the only major risk affecting sustainability of public finances. Other considerable risks are population ageing, public sector guarantees, government insurance schemes, need for financial sector bailout, natural disasters, need for military financing, etc. These risks can be divided in explicit and implicit government liabilities.

III. Assessment methods

There are various methods developed to assess public finance sustainability (sustainability indicators, intertemporal net worth, generational accounting etc.). In some cases the assessment is based on econometric models. The sustainability indicators are being considered as the most broadly used method in sustainability assessment. Assessment methods can be divided into cash flow principle methods and stock principle methods. Both types of methods are complementary and should be used simultaneously.

Cash flow principle methods are based on such indicators as revenue, expenditure and financial budget balance, all indicating changes over certain period of time. This method is used by European Commission and governments. European Commission bases its assessment primarily on cash flow principle method using sustainability indicators S1 and S2. These indicators include government debt level, primary structural budget balance and long term changes in age-related public expenditure. Long term age-related public expenditure projections cover expenditure on pensions, health care, long term care, education and unemployment benefits. Budgetary projections are based on long term demographic scenario provided by Eurostat and long term macroeconomic scenario provided by Ageing Working Group. Long term projections cover time period of next 50 years.

Stock principle methods are based on such indicators as assets, debt and other liabilities, all indicating stock at a certain time. International Monetary Fund has developed intertemporal net worth method, which is primarily based on stock indicators.

Assessment of sustainability of public finances faces many challenges. Main challenging task is to produce reliable long term projections of different indicators. This is linked with uncertainties, because projections are made very far in the future, usually for next 30 or 50 years. Same, risks appear when determining debt target. There is no clarity on what level of government debt is sustainable. For EU-27 countries Maastricht criteria for government debt is set at 60% of GDP. However, taking into consideration differences in size and structure of EU-27 economies, one cannot conclude that this is the most optimal debt level for each member state.

IV. Application of methods in case of Latvia

In response to fiscal sustainability problems due to population ageing and debt crisis in the euro area in recent years, more attention is being paid to strengthening analysis on sustainability of public finances. Not only international financial organizations make regular sustainability analysis for individual countries, but also those individual countries try to make their own assessment and to build national fiscal sustainability models (e.g. pension models).

Now, for Latvia, as well as for other EU-27 member states, assessment of sustainability of public finances is being made by European Commission once in every three years. Latvia participates in preparation of European Commission's assessment by providing relevant data and long term projections for public expenditure on pensions. The EC uses unified approach for assessment of all member states, including assumption of convergence in long term projections, as well as common projection methodologies.

However, independently sustainability of public finances in Latvia is not being assessed. Applying methods of sustainability indicators and intertemporal net worth could be a good starting point for first approximation in national assessment. Main strengths of these methods are simplicity of use and results can be easy communicated to policy makers.

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TRAILS – CCBM: Cross Cultural Business and Virtual Team Communication Training Platform

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Keywords **– Virtual Teams, Intercultural Management, eLearning, Blended Learnin, Business Communication.**

I. Introduction

TRAILS is a cross cultural business and virtual team communication training and eLearning platform based on a highly experienced blended learning methodology. It consists of analyzing, awareness and training tools. It is the result of the current research and development at the M2C Institute of Applied Media Technology and Culture Bremen and the Centre for Intercultural Management of the University of Applied Sciences Bremen. In July 2012 it wins the "Best of 2012"-Certificate of the IT-Innovation-Award from the German Initiative Mittelstand *(German Association for Medium-Size Businesses)*

II. General Regulations

High Mobility against the background of increasing global networks based on economy and media characterizes future dimensions of intercultural communication, especially in virtual working environments. Intercultural competence is considered as key qualification; in combination with virtual competencies it appears as a vital factor of success. European institutions and enterprises are instrumental in European integration and international economic actions. They lead the field in the global development and dissemination of technical products, infrastructures, services and logistics. Also in technical sectors the export of services, knowledge and methodologies rises. Recent studies of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the German Federal Ministry of Economics and Technology (BMWi) and the Federal Ministry for Economic Cooperation and Development (BMZ) point to deficits regarding know-how of intercultural networking and its implementation in technically supported virtual cooperation between global actors. This lack of knowledge transfer foils the otherwise higher-than-average professional competencies of European players. However, former approaches disregarding the current state of research have not anticipated the technical visualization of an increasing share of intercultural communication. To close this gap, TRAILS and the further research and development of the CCBM – Cross Cultural Business and Virtual Management Communication Analyzing and Awareness Tool joins and integrates applied research and development of digital tools with individually designed integrative methods of media-supported learning. Only this technical-methodological interconnection allows solving huge deficits regarding the quality of management, communication and apprehension in such a way that economic efficiency as well as sustainability in social, political and reputative concerns of global players can be augmented considerably.

III. Objects

The innovative potential of the TRAILS tool lies in the option to develop novel instruments and methodologies for analysis and learning within intercultural and virtual working environments. Examples are the Intercultural-Competences-Screening, the Intercultural-Preference-Profile, the Intercultural-Preference-Leadership-Profile, the Virtual-Team-Maturity-Model, the Virtual-Team-Competence-Analyser, das Virtual-Emotional-Leadership-Profile etc. The results of these analyses are integrated pinpointedly on several levels into new Blended-Learning-Approaches in order to tap so far idle potentials between digital media and new learning methods and to create new opportunities for application-oriented learning with auditive, visual and interactive aspects. Existing methods, e.g. the Critical-Incident-Method or the Cultural-Assimilator, are refined; via multimedia und mobilized technology they advance the learning process onto a higher level. Due to the learning platform's modular construction, its content and size can be modified and adapted to the needs of the respective target group at any time. The TRAILS tool also functions as pre-stage advisory service in favor of organizational work optimization. Within the TRAILS project, possible uses and practical applications are developed and advanced in cooperation with coaches and consultants to be utilized in a future CCBM-System. The end-user will accomplish tasks within the sectors of virtual workstreams, social navigation and intercultural acting in an optimized way. The further qualification of coaches and consultants will be supported and vitalized by the intercultural interaction between experts communicating about technical and methodological learning components. The project's future will be a multilingual, multifunctional European tool, ready for implementation all over Europe by academic training schedules and professional development programs for managers in industry, business and NGOs.

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Interaction of main stakeholders in an innovation process

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***Keywords* – game theory, innovation process, Shapley value, stakeholder interaction.**

I. Introduction

The concept of innovation has been broadened from having a solely technologic background to cover wider social, systematic, organizational as well as service novelties. Usually, economists and executive managers muse on the innovation concept, innovation types and put large attention to innovation management and its system. Even if innovation management has been considered as the key driver for sustainable growth and competitiveness, productive innovation management is an expedient target to reach for a certain stakeholder.

Therefore, it is useful to analyze the behavior and possible strategies, outcomes for individuals who interact with each other in the innovation development system. Situations and actions of stakeholders in the definite circumstances can be conflict or cooperative, depending on their interests. As a result, in order to get a clear insight into efficient innovation deployment it is necessary to analyze the current situation of stakeholders and their certain interaction in the whole workflow using game theory.

II. Stakeholder Analysis

Innovations, be it continuous improvement or effective management, in general, have a potential of creating wealth through the generation and exploitation of information, knowledge and intellectual property. Therefore, stakeholder alignment plays an important role. Alignment and integration of educational and innovation policies primarily depend on the capability of the education system to produce the required specialists for various fields.

The effectiveness of innovation development and implementation is dependent on social, political, scientific motivation and, of course, considerable capital investment. Thus, it can be said that main actor or stakeholder interaction analysis is crucial for defining an efficient innovation process delivery plan. With the help of such an analysis, a practical development model of an innovation process can be created. Every stakeholder group interest can be uncovered as well as group cooperation prerequisites found.

An economy is a system for coordinating the productive activities of many people. In a market economy, such as the one we live in, that coordination takes place without any coordinator: each individual makes his or her own choices. Yet those choices are by no means independent of each other: each individual's opportunities, and hence choices, depend to a large extent on the choices made by other people. So to understand how a market economy behaves, we have to examine this interaction in which my choices affect your choices, and vice versa [2].

V. A Game Theoretic Approach

We can assume that, when solving economic problems, it is often likely to analyze situations, where interests of different groups collide or are shared. In a free market economy these groups pursue different goals. Situations and group actions in these circumstances can be conflict or cooperative, depending on their interests. A mathematic theory of conflict or cooperative situations is, undoubtedly, game theory. Two or more players' interests can confront each other in a game. If in a multi-player game players create a coalition, the game is cooperative. If there are two or more coalitions, the game becomes a double game.

VI. An Interaction Model

The Shapley value defined a fair way of dividing the grand coalition's payment among its members. However, this analysis ignores questions of stability. Unfortunately, sometimes smaller coalitions can be more attractive for subsets of the agents, even if they lead to lower value overall.

A model of a coalition game of four stakeholders can be created (refer to Part IV of the full version for more details). The game model's outcomes can be calculated by a hierarchy method analysis, of which player's action is most important for the other player's outcome and, thus, their outcome while in a coalition. As a result, outcome values can be put into barycentric coordinates to provide a clearer picture of stakeholder alignment. Based upon outcomes, interests, mutual interests an efficient innovation process development plan can be created in order to improve and speed up its practical delivery.

VII. Conclusions

It can be pointed out that a lack of cooperation between higher education institutions and businesses significantly slows down the process of innovation. R&D expenditure can be high, but if patents and engineering innovative solutions created are not bought or even acknowledged by enterprises, their added value can be considered very low. Overall, it can be said that innovation acknowledgement, exploration and stakeholder cooperation in order to steer the process of innovation forward is crucial for effective all-round economic development.

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Insurance liabilities evaluation in small economy environment

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Keyword **- insurance liabilities, technical provisions, risk-free rate, Solvency II.**

The valuation of insurance liabilities is a topic which keeps currently all insurance industry in apprehension. There are two factors that change insurance liabilities evaluation: Solvency II requirements which are supposed to be implemented from 2014 and IFRS 4 "Insurance contracts" phase II requirements which plan to emphasize the importance of time value of the insurance liabilities. This research analyzes the influence of these factors to insurance companies in small local economy and looks at the future legislation requirements in this field.

The discount rate for insurance technical provisions calculation nowadays is usually understood as the market variable which could significantly influence the result of insurance liabilities valuation [1]. In the past though discount rate was more a technical term used in insurance business to describe the internal rate of guaranty incorporated in the endowment or whole life assurance policy. This type of guaranty was usually fixed for duration of insurance policy and was not supposed to be changed until the lump sum was paid according to the insurance policy conditions. This practice is now changing very rapidly and the value of not only life insurance, but also non-life insurance liabilities in the future will be evaluated by recognizing they time value. The forecast changes in this type of evaluation will significant influence the financial results of insurance company.

For this reason it is very important to use the relevant interest rate for insurance liabilities' discounting and to assure its comparability with the discount rates which are internationally used for similar liabilities' (defined benefit pensions, financial guaranties, non-insurance provisions etc.) evaluation.

Each country adopted own approach for technical provisions calculation as the insurance regulation leaves some freedom in this regard. There are member countries, which are using single discount rate for all life assurance provisions (Lithuania is one of them), but there are also several member countries which use for that purpose the term structures of government bonds' interest rates in each of world major currency, based on their swap curves or risk-free recalculation (example, UK and Netherlands). In Solvency I regime the interest rate was calculated using the premise that the average spread for government default risk could be around 40% for some the yields of government bonds, therefore the "pure" risk-free interest rate could exactly be valued at 60% yield level.

Actually, this approach could go in totally different direction, as EIOPA (former CEIOPS) now proposes not only to use the more sophisticated interest rate curve for the main currencies and to include an illiquidity premium in the discount rate.

As the major part of life assurance provisions and significant part of property insurance provisions are classified by the insurance companies as long term provisions, which are paid out as insurance claims only after 5 or even 30 years, the discount rate should be chosen also looking at the bonds with similar maturity. This matching requires checking if the discount rate has the corresponding quality, i.e. is highly liquid for all maturities. The problem is that a small government bonds markets as it is in Latvia or Lithuania have significant limitations in terms of availability and liquidity for the bonds with long-term maturity [8]. This presents significant difficulties for the insurance company willing to establish a coherent interest rate term structure which could be used for insurance liabilities discounting

The research concludes that the non-life (property) insurance liabilities in these markets are valued using usually retrospective and cost based methodology (with one exemption - outstanding provision for annuity payments). Even when insurance liabilities are discounted, the interest rate used for that calculation is very often over-prudent.

The author refers to the better situation in life insurance sector, where liabilities are in contrary valued using prospective methodology (ex. life assurance provision) and are discounted to evaluate time value of money. For this reason the valuation of expected claims dispersion is implicitly incorporated in life assurance provision and not valued through separate risk margin.

The research is finalized with conclusion that the proposed new valuation method (best estimate + risk margin) for insurance liabilities evaluation therefore will have huge impact to insurer's capital not only in foreign [12], but also in local market. The author analyzes this issue on local insurance market example and concludes also the local companies still do not use stochastic methods for insurance liabilities valuation and use more prudent interest rate for liabilities discounting then it would be required according to Solvency II requirements, which are test in EIOPA quantitative impact studies.

The research also concludes that insurance liabilities evaluation in small economies will be dependent of broader international practice and is still on the development.

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Funded Pillars in Pension Systems of Estonia, Latvia and Lithuania

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Keywords **– pension systems, funded pensions, yield, Baltic States.**

I. Introduction

Since early 2000s three-pillar pension systems have been launched in all three Baltic countries. Funded second pillar (mandatory) and third pillar (voluntary) pension schemes in Estonia, Latvia and Lithuania exhibit both similarities and differences. The author is analyzing the pension legislation of the three study countries, as well as statistical data from different sources.

II. Statutory Regulation of Funded Pillars

The funded pensions have been introduced in Estonia in 2002; in Latvia the introduction of 2nd mandatory funded pillar in 2001 was preceded by voluntary funded pension schemes that had commenced their operation in 1998; Lithuania was the last launching pension funds from 2004.

A. Eligibility

The second pillar is mandatory in Estonia to the persons born in 1983 and later and was open for voluntary subscription for those born in 1972-1982. In Latvia it is mandatory for all born on 01/07/1971 and later and voluntary for the persons born after 01/07/1951. In Lithuania the participation is voluntary irrespective of age. Voluntary third pillar pension schemes function almost uniformly in all three countries.

B. Contribution rates

The proportion of social insurance contributions going to the 2nd pillar varies across the three study countries and was varying over time. In 2009 all three countries have increased the mandatory contributions to the 1st pillar public pay-as-you-go schemes at the expense of funded pillar contributions.

C. Miscellanea

Administrative charges, rules for shifting to another pension plan, ways how the 2nd pillar pension benefit can be received upon reaching the pensionable age, inheritance rights, and taxation rules for voluntary contributions are regulated differently in Estonia, Latvia and Lithuania.

III. Performance of Funded Pillars in the Recent Decade

Since the participants of funded pension pillars have not reached pensionable ages yet, the pay-out phase has practically not commenced as well. The accumulation phase is going on. .

A. Asset managers and investment strategies

There are 6 second-pillar private asset managers in Estonia, 9 in Latvia and 9 in Lithuania. Scandinavian bankers are playing leading roles in all three Baltic States: Swedbank and SEB absorb 2/3 of the market. The asset managers offer 23 pension plans in Estonia, 27 and 30 pension plans in Latvia and Lithuania respectively. The plans are divided into three or four groups in accordance with the investment strategy: conservative, balanced, active and aggressive. The borderlines between groups vary among the countries. The majority of participants are members of active and aggressive pension plans; Latvians are relatively more conservative than their neighbours; the most part of participants have chosen inappropriate fund to participate [8].

B. Real yields

The real rates of return produced by now, especially by Latvian funds, are very far from desirable indices. A fair share of such poor outcome owes to high inflation rate in the so-called fat years and recent crisis.

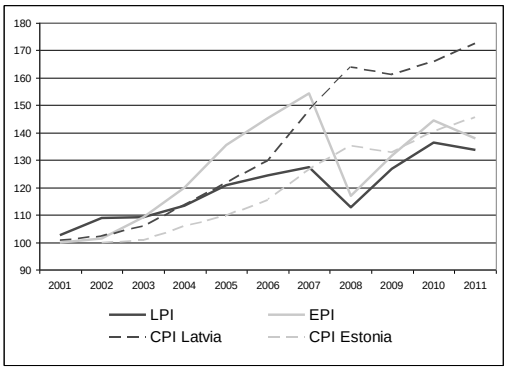

Fig. 2. Pension indices compared to inflation rates in Estonia and Latvia, 2001-2011.

Estonian statistics operates with a spectacular and clearly calculable Estonian Pension Index (EPI) showing growth in average weighted value of one share. The author has calculated analogous Latvian Pension Index (LPI) for key time points in order to compare the performance of asset managers. The results are shown in the Fig. 2 together with the inflation indicators.

D. Investments into home economy

Both mandatory and voluntary pension funds are mainly investing the accumulated assets outside their home countries and the share of the investments made abroad is increasing constantly.

IV. Conclusions

The importance of funded pillars in pension systems is increasing in all three Baltic countries due to demographical changes. Estonia, Latvia and Lithuania exhibit wide commonalities both in achievements and in difficulties in this sphere. Underperformance of funded pillars and insufficient financial literacy of population cast doubt on the ability of pension systems to provide adequate and sustainable pension benefits for future generations of pensioners in the Baltic States.

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Regional Integrative Agreements Effects

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Keywords **– regional integration, convergence, divergence, integrative effect, regional integrative agreements.**

I. Introduction

The changes in the national economics structure of the integrative blocks member states are challenging their labour markets transformation, modifying the level of the private income, altering the production and consumption structures, influencing on ratio between internal and external economic sectors. Accelerating or deceleration of the economic development is observed. Changes of the GDP per person in the member states of the regional integrative agreements (RIA) could be evidence of these processes. In RIA frames its could be developed in the two opposite directions: in case of closing in the economic development levels of the RIA member states we have economic convergence, in opposite case - economic divergence.

II. Main Results

Decreasing statistic on dispersion of the private real income and dispersion GDP per person in EU member states is empirical evidence in favour of economic convergence in RIA [1]. Dynamic of the GDP per person in EU with the regard for six EU extending was analyzed in accordance with decimal logarithm dispersion of this index for EU-6, EU-9, EU-10, EU-12, EU-15, EU-25, EU-27. Data of this analyze is showing the increase of the GDP per person gap between the EU member states in different periods of the EU extending. This gap is pronounced during the fifth stage of extending (2004), when Cyprus, Malta and 8 CEE countries joined to EU. However dispersion lessening between indexes of the EU member states is observed during following years. Therefore the economic convergence as the result of the regional integration is demonstrated.

Most of the "North-South" type RIA, and, especially, "South-South" type, in contrast to EU, don't demonstrate the evidences of the economic convergence and what is more the disparity of the economic growth levels deepening is observed in these RIA. Thus, logarithm dispersion of the GDP per person during the period of the RIA existing is increase: for SADC in 4,75 times, for ECOWAS – in 1,81 times, for MERCOSUR – in 1,54 times (2010) in comparison with pre-integration level.

Another type of the RIA economic effects are presented by phenomena of the scale economy and competition reinforcement and based on postulate that mass production is reduce average expenditure for unit production that in one's part is unachievable for limited national markets [8]. Such value decreasing is the result of the most effective producer's goods cheapens in the integrative block. Increasing of the production concentration and size of the companies – producers in EU countries for the production of the large number of goods in frame of the custom union are the consequence of this process.

Dynamic effects of the RIA are presented by competition reinforcement on the regional markets and rising of the scale economy, first of all, for small economics because its have low pre-integration competition level and small internal markets.

Empirical data are confirming the theory of the competition reinforcement and scale economy influence as the integrative process results on the RIA member states national economies, but the most importance have competitive and regulative policies of these countries.

Market segmentation is the one of the reasons why the competition reinforcement and scale economy effects in RIA are remaining potential but not real. Market segmentation is found in RIA which didn't reach high level of the integration and mostly are on the stage of the free trade zone. But even deep integrate EU countries were exposed by market segmentation. In particular, in concerning of the motor-car sales in EU frames: motor-cars import form other European countries was unprofitable for consumers in the mid of 1990th, because imported cars didn't correspond to national technical standards and requirements for production and sales licenses.

There are evidences of the "border effect" between EU countries even against a background of the deepening of the integration. Its display through disparity of the market prices, additional expenditures for export-import, less intensity of the trans-border trade etc. Such limitations there are in trade between NAFTA, MERCOSUR and other RIA member states.

Analyze of the production relocation effects demonstrate that the relocation as the consequence of the regional integration is the result of the direct foreign investments (DFI) inflow increasing for certain sectors of national economic.

The example is joining of the NMS CEE to EU which has DFI inflow increasing for machinery construction NMS CEE from other EU countries (motor-car construction, electronics and electrotechnical industries). However the integration promotes the DFI inflow increasing not only for most progressive economic sectors and DFI donors could be not only partners in RIA frames. So, after NAFTA creation was sizeable DFI inflow to Mexico. Mexico received annually $ 3,2 billons within seven year before this RIA creation, but as NAFTA member state Mexico received in average annually $ 12,4 billons [19].

III. Summary

RIA stimulate DFI inflow to counties which are members of the integrative blocks both from the partner-countries and from the third countries which investors try to receive free excess to RIA common market. Thus the countries recipients receive a number of the economic and social positive consequences: improvement of branch structure of economic, increase of technological level of of manufacture, perfection of commodity structure of export and improvement of trading balance, increase of population welfare, reduction of social intensity etc.

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Innovation behaviour support of Czech firms

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Keywords **– innovations, barriers to innovations, impulses of innovations, finances, quality employees, enterprise culture**

I. Introduction

Innovation is one of the sources of competitiveness, both at the state level and at the level of enterprises themselves. At national level, the socially oriented EU supports innovation as a source of job creation and sustainable development. Innovation support has focused on improving the quality of human life. Success of innovation is affected by many factors - stress in particular expenditure on R&D and increase in education (measured by the number of university students). It is a long process and it is all right that strategic view is the preferred form of examining any results. But there are only inputs.

II. Sources and methods

The article is based on data from surveys conducted in the Czech Republic in the last 10 years.

It especially concerns these questionnaires:

1) Conduct a survey of enterprises in 2007, organized by the faculty research project [3],

2) conduct rapid surveys in a downturn (in 2009, 2009 and 2010), organized by the faculty research project,

3) publicly available survey [1],

4) Internal research conducted in 2012.

Surveys come from different sources, their issues do not fully overlap- their processing is not linked together, and the results are presented individually. The conclusion points to the common key areas.

III. Sources of innovative Ideas

The sources of innovation can be classified – according to the originator – into two categories: external and internal.

All studies have confirmed that internal sources are perceived as especially important. Employees outside of R&D were often prioritized higher than R&D. One reason for this is the direct link to the product and its production process. Innovations do not only concern fundamental changes, but even slight significant improvements in the manufacturing process or the improvement of product features. As far as external sources are concerned, the major stimuli are subscribers (customers) and suppliers (business partners). A recent research, carried out within their own small firms, has shown that as internal impulses marketers (68%) and as external impulses customers (90%) are more significantly evaluated.

It should be noted that none of the researches triggered the information, that financial subsidies or funds obtained were the stimulus for this.

IV. Barriers of innovations

One could assume that the greatest barrier to innovation is the suppression of any innovation impulse. The whole innovation chain (from initial idea to successful commercialization) consists of its inputs (technology, finance, skills) and entities (product, customers, employees, suppliers, R& D). However, what is essential are their interrelationships.

Generally, lack of funds is cited as a frequent barrier to innovation. If we take a closer look at this (and we already mentioned it was not an impulse), it appears that this reason is stated by firms that do not innovate. In 2006, lack of finances as a barrier to innovation was quoted by 17% of non-innovative firms, but only 8% of the innovating ones. Another survey in 2010 observed only innovative companies- 31% quoted that their funding problem seemed to be increasingly felt which can be seen as a consequence of the crisis.

On the contrary, innovating firms reported a lack of qualified workers as the main barrier 3 times more frequently than non-innovating firms. In 2006, 22% of innovating companies but only 7% of non-innovating firms reported a problem in obtaining quality employees .In 2010, only 11% of innovating enterprises cite this as a barrier. This might be attributed to the idea, that the labor market instability encouraged the effort and motivation of many employees.

The same tendency is also confirmed by our studies. Finances are a prerequisite for business survival and allow the possibility for deeper innovation activity. Nevertheless, continuous implementation of enterprise innovation requires a combination of high quality and motivated employees and functional organizational structure. Our faculty´s research [3], conducted mainly in large enterprises, has shown that 80% of companies consider poor corporate organization, internal administration and staff reluctance to change as the most significant obstacles to innovation. High innovation costs were perceived as a barrier by 32% of firms, lack of capital by 20% of firms.

Custom research carried out in 2012 in small and medium-sized companies with technological and innovation focus outlined that the greatest threat to innovation is the perceived lack of equity capital (49%), which can be linked with a perceived high risk in the market (37%) - companies prefer conservative financing which limits the use of their innovative potential. 44% of firms feels the issue of low-quality workforce.

V. Conclusion

Innovating companies will always need capital, but the employees and corporate culture are essential components of the innovation process. In order to support innovative behavior, internal impulses, such as obtaining qualified employees and their interrelationships, have a greater sense than financial funds. To support innovation, the state should use rather indirect tools, ideally those, that help to reduce and eliminate barriers to innovation.

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Structure of the national debt, credit rating and state financial security

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***Keywords* – financial security, credit rating, government debt**

I. Introduction

One of the most important aspects of the state economic security is the condition of the financial system, and, especially, system's ability to provide state with adequate financial means the state needs to carry out its functions.

Following [1], there are number of parameters, reflecting economic welfare of the state: general condition of the national economy, availability of natural resources, development of infrastructure, availability of qualified and educated work force, development of education system, integration of the state in the world economy.

This methodology, however, does not include any measure to characterize financial stability and security of the state, in particular, state independence from foreign creditors. One of the parameters that may be used for such a purpose is *per capita* governmental debt. For Latvia, the *per capita* governmental debt at the end of 2011 reached 4167 € [2], at the same time, average income in Latvia is 711,5 € and at the year 2011 0.4% of the economically active inhabitants left the country.

Nevertheless, rating agency Standard & Poor' had raised credit rating of Latvia to BB+ in the middle of the year 2011, changing it to BBB- at the end of the year. Credit ratings are widely used tool for evaluation of financial stability. Those are assigned by number of international agencies and are based on analysis of numerous economical and financial indices [3]. The question "in what extent credit ratings reflects financial independence of the state" is addressed in the present work.

II. Credit ratings worldwide

The work is based on rating agency Standard and Poor data for the end of the year 2011 – beginning of the year 2012. For this period, the agency reduced rating of 9 Euro zone states out of 17, France, Italy, Spain and Portugal being among them. France, being the second biggest economies in EC, had lost their highest AAA rating to the next AA+ and the prognosis for France is negative. Rating of Germany, Finland, Luxemburg and Netherland still is the highest. Besides, all countries, except Germany, has now negative prognosis, so, rating may be reduced.

Credit rating of "problem" countries in Euro zone is dropped dramatically. For Portugal and Cyprus it is fallen down "garbage" level „BB" and these states prognosis is negative.

Out of Europe, S&P confirmed long term credit rating „AA+" for USA. USA rating was highest until august 2011, and S&P decision to reduce it raised panic in the world marked. It is remarkable, that it was the very first USA rating drop in history, related to the rapid grows of state budget deficit. At the moment, prognosis for USA is negative as well.

For the present research, the pool of 15 European countries and 23 countries from around the word was selected. The S&P rating was quantified by means of the following point scale: AAA was equal to 9 $^{2}/_{3}$, AA+ was equal to 9 $^{1}/_{3}$ points, AA to 9 points *ets.* down to D, that was equal to 0 points.

Quantified ratings were compared with the ratios of foreign debt to the total governmental debt for all 38 countries. Countries' data were taken from the report of the Word Bank, available on-line at the bank web-site. For Latvia, the percent of foreign debt increased from 84% at the beginning of 2011 till 86% in the end of the year.

III. Results and discussion

The diagram, demonstrating correlation between credit rating and percentage of foreign debt is presented at the Fig. 1.

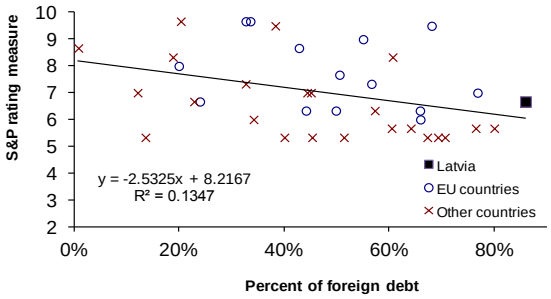

Fig. 1. Correlation between S&P rating (expressed in arbitrary points) and percent of foreign part of government debt

There is slight correlation between rating and percentage of foreign debt: correlation coefficient is equal to -0.36, p = 0.023. The value of the coefficient for European countries was not differs from one of the rest of the word.

The data on the Fig. 1 was approximated by the straight regression line. Although the slope of the line significantly differs from zero (p = 0.023), low determination coefficient R^2 = 0.13shows, the percent of foreign debt affects credit rating only slightly.

IV. Conclusion

Because of weak correlation between percent of the foreign debt and credit rating one may suspect the latter as insensitive indicator of the financial security of the country. Thus, one could recommend inclusion of the ratio between foreign and total governmental debt in the list of the state economic and financial parameters, given in [1].

Besides, since S&P has claimed the economy of Latvia become less dependent on external financing, despite of highest percent of foreign debt among all analyzed countries, the influence of this parameter on state financial security still has to be clarified.

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Tax policy impact on the development of the entrepreneurship in Latvia

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***Keywords* – tax policy, entrepreneurship, development, questionnaire.**

According to the first National documents, it is obvious, that before joining the EU Latvian tax policy goals were the following:

- To promote economic growth and investment providing a stable business environment;
- To provide of competitiveness in Latvia.

The following objectives were set to the fiscal policy key challenges:

- To create a fair, impartial and easy to administer the tax system;
- To improve tax administration and the recovery of tax claims;
- To guarantee the state budget projected tax revenue collection.

Before joining the EU, one of the main aspects of the tax policies in Latvia was reducing the tax burden business in order to promote sustainable development and economic competitiveness (see "EU Pre-accession economic program" subparagraph 3.1.1."Tax Policy" (the "EU Pre-accession Economic Programme", 2002. - Page 3)).

Moreover the emphasis was set on consumption rather than income tax, thus, contributing to capital accumulation and investment.

The survey was carried out to analyse these tasks in 2012.

It is important to take into account the business views because they are the core, which in the most tax deductions to the state budget.

The survey finds out entrepreneurs attitude of the government and tax policy on business processes (table 1).

The author came to the conclusion, that too heavy tax burden really interferes with new enterprises and business in general.

The survey analyse provide real abidance, that modern tax policy in Latvia does not take into account the economic crisis impact on business.

The programme mentioned above fails to stimulate economic growth, high financial results and ignores the interests of taxpayers.

TABLE 1
OBSTACLES FOR BUSINESS DEVELOPMENT IN LATVIA

Nr.	Barriers	%
1.	Tax rates	11,1
2.	Tax law	12,7
3.	Taxation system	15,9
4.	Lack of government support	14,3
5.	The economic situation	9,5
6.	Lack of knowledge of business	7,9
7.	Limited financial resources	7,9
8.	Bureaucracy, corruption	14,3
9.	EU	1,6
10.	Buyers insolvency	4,8

The tax policy plays the key role for Latvian business competitiveness. Therefore, the author is convinced that the existing tax policy has to be revised by relevant authorities.

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The interaction of public debt and macroeconomic factors: case of the Baltic countries

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Keywords – **Baltic countries, evaluation, general public debt rates, debt, public debt ratios.**

I. Introduction

Recent global financial crisis accelerated growth of public debt in many countries. Therefore, the main focus when raising question about stability of EU economy and euro, is on public debt management problems caused by the changing economic environment, both in theoretical (Karazijiene, 2011, Levisauskaite, Ruskys, 2003, Rose, 2005, Kazlauskiene, 2012, Kellermann, 2007, Buckiuniene, 2011, Karazijiene, Saboniene, 2009, Aliabadi et al., 2011, Ribeiro et.al., 2012, Nicolescu et al., 2011, Batrancea et al., 2011, Furceri, Zdzienicka, 2012, Gelos et al., 2004) and practical aspects. Therefore, **the purpose of this paper** is to disclose and compare characteristics of public debt in the Baltic Countries. **Research methods** are following: systematic literature analysis, logical comparative and generalization analysis, mathematical statistics methods.

II. Valuation of Public Debt in Theoretical Aspect

Public debt is formed considering many different economic, political, social and technological factors; so its structure is complex. Public debt can be classified and analyzed according to many criteria. Each of them indicates different borrowing demand, resources, nature or means. Extent of public debt in a country depends on country's economic power, population and ongoing processes. Comparison of public debt in different countries using currency would be inexpedient. Therefore the evaluation of public debt and its growth trends in particular country must first consider not the absolute amount of debt, but some ratios that objectively show burden of public debt to a country and if borrowing trend is beneficial to ongoing economic processes in a country. Therefore, according to an analysis of the scientific literature, we distinguish three main groups of indicators: 1) general public debt rates, 2) economic – financial indicators of a state, and 3) public debt ratios.

III. Estimation of Public Debt and Macroeconomic Indicators in the Baltic Countries

The common feature of economy in Lithuania, Latvia and Estonia is that they are dependent: generated GDP partially depend on consumption in other countries because domestic market is small, so goods and services are exported. Transport sector is important to Latvia's and partially to Estonia's economy; it serves the flow of goods to Russia. Unlike in other countries, industry has a greater role in Lithuania, especially energetics sector. Therefore, the analysis of debt in the Baltic Countries according to debt to GDP ratio evidences different situation than that of the expression in currency; however Estonia's debt is still the lowest (Fig. 5).

In order to perform a miscellaneous analysis of public debt and economic environment in the Baltic Countries, strength of relationship between the selected indicators and public debt is established by correlation analysis; significance of the results is examined by the Student t-test.

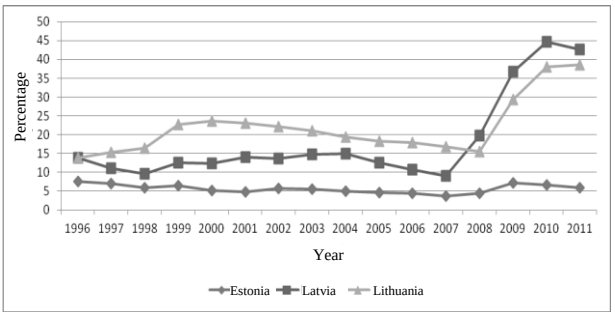

Fig. 5. Public debt to GDP ratio in The Baltic Countries (structured by the authors according to Eurostat data)

Following macroeconomic variables were selected on purpose to establish a relationship between debt and macroeconomic environment in the Baltic Countries: GDP (X1), exports (X2), number of unemployed (X3) and budget deficit (X4). Public debt is marked by Y. We used data set composed using the Eurostat database and covering the period of 1996-2011. The factor which has the strongest correlation with debt is picked out for each country. The research results evidence that exports is one of the most important macro-economic factors affecting public debt in the Baltic Countries (see Table 3).

TABLE III
Summary of Correlation Analysis in the Baltic Countries

Country	GDP, million EUR	Exports, million EUR	Number of unemployed, thousands	Budget deficit, million EUR
Lithuania	**0.801754**	**0.863119**	0.333929	-0.26454
Latvia	0.709759	**0.836719**	0.559247	**-0.834847**
Estonia	0.751014	**0.862049**	0.202699	**-0.828458**

The research evidenced that economic growth of the Baltic Countries greatly depends on exports. Lithuania has the top exports of goods and services in currency terms; however this does not reflect the true exports capacity, because it has more population and employed who create a larger amount of exportable production. According to ratio to GDP, Estonia has top exports; however this factor is one of most significantly related to public debt in all three analyzed Countries.

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Evaluating the Significance of Structural Changes within National Economy for Economic Growth of Latvia using the Econometric Model

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***Keywords* – structure of national economy, sectors of national economy, structural changes, and economic growth.**

I. Introduction

In recent decades structure of both global and national economies have changed significantly, resulting in positive and negative aspects – that is proven by existence of developed and less developed countries, as well as recent economic and financial problems. The aim of this paper is to evaluate the significance of structural changes in national economy for economic growth in Latvia, using theoretical guidelines of structural changes in national economy and developing econometric model.

II. Theoretical Aspects Of Structural Changes Within National Economy

From economic point of view there are three main sectors in the structure of national economy nowadays: agriculture, manufacturing and services or the primary, secondary and the tertiary sectors. In economic theory structural changes of national economy mean changes in sectors` proportions in long term period. The three sector hypothesis (*Fourastie*) gives the theoretical explanation, essence, of structural changes in national economy: in long term during structural changes of national economy the proportion of the primary sector decreases, of the tertiary sector – increases, but changes of the proportion of the secondary sector in the structure of national economy is similar to an inverse-U curve, when increase is followed by decrease. In economics structural changes usually are represented as changes of each sectors' shares in total GDP (or added value) and number of employees.

In the literature of structural change theory it is the prevalent opinion that main causes of structural changes are shifts in the demand and in labour productivity. Technological progress is the major driving force of the causes mentioned above. Price reduction and raise of per capita income and of the share of income that may be spent on other goods have a different income elasticity of demand for each sector`s goods (according to Engel`s law) that reflects on the structural transformation. The role of investment, capital accumulation, interaction between sectors, institutional changes and other factors have also great importance in the process of structural changes.

Structural changes of national economy and economic growth are interrelated processes that interact with each other. On the one hand, economic growth affects structural changes of national economy – there are changes in the structure of consumption and manufacturing due to increase in per capita income. On the other hand, the structure of national economy influences economic growth too: in poor countries the proportion of GDP that is agricultural sectors' value-added is higher, while the proportion of GDP that is services' value-added is higher in rich countries [1].

III. Evaluating The Significance Of Structural Changes Within National Economy For Economic Growth In Latvia

Evaluation of the significance of structural changes in national economy for economic growth of Latvia is based on econometric model, using data of the Central Statistical Bureau of the Republic of Latvia for the last 20 years.

The developed macroeconomic model includes four interrelationships: the first three relationships show the growth rate of added value of each sector depending on the growth rates of nonfinancial investments, number of employed and labour productivity at each corresponding sector; the last relationship shows how the growth rates of added value in each sector influence total growth rate of added value in the economy of Latvia. The growth rate of added value of tertiary sector has greater influence on Latvian economic growth, rather than two others sectors.

The greater impact on the growth rate of added value in agriculture has growth rate of labour productivity. In manufacturing and services greater impact on the growth rates of added value has the increase of employment.

Changes in the growth rates of number of employees and labour productivity have greater effect on the growth rate of added value in services, rather than in others sectors. Changes in the growth rate of nonfinancial investments have greater impact in agriculture and manufacturing.

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Importance of attitude and motivation for knowledge transfer

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***Keywords* – knowledge transfer; innovation; attitude; motivation.**

I. INTRODUCTION AND DEFINITIONS

The purpose of the paper is, first, to identify the importance of attitude and motivation in developing collaboration for knowledge transfer, in order to innovate, thus bridging the gap between higher education institutions (HEIs) and enterprises; second – to examine national policy planning documents, in particular, financial incentives and non-financial incentives for promoting collaboration between HEIs and enterprises.

Creation of new knowledge is a key to economic growth and prosperity. However, equally important is the transformation of scientific research results into new products involving wide range of actors.

The translation of the results of scientific research into an economic value is also called knowledge transfer. The scientific literature provides numerous definitions for the term ”knowledge transfer”. First, there exists conceptual differences between intra- and inter-organisation knowledge flows; second, although knowledge transfer is not a new concept, knowledge transfer as a field of research is still in its infancy (Mitton *et al.*, 2007).

II. KNOWLEDGE TRANSFER AND INNOVATION IN EU

One of the weaknesses of the EU is the transformation of scientific research into competitive advantages (Brennenraedts *et al.*, 2006). Therefore, knowledge transfer is seen as one of the key areas for action in the EU and its member states (European Commission, 2011). Besides, according to the Innovation Union Scoreboard 2011 Latvia has been ranked last amongst the EU countries in innovation performance.

However, innovation is the engine for the economic growth.

III. FACTORS AFFECTING KNOWLEDGE TRANSFER FREQUENCY

Attitude and motivation of the HEIs and enterprises to create collaborative platform for knowledge transfer are two of many factors affecting knowledge transfer frequency.

A. Attitude

Such authors as Mathieu (2011), Meissner (2010), Freitas and Bekkers (2007) etc. analyse”attitudinal” factors that influence academia-business interactions. Freitas and Bekkers (2007) assert that attitudes towards knowledge transfer to industry depends both on funding and research focus of HEIs. While Williams focuses on individuals and argues that attitudes and values of individuals determine whether he holds the perception that knowledge is a valuable resource and treats it accordingly, or not (Zyl, 2006).

B. Motivation

Motivations and outcomes are related positively. (Mathieu, 2011). In literature little attention has been paid to analysis of the motivation of HEIs and enterprises to collaborate in order to create new products, and in particular to explore differences in motivation of HEIs and enterprises.

As researchers engage in patenting not only for personal profit but also to show their achievements and gain reputation in the academic and industry-related community, policy should consider wider range of incentives for promoting collaboration rather than focus only on financial incentives (D’Este and Perkmann, 2010). However, enterprises are driven by the motivation to acquire the source of scientific knowledge and new ideas, to get access to staff development, qualified human resources and resources from the HEIs laboratories, to limit risky investments and to get access to government funding, to initiate long term research projects etc. (Debbie, 2008; Suwannatat *et al.*, 2012; Zyl, 2006)

IV. THE POLICY FRAMEWORK IN LATVIA

The question remains on the reasons explaining why Latvian entrepreneurs are not sufficiently concerned about knowledge transfer for achieving their competitive advantage. Although various financial and non-financial initiatives of the Latvian government relating to HEIs-enterprises interaction can be identified (e.g. development of infrastructure, motivation enhancement etc. by using different funding) in order *“to ensure an increase of competitiveness”* (NDP, 2007), the number of innovative enterprises and private sector investment in research is still critically low.

V. CONCLUSIONS AND RECOMMENDATIONS

The national support for science in Latvia should be provided with a view to promote knowledge transfer between HEIs and enterprises in general and not to treat it as a separate task. Financial incentives for knowledge transfer are as important as financial incentives. More attention should be paid at government level in order to raise the awareness of institutions and individuals on the importance of interaction between HEIs and enterprises for development of new products. Changes in HEIs’ and enterprises’ culture, development of attitudes, motivation enhancement activities could contribute to the creation of long-term cooperation platforms for knowledge transfer and increase private funding in R&D.

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Perspectives of Rural Development in Latvian

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Keywords **– regional development, rural development, migration, commuting.**

I. Introduction

The proportion of rural population is decreasing not only in Latvia, but all over the Europe. It is forecasted that along with a further increase in agriculture's productivity the number of jobs in Latvian rural areas will continue to shrink. Therefore questions arise on the future of rural population. We are going to outline the perspectives of the rural development based on theoretical considerations, Scandinavian experience and an example of a rural municipality – Durbes novads – in Latvia.

II. Rural development in long-term

The latest data show that the decrease of the rural population in Latvia was one of the highest in the European Union. The number of inhabitants in the rural areas decreased more rapidly than in the cities. It is assumed that nowadays approximately 30% of Latvia's inhabitants live in the rural areas (of which 10% commute to work in cities) and this proportion is going to decrease to 25-26% in the year 2030 due to a decrease in the number of jobs in agriculture and consequently services [11].

III. Rural development perspectives in 21st century

A. Changes in the economy, work organization and the role of place

The nature of economy is changing towards the creative or conceptual age. During the last 40 years the role of employed has changed significantly. Routine task have been replaced by creative and project type activities. Undoubtedly, the concentration of resources in the agglomerations brings benefits to the economy. But the information and communication technologies (hereinafter – ICT) allow reaching the concentration of resources not only physically, but also virtually (digitally).

B. The rise of the creative economy

According to three T's economic growth theory by Florida, main drivers of the development are technologies, tolerance and the creative class and talent – people that are well educated and deal with creative or conceptual tasks in their professional life [19]. Although the concept of the creative class most commonly is associated with large cities, the creative class successfully acts also in rural areas. For example, the majority of Swedes have an access to a second home in countryside, one fifth owns such house (such practise is common also in Canada, Norway and Finland). Academics, managers, officials from cultural institutions and public institutions – undoubtedly, the creative class - have access to such homes more frequently [20].

The Swedish experience also shows that young families with children and also elderly people move from cities to rural areas, especially to territories with rich cultural and historical heritage not too far from large cities. The main reasons for this life-cycle related migration are the proximity to nature, high costs of real estate and living in cities, as well as children-friendly social and cultural environment. Moreover, the development of ICT has encouraged the development of companies that offer such services as customer catering using ICT and the gathering, storing, processing and selling information in the North of Sweden [20].

IV. The example of Durbe municipality

Durbe region is a small (2998 inhabitants), rural municipality located approximately 200 km from the capital city Riga and 20 km from Liepaja, the 3rd largest city in Latvia. It has a significant natural and cultural heritage. Durbe town (554 inhabitants) is the smallest town in Latvia and probably also in Europe. In the last ten years the municipality has lost 24% of its inhabitants due to natural causes and long term migration. Most of the young people do not return to municipality after their studies. However, the number of newborns in the last years has slightly increased.

The main economic activity in the municipality is agriculture; it covers 76% of the economically active market sector statistical units. The largest employers in Durbe novads are the local municipality, surrounding municipalities, local cooperative and agricultural companies. The employer of 73,2% of the employed inhabitants is located in Durbes municipality, Liepaja (it covers 30% of incomes by the employed) and surrounding municipalities. 20,4% of the employed work in the capital city Riga and its surroundings. Thus we conclude that ¾ of official inhabitants of Durbe municipality actually live in this municipality.

V. Conclusions and suggestions

If we plan to sustain the rural population, cross-sectoral approach is needed as the increase in agricultural productivity is going to further decrease the number of jobs in rural areas. Special attention should be paid to the promotion of non-agricultural business, as well as the physical and virtual connectivity to large agglomerations in order to join the resources. In order to facilitate the migration (at least seasonal) from cities, rural territories should position themselves as green, peaceful, children-friendly settlements with a good social infrastructure, which is true for a large part of small towns and villages. The promotion of distant work also might help to sustain of even increase the rural population. Last but not least, the rural youth should be encouraged to start their own business by giving them practical knowledge and exchanging good practice.

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Governance and Socioeconomic Performance

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Keywords **– policy, government effectiveness, development**

I. Introduction

There are wide discussions on the causes of the differences in the economic performance. Recent studies have stressed out the crucial role of institutions – formal and informal constraints that shape human interaction. It has been argued that such factors as innovation, economies of scale, education and capital accumulation are not the causes of growth, but the growth itself, and that institutions are the fundamental cause of differences in the economic performance [2].

Equation (f.v.1) shows policy (p) as a flow variable and institutional quality (I) - as a stock variable; i denotes dimension of policy, α – the impact of policy on institutional quality and δ - the rate at which institutional quality decreases absent countervailing action [1]. Thus the government may change institutions and consequently the socioeconomic performance. Therefore the aim of this article is to evaluate the influence of governance – traditions and institutions by which authority in a country is exercised [6] – on the socioeconomic development.

II. Data and Methods

To measure the level of governance we used World Bank's Worldwide Governance Indicators (voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law; control of corruption) and to measure the level of socioeconomic performance – indicators such as GDP per capita, unemployment, life expectancy at birth, public expenditure, school enrollment (tertiary) and GINI index. The analysis was done by calculating correlation and regression coefficients. It covers up to 202 countries on the world scale and 34 countries on the European scale. To cross-check the results, the analysis was also performed to such groups of countries as factor-driven economies, efficiency-driven economies and innovation-driven economies.

III. Results

C. The results on the World and European scale

Correlation analysis shows that the governance indicators closely correlate with such socio-economic performance indicators as GDP per capita and life expectancy at birth – states with higher governance level have higher GDP per capita and higher life expectancy at birth. On the world scale governance indicators also closely correlate with public expenditure and tertiary school enrollment – states with higher governance level have higher public expenditure and tertiary school enrollment. On European scale governance indicators closely correlate with unemployment and GINI index – states with higher governance level have lower unemployment and GINI index (f.v. Table 8). Regression analysis shows that the level of governance may account for more than 50% of differences in such socioeconomic performance indicators as GDP per capita and unemployment. Governance indicators may account also for significant changes (more than 40%) in life expectancy at birth and GINI index (Table 9).

Table 9

Regresion results on World and European scale

Indicators	GDP per capita	Unem-ployment	Life expectancy at birth	Public expen-diture	School enrollment (tertiary)	GINI index
Voice and accounta-bility	E**		E**	P**	P* E*	
Political stability and absence of violence						- E***
government effectiveness	P**		P**		P**	-E*
regulatory quality			-E**			E**
Rule of law	P**	-P**				- P***
Control of corruption						
R2 (W) R2 (E)	0,621 0,963	0,777 0,563	0,448 0,732	0,322 0,100	0,371 0,198	0,406 0,568

E – Europe, W – World, ***p<0,01, **p<0,05, *p<0,10

Based on the results of analysis, we may assume that the significance of specific governance indicators on the socioeconomic performance depends on the state's level of socioeconomic performance. Thus in countries with lower socioeconomic performance rule of law is of the highest significance, whereas in more developed countries government effectiveness and voice and accountability prevail (f.v. Picture 4).

D. The results on the three groups of countries

The results of the regression analysis in such groups of countries as factor-driven economies, efficiency-driven economies and innovation-driven economies partly approve the above mentioned assumption on the significance of specific governance indicators on the socioeconomic performance. Government effectiveness has a significant influence on the socioeconomic performance in all the groups of countries, voice and accountability – in efficiency-driven economies, whereas rule of law and regulatory quality – in factor-driven economies.

IV. Conclucions

The results of the analysis approve that governance plays an important role in state's socioeconomic performance. Investments in the governance and especially government effectiveness will bring socioeconomic benefits to the state and its inhabitants.

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Russian Capital in Latvia: Trends and Perspectives

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Keywords **– Russia, Latvia, foreign investment, energy, economic interests.**

I. Introduction

In the early of 1990s Latvia was deeply integrated into the Russian economy, which was its major source of raw materials and the primary market for finished goods. This legacy of Soviet times, however, has been gradually disappearing during the last decades as Latvia was becoming closer to its European neighbours. Nevertheless till now both countries have mutual economic interests that constitute the basis for trade and investment cooperation. Supply of Russian oil and gas is the key interest for Latvia. Russian economic interests in Latvia are closely connected with such sectors as maritime transport (Baltic Sea ports) and transit corridors, which Russia uses for its energy delivery. That is why the question of position of Russian capital in Latvian economy is still urgent.

II. Russian investment in Latvia: quality and quantity

Foreign capital came to Latvia at the beginning of the 1990s, after republic regained the independence from the Soviet Union. It was generally investment from Scandinavia into the sector of telecommunications (Lattelecom) and finances (Hansabank/Swedbank). Financial flows from abroad were fostered also as a result of the privatisation of state-owned enterprises, which took place in 1993-1995. Thus, German Ruhrgas and Russian Gazprom got substantial portions of Latvijas gāze in the process of its privatisation (47.2 and 34.0% of stocks correspondingly).

Nowadays up to 85% of foreign direct investment (FDI) in Latvia comes from European Union; the main sources of FDI are Estonia, Sweden, Denmark, and Germany. Accumulated FDI is accounted for 8.2 billion EUR [1]. The official share of Russian investment in Latvia declined over the last decade and by the end of 2010 Russia was only the 8th largest investor with 336.7 mln. EUR of FDI stock (4.08%). However, according to some estimates, the Russian portion is bigger because some Russian capital comes to Latvia via transit countries like Cyprus, Switzerland, Luxembourg and Malta. If we assume that these countries are significant channels for Russian investment, the share of Russian investment in the overall picture changes significantly, and may account for as much as 13%. This would make Russia the second largest source of foreign investment after Estonia.

Russian FDI is concentrated in a few sectors – up to 70% of the capital is invested in energy, transport (pipelines), and banking; some investment is in wholesale and retail trade [2]. This structure of Russian investment is a clear reflection of the fact that Russia is trying to support its economic interests in Latvia by flowing financial resources in appropriate sectors.

III. Energy and politics

The British Conservative politician Harrold Elletson has underlined that "the Baltic states need to bear in mind that it is not Russian energy per se that is the problem, but the fact that an overdependence on it has potentially uncomfortable political implications" [3].

Latvia is heavily dependent on Russia's oil and especially, gas supply and this fact can definitely increase its political vulnerability. This dependence is the strongest tool Russia possesses to push economic and political interests in Latvia. First of all, Russia is trying to make alternative transit infrastructure (e.g. North European Gas Pipeline under the Baltic Sea), which is directed towards the exclusion of the Baltic States from newly developed transit routes. Secondly, Russia is heightening control over transport corridors of energy resources in CEE area as a whole.

A number of independent thinkers, interviewed in Riga, were concerned that the direct or indirect Russian presence in the Latvian energy sector could lead to a so-called "Gazpromisation" of the Latvian political elite, as exemplified by the willingness of some Latvian politicians to increase Gazprom's power over the Latvian energy sector even further.

Could anything be done to break Latvia's dependency on Russia's energy? The only way for limiting an energy supplier's influence is Latvia's ability to diversify sources of energy imports.

IV. Conclusion

There are different views on the future of Russian-Latvian economic cooperation. Latvian official position on Russian investment is rather controversial. In June 2008 President Valdis Zatlers said that Russian investments represent risk for economic and political independence of Latvia. On the other hand, in May 2010 Latvia's newly-appointed foreign minister Aivis Ronis told that he wouldn't be averse to heavy Russian investment in the Baltic States' economies, particularly in transportation.

In December 2010 President Valdis Zatlers, during his meeting with the President of Russia Dmitry Medvedev in Moscow, underlined that this visit would bring some economic benefits for bilateral relations, such as the growth of Russian investments in the economy of Latvia. The visit of Zatler's was broadcasting on Russian official TV channels, and this is the impressive sign that Russia is ready for economic convergence with Latvia.

Geographical proximity, relative economic interdependence in some spheres and mutual economic interests – that are milestones for the future search of effective equilibrium in economic relations between Latvia and Russia.

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National Economy and Entrepreneurship

Production Economics, Finance and Marketing

Essential factors influencing dwelling space market price in Latvia

Didzis Ādmīdiņš (*RTU*), Jānis Zvanītājs (*RTU*)

***Keywords* – real estate, real estate cycles, demography, real estate affecting factors.**

I. Introduction

The real estate market prices including dwelling space market prices are fundamental influencing factor of national economy which can influence both the very real estate market development and other market sectors. The importance of the real estate market is not only in the investment return from this market, but the economically justified development of the real estate market is one of the preconditions of sustainable development of the overall economical structure.

II. Essential factors influencing dwelling space market price in Latvia

The economical development of Latvia despite its small territorial area is uneven and sharp differences in regions are visible also in the real estate market. Relevant territorial market segments are largest cities but in some populated areas the number of market deals is so small that some market tendencies are very hard to observe.

Within this article there will be examined only the dwelling space market in Riga which narrows the research object, but nonetheless it is the most relevant dwelling space market segment in Latvia. It is already five years since the maximum market price was reached and after which a rapid downfall of the market prices were followed. Although after the lowest point was reached the prices of dwelling space market are increased, in the few last years market prices are constant. In the middle of 2012 the price per square meter of a serial apartment is app. 600 Euros, but at its lowest point in the second half of 2009 it was less that 500 Euros per square meter. Since the end of 2010 the prices of serial apartments in Riga have not changed more than 4-5% within a period. Although in other dwelling space market segments, e.g., for dwellings built after 2000 the average price is higher, the tendencies in the development of market prices are similar.

The real estate market and all its segments are connected with many other economical sectors and such development does not have territorial boundaries. Development of real estate market in one region can stimulate development of different economical sectors in other region. It is due to the fact that the real estate market and its development need financial resources, labour forces and natural resources. Necessary resources can be of local or international origin. The influence of globalization on the real estate market is essential and dependent on the pace of the real estate market development and development structure it is possible to evaluate the cyclical impact of the globalization. Changes in any of the resources costs including financial resources costs cause material impact on the very final product development costs. Some of necessary resources are of global origin with globally regulated price and the real estate market development costs are influenced by the fluctuations of the costs of these resources.

However the real estate market is relevant not only because its formation costs are dependent on global resources markets and their processes. The real estate dwelling space is important good of prime necessity for any inhabitant. Actually the dwelling space is not only an essential good, it can be also social status and luxury goods, which fulfils also the function of the essential good. On a regional scale and overlooking individual's level, dwelling space, its availability, quality, costs are characterizing factors of the region and from the perspective of the inhabitants and potential habitants these can be important factors of the decision of the place of residence. The author concludes that on a regional level dwelling space and its describing factors are one of the most important attraction characteristics of the region. Such dwelling space market describing factors as average market price, apartment availability, quality, infrastructure and others are also describing factors of the region. These factors have considerable impact on economically justified development of the region and real estate market is one of the preconditions which should be taken into account when deciding sensitive issues regarding the dwelling space. Dwelling space market is not only a separate market sector; it is also a precondition for the development of the rest of the market sectors.

It should be understood that although dwelling market is important precondition for economical development, it is also an investment object in all its development stages and if the investments in the real estate market will be made economically unjustified, the development of the market will not be stimulated. Whereas the real estate market influencing factors are those which through the balance of demand and supply affect processes in the very real estate market and of the market price.

In strong economics real estate market influencing factors will have a greater impact because having a qualitative demand will result in a flexible supply.

Another important factor that in the near future will affect the real estate dwelling space market in Riga's region is the great proportion of serial apartments in comparison to the rest dwelling space market segments. The serial apartment houses are gradually getting out-of-date and they should be replaced by dwelling spaces of good quality and corresponding to modern standards of living although currently it is not practically possible to assess the impact of this factor on the average market price.

III. Conclusion

Real estate market objects themselves are valuable assets but as much important is the interaction between the real estate market and the common economics and not only on the level of national economy. The parties involved in the market should acknowledge and understand the relevance of the real estate market and reasons of its development, as well as ways how to influence it on economically reasonable ground.

Financial Risk Management in the Execution of Corporate Innovation Projects

Jordanka Angelova (*Technical University of Sofia*)

Abstract: **Innovative projects implemented by companies pose significant risks. The article puts forward the idea that it is possible and necessary the risk in this type of projects to be managed. Examine the reasons for risk nature of innovative projects. Identifying the most common risk events specific to the different activities in carrying out innovative projects - the development of applied scientific product, design, preparation for innovative, experimental production and utilization of production and marketing activities. Analyzing the possibilities for implementation of some specific methods for managing risk - expert methods, matrix utility, decision tree, writing and analysis of scenarios, a method of analytical hierarchy, some quantitative methods.**

Keywords **– Risk, Risk Management, Project Management, Innovation, Innovative Project.**

Opportunities for improving the effectiveness of EU funds in Bulgaria in the next financial framework (2014-2020)

Kiril Anguelov (*Technical University of Sofia*)

Keywords **– Administrative capacity, Mechanism of EU assistance usage in Bulgaria, European Regional Development Fund, European Social Fund, Cohesion fund.**

I. Introduction

The Bulgarian Authorities are strictly following the partnership principle in the preparation of the strategic documents (NDP, National Strategic Reference Framework and OPs). The relevant social-economic partners such as nationally representative workers and employers associations, non-governmental organizations, consultative bodies, are participating in the National Strategic Reference Frameworks and national and regional Operational Programmes Working Groups and are being actively involved in the elaboration of the documents.

There are three main results from the application of EU funds in Bulgaria [1]:

1. Development of infrastructure (transportation, environmental, etc.);
2. Development of the competitiveness of the economy. An important aspect of this is to increase the effectiveness of interactions in the economic system;
3. Enhancing human capital.

II. Increasing the effectiveness of The mechanism of EU assistance usage in Bulgaria

The article presents the concept of the author for necessary changes in the management of EU funds. This concept involves:

- Concentrations of the efforts being implemented EU policies and;
- Decentralization of the implementation of European policies in the regions (NUT2).

The article also provides comparisons with the management of operational programming in Lithuania and Latvia.

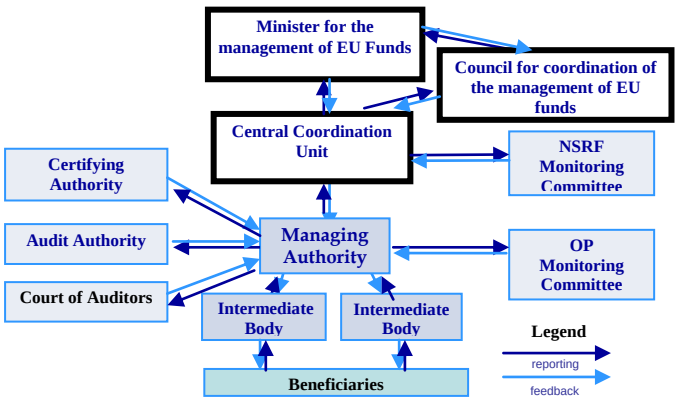

Figure 1. The mechanism of EU assistance usage in Bulgaria [2]

The following bodies are designated as Managing Autorithies of Operational Programme in Bulgaria:

- "Programming of Regional Development" General Directorate at the Ministry of Regional Development and Public Works as a Managing Authority of OP "Regional Development":
- "European Funds for Competitiveness" Directorate at the Ministry of Economy and Energy as a Managing Authority of OP "Development of the Competitiveness of the Bulgarian Economy";
- "European Funds, International Programmes and Projects" Directorate at the Ministry of Labour and Social Policy as a Managing Authority of OP "Human Resources Development";
- "Coordination of Programmes and Projects" Directorate at the Ministry of Transport as a Managing Authority of OP "Transport";
- "Cohesion Policy for Environment" Directorate at the Ministry of Environment and Water as a Managing Authority of OP "Environment";
- "Management of Programmes and Projects" at the Ministry of State Administration and Administrative Reform as a Managing Authority of OP "Administrative Capacity";
- "Management of EU Funds Directorate" at the Ministry of Finance as a Managing Authority of OP "Technical Assistance".

The article also presents opportunities for increased efficiency in the management of each operational program.

III. Exploring ways to increase the capacity of the beneficiaries of operational programs and the administrative capacity

One of the major shortcomings in the management of European funds is the low capacity of the participating beneficiaries (for example as part of the municipalities). The article indicated the possibilities of overcoming these challenges.

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Challenges and results in absorption of EU funds in Bulgaria (financial framework 2007-2013)

Kiril Anguelov (*Technical University of Sofia*)

Keywords **– EU Structural Funds, European Regional Development Fund, European Social Fund, Cohesion fund, Mechanism of EU assistance usage in Bulgaria.**

I. INTRODUCTION

Based on the Structural Funds regulations, which lay down common management rules, Community Strategic Guidelines on Cohesion provide for concentration on the objectives of the Union's Growth and Jobs Agenda. Against this background, Member States prepare National Strategic Reference Frameworks and national and regional Operational Programmes emphasising strategies and fields of intervention.

II. THE MECHANISM OF EU ASSISTANCE USAGE IN BULGARIA

The institutional framework for the management and control of the Funds is set out in Council Regulation. It describes the roles and responsibilities of the following authorities [1,2]:

- Managing Authorities (MA) of the Operational Programmes;
- Certifying Authority;
- Audit Authority.

In addition, Managing and Certifying Authorities can delegate their functions to Intermediate Bodies (IB) of the Operational Programmes (OP). Their roles and responsibilities are defined in the Agreements between the IB(s) and the respective MA.

Subsequently, each MA is responsible for managing and implementing its OP in accordance with the principle of sound financial management. The main functions of the MA are, namely:

- Ensure that operations are selected for funding in accordance with the criteria applicable to the Operational Programme and that they comply with applicable Community and national rules for the whole of their implementation period;
- Verify that the co-financed products and services are delivered and the expenditure declared by the beneficiaries for operations has actually been incurred and complies with Community and national rules; verifications on-the-spot of individual operations may be carried out on a sample basis in accordance with the detailed rules to be adopted by the Commission in accordance with the procedure referred to in Article 103(3);
- Ensure that there is a system for recording and storing in computerised form accounting records for each operation under the Operational Programme and that the data on implementation necessary for financial management, monitoring, verifications, audits and evaluation are collected;
- Ensure that beneficiaries and other bodies involved in the implementation of operations maintain either a separate accounting system or an adequate accounting code for all transactions relating to the operation without prejudice to national accounting rules;
- Ensure that the evaluations of Operational Programmes referred to in Article 48(3) are carried out in accordance with Article 47;
- Set up procedures to ensure that all documents regarding expenditure and audits required to ensure an adequate audit trail are held in accordance with the requirements of Article 90;
- Ensure that the Certifying Authority receives all necessary information on the procedures and verifications carried out in relation to expenditure for the purpose of certification;
- Guide the work of the Monitoring Committee and provide it with the documents required to permit the quality of the implementation of the Operational Programme to be monitored in the light of its specific goals;
- Draw up and, after approval by the Monitoring Committee, submit to the Commission the annual and final reports on implementation;
- Ensure compliance with the information and publicity requirements laid down in Article 69 of Regulation (EC) No 1083/2006;
- Provide the Commission with information to allow it to appraise major projects.

III. RESULTS IN ABSORPTION OF EU FUNDS IN BULGARIA

According to estimates by the end of 2012 Bulgaria will contract 90% of funding for the 2007-2013 financial framework period and to carry out payments with 38 to 40 percent of that amount.

The article gives specific data on the seven operational programs in respect of them. Identify key challenges in each operational program.

Current financial implementation of operational programs is as follows:

Operational Program	Contract of funding, %	Payments %
OP "Transport"	94.83	32.55
OP "Environment"	84.80	13.24
OP "Regional Development	88.49	25.80
OP "Competitiveness"	51.17	26.24
OP "Technical assistance"	60.91	28.26
OP "Human Resources"	75.87	22.79
OP "Administrative capacity"	69.66	31.59

The article makes recommendations for increasing the absorption of EU funds under the seven operative programs.

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The Role of Indicators in the Way to Sustainable Development

Dzintra Atstaja (*BA School of Business and administration*).

Keywords **– Sustainable development, strategy, territorial planning, stakeholders.**

I. INTRODUCTION

Throughout their recent history, sustainability indicators have been at the forefront of many political, academic and community debates. The main aim of this article is to show the indicators in the way to sustainable development. On the one hand from government side and other hand - from stakeholders view point.

II. SUSTAINABLE DEVELOPMENT CONCEPTS

The concept of sustainable development was developed by United Nations World Commission on Environment and Development report „Our Common Future" (1987), and is widely used since United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 1992. Sustainable development is one „which meets the needs of the present without compromising the ability of future generations to meet their own needs" [1].

Sustainable Development is characterized by three interrelated dimensions: environmental, economic and social. It means that strait requirements of environmental protection and high economic indicators are not in conflict with each other, that economic development is interdicted to degrade the environment and it ensures high quality of life at time.

Traditionally indicators are used to assess quantitative and qualitative characteristics of change. Task of indicators is not only to evaluate current trends of development but also to give an opportunity to evaluate the extent to what the goals of planning document are reached. With respect to decision making four main tasks are given to the indicators:

1. To describe and explain factual state of concrete development factors and elements as well as their deviation from the defined point of reference;
2. To evaluate influence of various measures on factual state of development factors and elements;
3. To prognosticate future development and characteristics of development factors and elements depending on various scenarios of socio-economic and environmental change;
4. To monitor process of change of development factors and elements and to argue necessary corrective measures.

Indicators can be divided by relation to pillars of sustainable development – environmental indicators, social indicators and economic indicators. Indicators can be categorized also by spatial scale that they are referred to i.e. local level indicators, regional and national level indicators, as well as by their importance – basic indicators, general indicators and specific indicators [2].

Eurostat has defined four main thematic sets of indicators that are related to the level of EU member states and those are:

1. Euroindicators that are core economic indicators for monetary policy purposes;
2. Structural indicators that allow to measure progress of Lisbon strategy concerning such domains as social cohesion, employment, innovation, and general economic background;
3. Sustainable development indicators which ensure monitoring of the EU Sustainable development strategy comprising various issues with an aim to reconcile social, economic and environmental aspects;
4. Employment and social policy indicators that cover employment and social policy issues as well as education and information society [3].

The hypothesis for research article – citizens' awareness about the indicators would encourage community involvement in the making of city's strategic development planning.

To achieve the objective such methods of research has been used: analyses of regulative documents for sustainable development, state and urban development and of conceptual guidelines; survey and monographic and logical approach methods.

III. RESULTS AND DISCUSSIONS

The practical part of publication reflects the results of the survey done by the author in period of time 2011-2012. More than 2000 respondents all over the territory of the country were interviewed for the survey to popularize society's involvement in the making of municipality's territorial planning.

IV. CONCLUSIONS

The article aims to encourage the discussion about the practical use of the indicators. Results of the survey showed that people lack understanding about the making of sustainable development.

The author argue, that based on theoretical findings and some successful examples from real policy making, sustainability indicators should be linked to some reference values and targets. Environmental sustainability, unlike the economic or social spheres, seems to be open for developing and using targets that are firmly rooted in the biophysical properties of the system. Scaling is important issue here. Environmental limits represent a nested set of rather different constraints at the local through global levels. At the local level, the challenge to maintain the necessary quantity and quality of environmental resources that the community depends on.

For generations, the world seemed so large as to be inexhaustible, but between our population growth and the scale with which science and technology have multiplied our impacts, planetary limits or boundaries suddenly seem very near or have already been overstepped.

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The Importance of Intangible Assets on Value of Latvian Private Health Care Company

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Keywords **– Company`s value, intangible assets, balanced scorecard, competitive advantage, private health care company.**

I. Introduction

Due to frequent changes in business environment the company's value depends on company's sustainability and its ability to compete in a certain market. Previously the focus was on the profit management aspects, but in recent years when the adaptation time for changing environment has become shorter, intangible assets have increasing role in company's value formation. This has created not only the need of identifying intangible assets for certain company group, but as well the necessity of measuring them. This paper provides theoretical aspects of intangible assets, company's value and practical examples how to identify and measure the intangibles for private health care company in Latvia.

II. The Theoretical Aspects of Intangible Assets in Company's Value Creation

In theory there are different intangible asset definitions, but the unifying factor of them is the focus on the impact on future value of the company.

According to Ken Standfield and intangible management there are two types of intangible assets [1]:

- Hard intangibles that can be owned such as trademarks, patents, copyright etc.
- Soft intangibles that cannot be owned, but only managed, leveraged, e.g., knowledge, service, satisfaction etc.

Soft intangibles are those that are usually related with the competitive intangibles, the value of them is the difference between the market and book value. The investments in intangible assets are identified as riskier than, e.g., investments in tangible assets, because the return generated from intangible assets can be much higher. This shows the intangible asset role to maintain higher company's value in longer term. The problem usually arises when companies want to identify and manage the intangibles. The Fig. 1 reflects the emphasis on unique combination of related economic forces that have made changes in the structure and intangibles are taking more and more significant role.

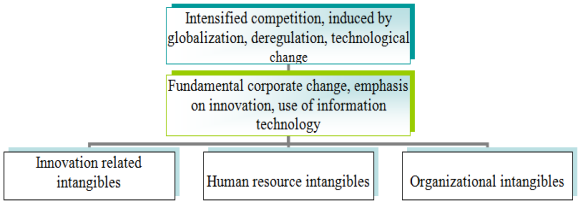

Fig. 1. The Ascendancy of Intangibles [2].

III. The Relationship between the Intangible Assets and Balanced Scorecard - the Model to Increase Private Health Care Company's Value

Health care company performance in the past was more measured only from financial point of view, but R. S. Kaplan and D. P. Norton in 1992 have combined four perspectives of indicators: customer relationship, financial, internal business, innovation and learning growth [5]. These all are crucial for company to be competitive. Each perspective combines balanced set of indicators and can assist in intangible asset evaluation and allows to control and improve the company's value increasing. The world experience shows that balanced scorecard model is often used in health care industry, but in Latvia it is not so popular, mainly due to lack of experience and no information about the model. In addition, human resources have a significant role in intangible asset contribution and development. Based on research, indicators of four perspectives for private health care companies are developed. Through measuring intangible assets, using balanced scorecard, private health care company can measure and improve its value and it can lead to added value to overall health care sector in Latvia.

IV. Conclusions and Recommendations

Based on the research, the author of the paper has come to following main conclusions and recommendations:

- Competitive assets are creating the company's uniqueness and differentiate it from other companies, because they are adding value to overall company's value.
- It is important to recognize intangible assets in the company, analyze them and manage, in order to achieve higher efficiency and better position in the market.
- Private health care companies leave impact on social development level of the country; companies in Latvia do not use the balanced scorecard model in their company management due to no information about it.
- The intangible asset value can increase the company's overall value and that is why also the company's competitiveness.
- Human resources have a significant role in intangible asset contribution and competitive advantage creation. There is also a linkage between the soft intangible assets and the company's competitiveness.
- Using balanced scorecard can better allow organizing the private health care company's work.
- The use of balanced scorecard can assist in increasing private health care company's value by focusing on business areas that require better management.
- Private health care companies should analyze changes of balanced scorecard measures and their impact on company's value in order to maintain sustainable competitiveness.

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Dividend Payment Behaviour in CEE Countries

Julija Bistrova (*Riga Technical University*), Natalja Lace (*Riga Technical University*)

***Keywords* – dividends, dividend payout ratio, corporate profitability, dividend yield, CEE Countries.**

I. Introduction

There is a large number of stock investors, who follow "bird-in-hand" theory, and, therefore, invest in the dividend-paying companies. It can become especially topical for the companies listed in the Central and Eastern Europe (CEE) as the region is often associated with the high level of risk, while the dividends can offer certain shield from the price decline. The present research is dedicated to studying dividend payment behaviour of the CEE companies as well as looks into the factors, which determine dividend payment policy.

II. Factors Affecting Dividend Payments in Emerging Markets

With the concerns about European debt and slowing growth in China, companies that pay dividends seem to become even more attractive by offering downside protection. Co-CIO of Charlemagne Capital, Julian Mayo, says that "Improving corporate governance and management has led to falling debt levels and steadier cash flows, creating a platform for sustainable dividend payments."

Several prominent researches suggest that dividend policies and dividend payment behavior is very similar to the one observed in the developed countries, and specifically in US. The factors, which have the most significant influence on determining the dividend payments, are profitability, market to book ratio, sales growth and amount of debt [3].

Besides, Aivazian et al. pays special attention to the country specific factors such as high reliance on banking system of the companies located in emerging markets [1]. Therefore, the dividend policy is also being affected by the proportion of long-term debt to total assets.

Other researchers add the list of the dividends affecting factors with the level of institutional ownership, business risk, growth rate and firm size [2].

III. Dividend Payment Policy in CEE Countries

The following passage briefly describes how and which factors affect dividend payment in CEE countries and provides an overview of the dividend payment behavior during the last seven and a half years, including also crisis period.

A. Dividend Yield and Dividend Payout Ratio

Average dividend yield in CEE countries ranges from 3% to 6.5%, which appears to be relatively high, which is rather asto

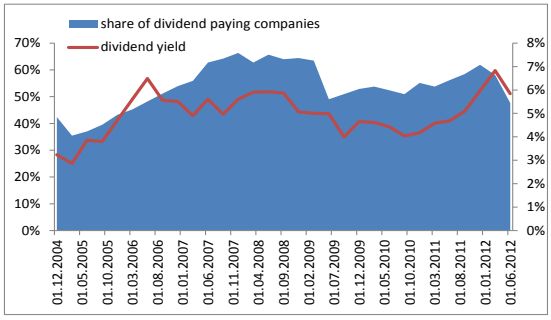

Fig. 1. Dividend Yield and Share of Dividend Paying Companies in CEE

nishing, taking into account the nature of developing markets, which requires large capex. Partly this can be explained by the favourable dividend tax policy. During the crisis time the dividend yield declined a bit as well as the share of dividend paying companies.

B. Industry factor

On the industry dimension CEE firms follow the classical pattern, when the highest dividend yields are delivered by the utilities, communications and financial companies.

C. Size factor

Size factor seems to have a certain influence on the dividend payment behaviour as there is a clear discrepancy in dividend yields and payout ratio between small capitalization companies and mid/large capitalization companies, which obviously are paying more to the investors.

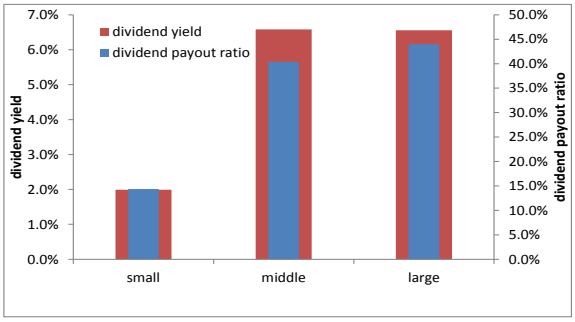

Fig. 4. Dividend Yield and Payout Ratio based on CEE Firm Size

D. Sales Growth Factor

Analysis of the sales growth factor influence provides rather ambiguous picture. The companies capable of posting highest sales annual growth rate are also paying the highest dividend yield and stick to rather high payout ratios. The lowest yields and payout ratios are seen in the 25% of analyzed companies, which show second lowest growth rates.

IV. Conclusions

The companies located in Central and Eastern European region are rather willing to share the parts of their profits with the investors as indicated by the high dividend yields, which did not suffer significantly due to crisis. Analysis of 117 CEE companies shows that there is a certain influence of the factors, which usually define dividend payment behavior such as industry and size factors. However, the impact of the dynamics of the sales growth does not appear to be very consistent with classical notions. Additional research needs to be done regarding the main shareholders influence exerted on the dividend policies in CEE countries.

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International competitiveness and innovation development in Latvia in recent years

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Keywords **– innovation development, competitiveness, innovation scoreboard, performance analysis.**

The European Commission has published the annual edition of the Innovation Union Scoreboard (IUS). Based on the previous European Innovation Scoreboard (EIS), the tool is meant to help innovation process monitoring by providing a comparative assessment of the innovation performance of the EU27 Member States and the relative strengths and weaknesses of their research and innovation systems.

The IUS includes innovation indicators and trend analyses for the EU27 Member States, as well as for Croatia, Iceland, the Former Yugoslav Republic of Macedonia, Norway, Serbia, Switzerland and Turkey. It also includes comparisons based on a more reduced set of indicators between the EU27 and 10 global competitors (as presented in Fig. 1.) [1].

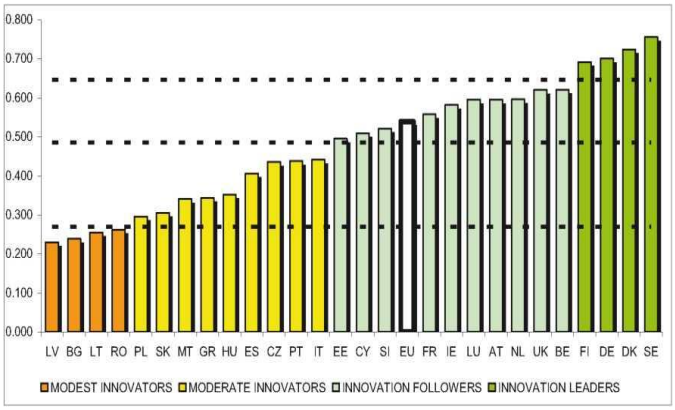

Fig. 2. EU member states' innovation performance

Average performance is measured using a composite indicator building on data for 24 indicators going from a lowest possible performance of 0 to a maximum possible performance of 1. Average performance in 2011 reflects performance in 2009/2010 due to a lag in data availability.

The IUS 2011 distinguishes between 3 main types of indicators and 8 innovation dimensions, capturing in total 25 different indicators. The Enablers capture the main drivers of innovation performance external to the firm and cover 3 innovation dimensions: 'Human resources', 'Open, excellent and attractive research systems' as well as 'Finance and support'. Firm activities capture the innovation efforts at the level of the firm, grouped in 3 innovation dimensions: 'Firm investments', 'Linkages & entrepreneurship' and 'Intellectual assets'.

Scoreboard is to inform policy discussions at national and EU level, by tracking progress in innovation performance within and outside the EU over time.

The innovation scoreboard index is non-complimentary for Latvia, especially taking into account that policy makers state that innovation development is our priority. There is also possible discussion about statistical errors and data misinterpretation, but 25 indicators are quite representative number, also taking into account that other Baltic countries with similar economic structures show better scoreboard performance, and the facts that these years 2009 / 2010 were crises peak years.

During the current 2008 – 2013 EU funding period there was available financing of 163.83 million LVL, divided in 7 programs. If Latvia still has so low innovative activity indicators, may be the funding was not planned properly, the process supervision lost among different institutions. The project performance analysis has to be provided, taking into account that there is possible not to repeat the same mistakes in next planning period 2014 – 2020.

Competitiveness is closely linked to innovation development, productivity, efficiency. These factors correlate with each other and 'build up' competitiveness. The problem in Latvia so far was that we had many long-term programs, without the route of daily figures and interpretation. The IUS could be one of the tools to be monitored on the national level, observing what are everyday small or big obstacles that interfere innovation development process in Latvia.

There is a general view that innovations can be created by genius ideas [2], that it is something extraordinary. But there are also possible innovations in any process or activity, the sense is to improve something, just start with something.

It is possible to evaluate innovative company using different parameters. One of the most common approaches is classical "rate of return" approach or profitability ratios. Though, it is very important to take into account the innovation project itself, as it could be the most important aspect for successful company development process in the future.

The innovation project has to be evaluated using several criteria: scientific novelty, profitability, turnover increase, market share, customer focus. It is also important to evaluate how the new innovative development will affect company's overall performance, sustainable development, social and environmental impact and company's value after project implementation.

The core of this approach is to achieve maximum production level [4], and highest quality with possible minimum resources, at the same time not loosing customer focus and needs. In order to improve innovation entrepreneurship and entrepreneurial environment in general, it is necessary to improve all innovation and product development process, from R&D till commercialization, using relevant specialist knowledge.

When innovations become successful on company level, it will have positive effect on national level.

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Efficiency assessment of websites designed for small and medium-sized enterprises

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Keywords **– SME, internet, cloud, site efficiency.**

I. Introduction

Obviously, information technologies and the opportunities provided by them play a large role in company management systems. The latest trends show that the big IT market leaders (Google, Microsoft, etc.) have determined a new IT development cycle, and are working hard at the development of this area. It is about creation of remote access solutions, the so-called 'cloud solutions'. Here, companies are offered IT solutions with identical parameters, which do not have to be installed in the companies' computers and do not require constant updating. All the necessary tools can be found on the Internet, and may be accessible from anywhere in the world.

Both Google and Microsoft offer a wide range of ready-made solutions that can be immediately implemented in the company's activities, but most of them are very general and do not fully fit for each particular company. Therefore the internet offers a wide range of similar solutions, which focus on a specific customer niche, and lately many such websites have appeared in Latvia.

This article aims to evaluate the offer of cloud solutions, and determine whether they are suitable for Latvian small and medium-sized enterprises. More attention is paid to small businesses operating in B2B markets.

II. Literature review

The internet impact on business processes is analysed from different angles. Some authors focus on the analysis of website content, layout and other technical parameters [13,15], others analyse the need to apply the concept of internet resources [14]. Thus, there are attempts to get an understanding of the necessary parameters that would be of interest to potential users.

Recent studies related to use of the internet in SMEs are very closely associated with cloud technology development. Study results indicate that this type of technology is more appropriate for SMEs, as it reduces the company costs associated with IT implementation and maintenance. But these studies also reveal the attitude of European SMEs towards this type of technology. Many authors have identified three basic services that can be provided by a 'cloud' based service [14]:

Infrastructure as a Service (IaaS) – such services envisage remote use of all types of hardware (servers, databases, VPN, etc.);

Platform as a Service (PaaS) – a service that offers a complete working environment, which is controlled by a team of specialists;

Software as a Service (SaaS) – the most widely used type of service. The software is installed on the server instead of the users' computer, which means that the user can access the programme at any time, even while working on another computer. An example is Office 365 or Google Docs that offer text editors, which are not necessary to be installed on each computer, it is enough to log in to your 'office' via the internet and perform all necessary actions;

SaaS popularity is easy to explain: creating or using any of these products do not require large capital investments. Thus, it is not difficult to offer a variety of solutions. Most often, however, the SaaS principle is used to deliver CRM or ERM applications.

In the last section, the authors have analysed Latvian researchers' articles that are related to SMEs, the challenges they face, as well as use of the internet technologies in business. These articles are summarized in a portrait of a Latvian entrepreneur with the aim to adapt Internet site assessment methods developed by foreign authors to Latvian conditions.

III. Research results

For the research, the best SaaS solutions in Europe and the world were selected, as well as the offer of Latvian SaaS.

In the next step, the website weaknesses and strengths were individually assessed and grouped, and then compared with each other.

The results indicate that the Latvian SaaS providers have not fully realized the benefits of cloud technologies, and the services they provide are insufficient, or in some cases unnecessary. In contrast, European solutions try to better understand customer needs and continuously improve service quality.

On the basis of the previously gained knowledge and literature analysis, a conceptual model of criteria for assessing the need for SaaS solutions is offered.

The research results provide a better understanding of the Latvian entrepreneurs' attitude towards 'cloud' technologies, and also try to determine what solutions are necessary for managers of Latvian small businesses. The study results also indicate future research directions:

A. Wider approbation of the developed criteria in enterprises,

B. Quantitative evaluation of the information technology impact on competitiveness

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Maple as Effective Means of Production Modeling and Analysis in Entrepreneurship

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Keywords **– Cobb-Douglas production function, modeling, Maple system, total costs.**

I. Introduction

A suitable combination of advanced mathematical methods, information and communication technologies (ICT) tools and the need to model and analyze the economic phenomena are an important competitive advantage for every top management decision making in the current market environment, in entrepreneurship. The aim of production function modeling and analysis is to determine the dependence of the output of the production process (production) on the inputs (production factors). This dependence is determined by many external conditions (technical progress, organization of production, etc.). The neoclassical concept, so-called the Cobb-Douglas production function, plays an important role in economic theory, especially its high-ability statements in specific applications. The powerful tool is a mathematical multivariable calculus and using the appropriate computer software. We will use the Maple software. It's the world-wide product of the Canadian company Maplesoft Inc. The chosen properties of the Maple system will be present.

II. Maple System

The Maple system has been developed since 1982 by the Canadian company Maplesoft Inc. Its actual version 16 was distributed in April 2012. Maple also helps to model, analyze, visualize, and solve problems in economics and finance using mathematical and statistical methods. It has many professionally attractive and user friendly properties and built components. It executes the numerical and also symbolic calculations, the support of many interactive elements. For example the Finance package of Maple contains many tools for advanced financial modeling and analyses. The Maplesoft web at Application Centre is important source of appropriate solvers and algorithms for Maple users.

III. Cobb-Douglas Production Function

This paper deals with the two factors Cobb-Douglas production function in the long run. Therefore, its inputs are two (labor and capital) values. Therefore we process the calculations and visualization using a multivariable calculus (functions with two variables whose charts are in three-dimensional projection (3D)). The monotonic logarithmic transformation is important for the construction of the Cobb-Douglas function model of empirical values as the functional form of a multiple regression (statistical fitting least-squares regression of the production function). Maple system offers highly specialized tool for it.

A. Cobb-Douglas production function – basic analysis

The Cobb-Douglas function has the form

$$Q = Q(L,K) = AL^{\alpha}K^{\beta} \qquad (1)$$

where Q is production, L is one input factor of production (labor), K is the second input factor of production (capital) and A is a scaling factor (level of technology, etc.), α, β are the impact rate of inputs on production and $0 < A$, α, β (from economic interpretation). The sum $\alpha+\beta$ determines the returns to scale on factor inputs (for $\alpha+\beta=1$ it is constant returns to scale, for $\alpha+\beta>1$ it is increasing returns to scale and for $\alpha+\beta<1$ it is decreasing returns to scale). In the Maple system we can simply evaluate these expressions or low diminishing marginal productivity, as well as important characteristics as a marginal product of labors, a marginal product of capital and a marginal rate of technical substitution which are needed for the analysis of economic phenomena dynamics.

B. Cobb-Douglas production function - visualization

The visualization of Cobb-Douglas function is three-dimensional graph (production hill) or two-dimensional maps of isoquants. The Maple system offers very quick and easy construction of these visualizations with possibility to integrate the interactive components. This is a significant advantage for company management decision making in the practice.

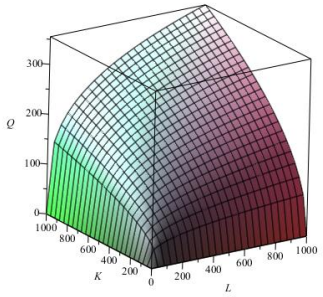

Fig. 1. 3D visualization Cobb-Douglas production function in Maple. Source: Owen work in the Maple system.

IV. Total Costs - Minimize

To optimizing company means we have to solve the maximization of profits, respectively the minimization of total costs. In the paper we choose sample to minimize the firm total costs in the case of Cobb-Douglas production function. We use the mathematical method of Lagrange (for bound extremes).

V. Conclusion

We discuss how to use Maple tools for analysis and application of two factors production for entrepreneurship.

VIII. Acknowledgment

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Management Control as a Tool of Effectiveness Improvement

Mina Daskalova (*Technical University of Sofia*)

Keywords **– Management Control, Management Control Systems, Internal Auditing.**

I. Introduction

The Control is a function of management, through which managers can define the extent of compliance between current and planned condition of the object of control at any time. The process of control include also, taking corrective actions, when there is non compliance between planned and reported indexes, describing the object condition. In conclusion, it can be said that through process of control, managers can maintain the right direction of organization activity.

Management Control can be defined as a process through which managers can affect the other employee in the organization to implement the organization's strategy.

II. Effectiveness Measurement

The main objective of the company is generating profit for the owners (shareholders) by satisfying public requirements.

The objective of financial management is maximizing the value of the company. The meaning of the concept of value has been developed in the economic for a long period of time. There are many different schools, which adopt and interpret the meaning of the value and its quantitative measurement. There are two basic concepts concern the meaning of the value – Consumer Value and Value.

The following ratios are the most popular ratios used for assessment of effectiveness of the organization:

- ROA (Return on Assets). It measures the effectiveness of invested capital. ROA = PBT/IC where PBT is profit before taxes (gross profit) and IC is invested capital.

This ratio is one of the main indexes, which measure the condition of the business. For every type of business activity, financial resources are of a great importance either in shape of owner equity or loans and their use for generating profit. If there are changes in the index it is necessary to make detailed analyses for finding out the reason of alternation. In the ratio calculation is appropriate to be used "profit before taxes", because in this way national special features of corporate taxes are eliminated and ratio can be used in international and inter-segments comparisons. The ratio can be considered as low if it is between 0.01 – 0.1, medium if it is between 0,11 – 0,2 and high if it is above 0,2.

- ROE (Return on Equity). It measures the effectiveness of owners' equity. ROE = P/E where P is profit and E is the size of the owners' equity.

This ratio measures the effectiveness of the company management from owners' stand point. It gives the information for ability of the management to achieving good results from business activities. The ratio ROE gives the answer of question if it is worth to invest own funds in this business or it will be more appropriate to search alternative investment projects. The recommended rate of this ratio is about 0,1. The information obtained from ROE ratio is not completed, because the profit in the equation isn't measures the real earnings for the owners, because only part of it can be distributed as shares and dividends.

- ROS (Return on Sales). It measures the profit margin of a company. ROS = NP/SR where NP is net profit and SR is sales revenues.

It determines the ability to withstand competition and adverse conditions like rising costs, falling prices or declining sales in the future. The ratio measures the percentage of profits earned per currency unit of sales and thus is a measure of effectiveness of the company. For low rate of profit can be considered 0,02, medium rate of profit can be between 0,03 – 0,08 and for high rate can be considered ratios above 0,08. For short period of time this ratio may vary, but from management stand point it has to be increase at strategic period of time. The subjects of activity and industry sector have influence on this ratio.

III. Conclusion

There is a great difference between variables, which are value driver and indexes and ratios from financial reports. The value driver is anticipative indicator and it takes part in setting the strategic objectives. The indexes and ratios from financial reports are subsequent indicators and they give information about past actions and results.

The financial measure of value driver is known as key performance indicator. They can be used, not only for complete comprehension of a value driver, but for measuring the effectiveness of organization. To define which operating indicators from business activities are value driver is very important, because the management can't directly influence the value of the organization.

Recognition and defining the value driver, in the process of Management Control, is of a great importance, because it helps management, achieving strategic objectives. It helps employee, at any organizational level, to be acquainted with a value creating process.

Classification of value drivers helps management to allocate the resources in these business areas, which are most profitable and joint the efforts of the staff for performing the strategic priorities. Formulating the necessary activity results, the organization objectives are set. The managers, who are performing Management Control directing the ability, knowledge and energy of the employee for solving problems in long term perspective.

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Trends in determining machine Life-expectancy in relation to the Innovation obsolescence and physical deterioration

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Keywords **– Physical deterioration life expectancy, Innovation obsolescence, Optimization requirements.**

I. Introduction

The current paper makes an attempt to determine the life expectancy through forecasting the period of physical deterioration (wearing out) and innovation obsolescence of the mechanical engineering products. This could also be defined as the optimum life expectancy. Applying, during that period, various mathematical tools, general criteria and particular indexes that set up the optimization requirements for the length of service of industrial products (machines) are determined. Put forward is an approach to calculate the best life expectancy period regarding physical deterioration and innovation obsolescence.

II. Optimum life expectancy determination in relation to the physical deterioration and innovation obsolescence

The physical deterioration is both a technical and organizational issue that can be studied, computed and settled with an utmost precision. It is determined and depends on the structure of the machine, the materials it is made from, its function, its reliability, as well as the current trends in the constructional and technological features of the new machines. The physical deterioration is to be realized for a certain time within the limit points from t1 to t2, which is also the minimum life expectancy of the machine. In other words, this is the period of time, within which the machine has to produce such a production volume so as to pay back the purchasing sum of money. In such a case the volume measure of the output, necessary for the payback is normatively agreed upon to cover 5 years. It can be examined and estimated in dependent variables taking no account of the reduction rate in labour productivity (Q1) , yet accounting for that reduction in each of the following years as a result of the machine physical deterioration(Q2). With Q1 we get the so-called ideal type, while with Q2 provisions are made for the effects of the wearing out of the machine components, the relative changes in its kinematic chains, failure in the machining accuracy, setting apart more time for preventive maintenance ("prophylaxis") and repair, etc.

$$Q_2 = Q_0 - Dt_{1-5} \tag{1}$$

Dt_{1-5} – reduction in the performance throughout the entire length of service

$$Q_{21} = (1,00 - Dt_1)Q_0 \tag{2}$$

$$D = 0,01t_1 \tag{3}$$

$$Qt_1 = (1,00 - 0,01t_1)Q_0 \tag{4}$$

$$Qt = Q_0 t_{1-5}(1,00 - 0,01t_1) \tag{5}$$

where:

Qo – performance of the machine (new machine);

Q1 – without accounting for the reduction in its performance throughout the entire length of service;

Q2 – accounting for the reduction in its performance throughout the entire length of service.

t = 1÷5 years (normatively determined);

D – decided on the basis of experimental studies, statistical analyses and reports.

This means, that with the reduction in the performance, the primary expenses and extra cost for repair and maintenance will be allocated to a less output. The least it will be in the last year and the statistics show, that the reduction varies on average between the limits of 0,01- 0,03 over a five-year period.

Innovation obsolescence refers to a relative reduction in the performance as a result of the production process and utilization of new, more highly-productive machines. Put differently, this is the starting point of the machine innovation obsolescence. In this case we could employ the following dependence:

$$M_o = P\left(1 - \frac{P_1}{Q_p}\right) \tag{6}$$

where:

Io – innovation obsolescence;

P – primary value of the machine;

P1 – the relation of the new machine value to the old one;

Qp – the relation of the productivity of the new machine to the old one.

Involved are all indexes such as productivity, machine value, etc.

III. Conclusion

The best result is achieved and the most profound effect is produced with almost equal length of the starting - point period of physical deterioration and innovation obsolescence. Furthermore, physical deterioration is not as predominantly significant as the innovation obsolescence. The accomplished study provides solid support for the latest trend of orientation towards manufacturing of machines which will meet the following requirements:

1. Shorter life expectancy period and higher reliability of the production machines.

2. Possibility of eliminating the innovation obsolescence impact through the use of modular principles of mechanical engineering products projecting and manufacturing.

3. Reconsideration of the payback periods (amortization) is essential, as to their potential shortening and alignment with the latest innovation obsolescence trends.

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Directions for improved effectiveness and efficiency of support for green energy generation in Latvia

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Keywords **– renewable energy sources, electricity generation, effectiveness, economic efficiency.**

I. INTRODUCTION

Since 1970s when the world economy experienced economic turbulences because of oil shocks, there has been an increasing interest in green energy. Nowadays an evident transition is taking place from economies based on extensive fossil fuel use, such as coal, oil and gas, to economies that are driven by renewable energy sources (RES), such as wind, biomass and the sun delivering important economic, social, environmental and energy security related benefits.

In order to promote faster development of RE projects, all countries of the European Union have implemented support mechanisms that vary in form and design from one country to another. The major objective of the support is to reduce risks related to RE generation and to promote investments in RE projects.

In this paper the authors have limited the concept of RE to electricity generation (RES-e) only, although heat can also be produced from RES.

II. MEASURING EFFECTIVENESS AND EFFICIENCY OF THE SUPPORT FOR RES-E GENERATION

Optimization of the available resources to achieve the best result forms the basis of each activity with economic nature. In general effectiveness and efficiency, both comparing outputs with inputs, are economic terms used to assess economic activities.

Although RE generators in Latvia are entitled to economic support since 1995, assessment of its effectiveness and efficiency has never been carried out. The aim of this paper is to present the main results of the authors` research on effectiveness and efficiency of economic incentives (support) for RE generators in Latvia.

The term *effectiveness* refers to ability to deliver certain effect or achieve the set goals. It refers to assessing whether inputs deliver outputs. It ignores whether the same output could have been achieved with less inputs. *Efficiency*, on the other hand, evaluates rationality and optimality of the input compared to the output achieved. It, however, does not necessarily mean that the result is fully achieved.

Electricity generation from RES is not yet fully competitive with the traditional electricity generation. Support provided to RES-e generators is meant to increase RES-e competitiveness. It can include several elements such as higher tariff than electricity market price, mandatory purchase, priority access to grids, tax rebates, investment subsidies, etc.

a. INDICATORS TO MEASURE EFECTIVENESS AND EFFICIENCY OF RES-E SUPPORT

Support can be considered as effective if RES-e generation potential available in a country is fully realised. In case of RES-e targets set by governments the support can be considered effective if the targets are achieved. Efficiency is achieved when the tariff or price paid for a unit of produced RES-e is the closest to its generation cost. However, in real life it is very difficult to obtain electricity generation cost data due to its commercially sensitive nature and to generalize it because of very different generation conditions for the same RES-e technology across countries. Therefore other indicators have to be used. The authors have created a classification system of indicators to assess effectiveness and efficiency of RES-e generation support as shown in Table 1 in full version of this paper. The main indicators are *support effectiveness indicator*, *support cost per unit*, *support cost for RES-e per capita* and *support cost index*.

b. ASSESSMENT OF EFFECTIVENESS AND EFFICIENCY OF RES-E GENERATION SUPPORT

Effectiveness and efficiency of RES-e generation support are determined using the above mentioned indicators and covering 15 years period from 1997 to 2011. In general the calculated indicators demonstrate low effectiveness and efficiency of RES-e generation support in Latvia. The authors have also calculated value forecasts for each of the mentioned indicators up to 2016 based on regression equitations obtained from respective trends. If no improvements are introduced into the form and design of the current support mechanism, its effectiveness and efficiency will remain low.

III. DIRECTIONS FOR IMPROVED EFFECTIVENESS AND EFFICIENCY OF RES-E GENERATION SUPPORT

Balancing RES-e generation development and RES-e generation support related costs is the basis for improved support efficiency. The main directions to improve effectiveness and efficiency of the current support are introduction of market principles into the design of the support mechanism, review of competences of public authorities responsible for development of RES-e projects and building better communication among them and review of administrative barriers.

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Alternative Supply Options of Natural Gas in Latvia and Related Risks

Vladimirs Didenko, Anatolijs Magidenko

Keywords **– natural gas, natural gas supply, natural gas price, liberalization, the third energy package.**

Currently, an important issue in the energy field is the possibility of alternative supplies of natural gas in the Republic of Latvia. Solution of this problem will help create a competitive environment between suppliers of natural gas and therefore reduce the purchase prices for natural gas for various consumer groups in Latvia.

It should be noted that the functioning of the gas industry in Latvia is carried out under conditions of monopoly. Natural gas supply on the territory of the Republic of Latvia is performed by enterprise JSC "Latvijas Gaze". This is the only company, which has exclusive rights to such activities as transportation, storage, distribution and sale of natural gas to consumers in Latvia at this moment. The existing conditions of monopoly, according to the agreement signed between the State of Latvia and the shareholders of JSC "Latvijas Gaze" must be maintained until the end of 2017. All natural gas consumed in Latvia is purchased and shipped entirely from the Russian Federation.

The "Third Energy Package" governing the European Union policy in the energy sector came into force in September 2009. The “Third energy package” includes five directives, and three of them belong to the regulatory processes of natural gas supply. Member states of the EU must bring their national legislation in accordance with the requirements of the "Third Energy Package". The main purpose of these documents is to create a common energy market in the EU member states and to strengthen competition among suppliers of electricity and natural gas. The reforming of the EU energy market will de-monopolize national markets of the EU member states, and form a common EU foreign energy policy, which will be controlled only by the European Commission. Performance requirements of the "Third Energy Package" will improve the energy security of EU member states and reduce the prices for electricity and natural gas, and this will help to reduce the energy component in the cost of manufactured goods.

At present, the process of liberalization of the gas industry in Latvia is developing in the line with EU requirements. According to Latvian legislation the reforming of the gas industry should be completed by April 2014. Fulfillment of the conditions of the "Third Energy Package" provides conversion of a vertically integrated company of JSC "Latvijas Gaze", separating the function of gas sale from technical support functions of supply. After the reforming of the gas company, completely or partially independent operators for transportation, storage and distribution of natural gas will be formed. The Government of the Republic of Latvia is responsible for the model of separation of the company. After the end the liberalization process of the gas industry in Latvia, for alternative gas suppliers it will be possible to access the transmission and storage gas systems. It will strengthen the competitive environment, and consumers will be able to choose their gas suppliers.

Compliance with the requirements of the "Third Energy Package" in Latvian legislation is not sufficient condition for the gas industry activity under the new rules. Therefore, it is necessary to create a technical ability to perform these requirements, such as the construction of connecting pipelines or LNG terminal. In case technical ability to create alternative gas supply by construction of connecting pipelines or LNG terminal will no implemented in Latvia in the near future, it will lead to more expensive tariffs for gas supply services and the final gas sale tariff for consumers in Latvia.

[1] Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC).

[2] Regulation № 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions of access to the natural gas transmission networks and repealing Regulation (EC) №1775/2005.

[3] Regulation № 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators.

Professional social responsibility of Landscape Architectures

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Keywords **– professional social responsibility, landscape architecture, sustainable development.**

I. Introduction

Activities in landscape architecture are directly related to the application of altruistic concepts for the improvement of public welfare. Experts, working in this profession, perform functions related to management of various complex projects for improving the living conditions of the community. Through their work they exert significant effects on the economic, social and environmental development. Professional social responsibility of the landscape architect is an integral part of ethical behavior not only within the profession but to society and is a factor for sustainable development of urban green systems.

II. Results and Discussions

A. Identification of Authors

The concept of professional social responsibility refers to individuals engaged in purposeful work within landscape architecture, and aimed at improving living conditions. Expression of social responsibility professional landscape architect is required in dealing with different stakeholders. These are private clients, other public institutions and community groups. In first the education system necessary educate young professionals in professional social responsibility. This is done by setting the necessary education standards. Educational standards reflect the public need from the landscape architect.

B. Standards in the profession and professional social responsibility

Demonstration of professional social responsibility for the profession is a part of the competencies standards for landscape architects. Profession "Landscape Architect" is a profession that requires specific educational training. (European council of Landscape Architecture School, ECLAS) International organizations like the International Federation of Landscape Architects (IFLA), European Federation for Landscape Architecture (EFLA), and ECLAS (European Council of Landscape Architecture Schools), the project LeNotre (Thematic Network Project in Landscape Architecture) establish standards for accreditation, licensing and practice profession.

Imposed educational standards include the acquisition of standards of professional conduct, leading to improvement of public welfare and implementing socially responsible decisions.

Last year MATRIX COMPETENCE OF PROFESSION "Landscape Architect" for conditions in Bulgaria was developed. In the development process possibilities for the expression in the practice of these professionals in both public and private sectors are covered.

All levels and groups reflect the educational competencies and skills acquired in "Landscape Architecture" at the Forestry University and in the practice. The job requirements for specialists in public administration and private sector were analyzed. These were formulated within the matrix including the necessary skills associated with demonstrating socially responsible behavior by the professionals.

The main application of the matrix is within professional organizations and associations of the landscape architectural activities and in favor of public sector institutions. The bases of the matrix were set at five qualification levels involving the professional positions and seven groups of competencies. In one group competencies "Teamwork, leadership and management" about the specialists from all levels of qualifications are intended to demonstrate a socially responsible attitude and ethics of the profession and the organization.

By applying the matrix, the socially responsible behavior of landscape architect will be not only the recommend element at work, but could be mandatory when included within the job requirements of working positions in the organizations.

III. Conclusions

Landscape architecture is profession important for social development that has direct relevance to the responsible use of land and improving the quality of life. Professional social responsibility is required to educate through the imposition of educational standards and professional ethical standards of professional associations. It is the sole responsibility of the professionals in practice and has to come from the person exercising the profession. The quality of living environment is directly related to the occurrence of socially responsible behavior in making professional decisions by landscape architect. Professional associations are those which should initiate and encourage the implementation of socially responsible decisions by professionals in practice

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Changes in business model of banks in CEE countries

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***Keywords* – Banks, Business model, CEE, Pillars.**

I. INTRODUCTION

The fact that banks cannot work according to the traditional principles in use before 2008 anymore was attested by the financial crisis, which forced the banks to refocus their activities from short-term to long-term goals.

With a term "bank's business model" considers the following factors: how the bank's operations are organized, the way it actually performs its business activities and the quality of its products and services, as well as their price [1].

The purpose of this research was to analyze the bank business models in CEE countries.

To achieve the goal the following research methods were used: quantitative and qualitative methods, including monographic and descriptive methods.

II. LITERATURE REVIEW

In the last decade banks mainly focused on consumer credits, considering lending as the main bank product, at the same time disregarding other products and services.

For example Beattie and Pratt (2002) state that with the increase of competition among the banks, know-how, patents, qualified staff and other intangible assets become the main values of the enterprise [2].

Discussing bank business models, Argosh (2012) points out that the processes used in bank operations are very obsolete, as still at present banks relatively widely use non-digitalised processes [3]. In this respect banks will have to introduce digital products, as well as products and services which will respond to consumer needs.

III. METODOLOGY

The authors consider Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia as the CEE countries. All previously mentioned countries joined the European Union in 2004 only with the exception of Croatia.

The authors performed analysis of business models on the basis of financial and non-financial information which is included in the annual reports of the banks of CEE countries for the time period from 2000 till the end of year 2011.

IV. RESEARCH DATA

Analysis of annual reports of the banks of CEE countries showed that certain banks, such as *Ceska Sporitelna* (Czech Republic), shifted their business model towards the direction of social and environment factors still before joining the European Union (in 2002). Meanwhile in banks of other countries the need for the assessment of environment and social factors appeared short before the economic downturn or after 2008. However there are still countries and banks, where the business models have not been changed significantly neither before nor after joining the European Union.

In order to better demonstrate the existing business models of the banks of each of the countries, the authors created four pillars, as it is represented in Table 1.

TABLE I

PILLARS OF BANK BUSINESS MODEL

Country	1st Pillar	2nd Pillar	3rd Pillars	4th Pillar
Croatia	Customer	Products and Services	Innovation	Development
Czech Republic	Customer	Environment	Social responsibility	Development
Estonia	Customer	Products and Services	Development	Innovation
Hungary	Strategy	Customer	Products and Services	Development
Latvia	Products and Services	Innovation	Customer	Development
Lithuania	Development	Customer	Products and Services	Innovation
Poland	Customer	Products and Services	Development	Social responsibility
Slovakia	Products and Services	Customer	Development	Social responsibility
Slovenia	Development	Customer	Products and Services	Environment

The business models pillars of the bank show that there still exist countries, where the customer is not listed as the most important guarantee for the sustainable growth of the bank.

V. CONCLUSION

The authors have concluded that one of the main factors that the banks may use to ensure their sustainable development is to develop a unique entrepreneurial strategy based on business objectives, which would include development tendencies of sustainable factors both in the sector and in the market, in which a bank operates.

As the performed research showed, the banks will be able to reach long-term objectives and development in the knowledge economy only in case if the customer will be proposed as the first pillar as well as when it's activities will be considered not only from the perspective of the influence of financial factors, but also non-financial factors, such as social and environmental ones.

In the future the authors see a need to perform additional researches on the other influencing factors of the business model.

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Organization changes and consumer experience 2.0: e-Tourism tendencies

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Keywords **– Tourism 2.0, Consumer experience, e-Tourism, ICT, e-Commerce.**

I. Introduction

The new world tourism stage requests the market must change its models as the way to guarantee its own survival [1]

ICT (Information and communication technologies) have always allowed organizing tourism organizations tasks from standardized management process and establishment of networks between strategic partners to different specific actions to communicate and trade in e-tourism.

Currently despite the global economics problems and while the expectations placed on other areas of business and stock market have not been fulfilled the online transactions of tourism market are continuously growing. Therefore both demand and offer constantly need to use ICT advances in the Marketing and Management area, especially on the information, trade and promotion that introduce a lot of benefits for tourism industry [2].

Constant transformation of structures and practices of organizations in the name of competitive differentiation through their images and identities of different tourism require experts' in-depth knowledge of consumer attitudes, behaviour, and experiences, seeking to influence decisions to visit a destination. Through the arguments of experts and institutions this paper proceeds to analyze how the use of ICT according to consumer experience, tendencies and innovation tools of organizations. Their use in Tourism 2.0 are contributing decisively to change needs and consequently, profiles of news tourism users, progressively leading toward other tourism dimension: Tourism 3.0

II. Methodology and approach to the investigation

As for the methodological model used in this paper it is based on documentary review of the scientific works of various authors and institutions of reference, which deal directly and indirectly the different trends in consumption patterns of the different profiles of European customers, mainly related to management, marketing, tourism promotion and Information and Communication Technologies (ICT).

III. Conclusions

The study results have confirmed that the future of e-tourism seems focused on technologies for the consumer to enable organizations to focus their profitability by extensive networks of collaboration and specialisation. Consumers are more sophisticated and more experienced and therefore it will be harder to please them. All indications the online information, trade and marketing strategies continue to be an important tool, and surely the only possible one in the future to carry on a business in the tourism industry.

Medium and long term the electronic tourism seems to address creation of new and innovating electronic trade models that allow extending supply chain and increasing the value chain. In short term tendencies seem to focus on: a) inter-operation (interaction between different participants where customer has main role; b) encouragement of electronic trade; c) accessibility through mobile terminals.

Different products should be provided for different consumers with different way to understand their life. Users will be able to subscribe and receive tourism information in the appropriate format in different media, with particular emphasis on computers and cellular.

Tendencies address to other tourism dimension with technologies with consumer-oriented technologies, ensuring that new customers, more sophisticated and experienced, receive personal attention and specialized treatment [3]. This requires agile strategies at management levels, both tactical and strategic, to develop specific online structures of tourism organizations, to guide its internal functions, their relationships with partners and their interactions with all members, including customers. Only those organizations that appreciate the opportunities offered by ICT, and successfully manage their resources, can increase innovation and competitiveness in the future. Tourism 3.0, involves the role of experience, responsible consumption, sensitivity for the environment, the search for experiences and relationships with local environments, is to understand that the offer of the end product are not the facilities or destinations, but experiences and the emotions, forcing tourism organizations to engage in change management. These new consumers increasingly demand higher levels of interactivity as content recommendation and emotional involvment, are mostly persons to engage in dialogue with the tourism service and the country you that provide welcomes you, what ultimately tourism makes a humanizing activity.

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Equilibrium Real Exchange Rate of the Latvian Lat: Comparison of Alternative Approaches

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***Keywords* – Equilibrium exchange rate, BEER, cointegration, NATREX, reduced form models.**

I. Introduction

The paper derives equilibrium real effective exchange rate of the Latvian lat using behavioral equilibrium exchange rate (BEER) and natural real exchange rate (NATREX) approaches for the period 1996Q1 – 2011Q4. The aim of the analysis is to assess if repeatedly heard assertions of overvalued lat and its harming effect on country's competitiveness are empirically validated. The use of the two alternative methodologies allows reliable conclusions to be drawn about the misalignment of the lat.

The paper is organized as follows. The published empirical literature on equilibrium exchange rates in Latvia is discussed in Section II. Estimates of the equilibrium real effective exchange rate of the lat are determined in Sections III and IV using the BEER and the NATREX approach, respectively. The final section summarizes the main findings.

II. Empirical estimates of the equilibrium REER of the Latvian lat

The most popular method for determining the equilibrium real effective exchange rate (REER) in Latvia has been the behavioral approach (BEER). The BEER approach was put forward by Clark and MacDonald (2000). The starting point for the derivation of the BEER is the uncovered interest rate parity (UIP) condition. Based on that, the authors derived a reduced-form equation that relates the current real exchange rate to the real interest rate differential and to a set of fundamentals explaining the long-term equilibrium rate. Typically fundamentals are chosen in view of the silent features of the economy, data availability and prior empirical evidence. [3]

Econometric modeling of the BEER is related to finding a significant co-integration relationship between REER and selected fundamentals.

Table 1 (in fv) provides an overview of the empirical studies of the lat, focusing on period examined, the fundamentals included in the analysis, signs of the estimated coefficients, and the main findings regarding any exchange rate misalignment. Main findings that stand out from the earlier studies are following. Firstly, the non-stationary stochastic trend of REER of the lat can be explained by the underlying economic fundamentals. However, results are sensitive to choice of country groups. [6] Secondly, relative productivity, openness, terms of trade and government expenditures are fundamentals that have the most robust impact of the lat's REER.

Literature survey shows that most of previous articles are related to the time period till 2004, and an investigation of the period that includes assessment of the EU (2004), change in peg of the lat (01.01.2005), period of rapid growth and following crisis, and recovering, is actual and interesting.

This article contributes to the existing literature in following aspects: firstly, we provide BEER estimation for the analysis of the lat's REER dynamics using the longest data sample to date (from 1996Q1 to 2011Q4) and employing a more comprehensive selection of econometric technologies for finding co-integration relationships. Secondly, we adopted small open economy's NATREX model [3] for Latvia and estimated its reduced form.

III. BEER: estimation and results

The real effective exchange rate (REER) is calculated vis-à-vis 12 main trading partners' currencies. The price index used to deflate nominal exchange rate is the consumer price index (CPI).

The following fundamentals are considered: productivity (**prod**, labor productivity, measured as gross value added per employment in Latvia against effective labor productivity in 12 main trading partners, in logs), the net foreign asset position as ratio to GDP (**nfa**), the terms of trade (**tot**, measured as relative effective value, in logs), the sum of exports and imports over GDP as measure of openness (**open**, relative effective value, in logs), government consumption as ration to GDP (fiscal policy measure, **govexp**, relative effective value, in logs), and the real interest rate differential (**RINT**, the difference between short term real interest rate in Latvia and weighted average of main trading partners).

Results are presented in Table 3 (fv).

The estimates of all specifications are used to calculate equilibrium level of the REER and to assess the extent of any misalignments. Results are shown in Figure 1. (fv)

IV. NATREX: Estimation and results

The natural real exchange rate theory was developed by Stein and is based on an internal-external balance framework. The NATREX in this article as often in the literature is written as a reduced form relationship. (Table 4 (fv))

BEER estimates are sensitive to chosen co-integration methodology. In this article the NATREX model was estimated in reduced form. Estimated equilibrium path is more volatile than for BEER model.

Results from two alternative approaches show that real effective exchange rate of the lat has not been continuously significantly overvalued. Therefore claims for devaluation are not well grounded.

It would be interesting to do the same analysis for bilateral real exchange rate against euro. It would give a chance to see which factors have been more important for Euro zone.

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Short-term stock portfolio securities selection methodology

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Keywords **– Stock market, stock selection, financial analysis, trading, short-term speculations.**

I. Introduction

One of the biggest problems when creating a stock portfolio is selecting the right companies. The aim of the publication is to develop a stock selection system that would help the potential investor to create a short-term stock portfolio. Short-term is considered to be a 3 months period. The basics of the presented system is a comparative analysis. It involves comparing companies quarterly reports. The subject of the publication is a USA stock-market but the object – the system of selection of companies stocks in a short-term stock portfolio.

II. MAin process

To meet the aim of the publication authors have developed a system that a potential investor can follow to select the best companies shares by implementing comparative analysis. The first step is to choose a specific stock market, for example, authors have chosen a USA stock market with stocks from DJIA30 index. Next task is to gather all data necessary to conduct a comparative analysis. Authors have concluded that quarterly published data from companies profit and loss account and balance sheet are useful for comparing.

Financial indicators selected by authors

Every value from financial reports can be compared with values from previous periods. It is the core of the system developed by the publication authors that could help to determine financially best companies shares to include in the stock portfolio. Table 1 shows which indices can be compared:

TABLE I

FINANŠU ATSKAITĒS ATLASĀMIE RĀDĪTĀJI

Nr.	Type of data	Data sourse
1	Total Revenue	Income statement
2	Gross Income	Income statement
3	Operating Income	Income statement
4	Net income	Income statement
5	Earnings Per Share (EPS Diluted)	Income statement
6	Return On Assets (ROA)	Modifier
7	Gross margin	Modifier
8	Operating margin	Modifier
9	Net income margin	Modifier
10	Cash and Short Term Investments	Balance sheet
11	Total Liabilities / Total assets %	Balance sheet
12	Total Assets / Shares Outstanding	Balance sheet
13	Stock Price in Exchange	Historical stock price
14	(Total Assets / Shares Outstanding)/ stock price in exchange	Modifier

Every financial quarter there is a lot of data to compare and evaluate its change. Authors have chosen 14 units of data and its modifications. Percental change is being evaluated according to a 5-point scale. How much percentwise has an indicator changed compared to the same period 1 year ago and compared to the previous quarter, n/n-4 and n/n-1 respectively. Authors have determined certain intervals for each percental change of an indicator and assigned a value from 1 to 5 for each percental change accordingly.

Percental change of every indicator to compare is being evaluated according to a 5-point scale and all 28 evaluations are summed and divided by 28 (14 indicators period n compared to period n-4, and 14 indicators period n compared to period n-1).

A. Rates of companies shares

Percental change of every indicator to compare is being evaluated according to a 5-point scale and all 28 evaluations are summed and divided by 28 (14 indicators period n compared to period n-4, and 14 indicators period n compared to period n-1).

B. The use of rate

Authors have made given recommendations of acquired value rates - 1-2=Sell, 2-3= Sell/Hold, 3-4=Buy/ Hold un 4-5=Buy.

III. Objects

According to DJIA index 30 rate values are acquired which are seperately collected in a common table. Companies with the highest rates are selected.

A. Rate and short-term shares portfolio

The rate value allows to evaluate financial state of the company with just one indicator. It helps to understand if the stock of a certain company will seem attractive to investors in the next 3 months until the next quarterly report.

B. Exceptions

However, companies are being evaluated according to the same system, there are exceptions, for example, companies of financial sector. The authors of publication have developed a way for unordinary cases to adjust the system of evaluating.

C. Diversification of short-term

Authors emphasize diversification, to select not only the companies with the highest rates, but in the case of DJIA index companies with the highest rates from 8 different sectors. Buy.

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Particularities of forming of strategies of sustainable development in some countries

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Keywords **− development strategies, social system, economical, financial, social, ecological potential, sustainable growth, externalities.**

I.INTRODUCTION

Economic and social development in XX ct. practically in all the countries, especially in European ones, was characterized by forming of their own model of economy. These tendencies, in particular, were spread in the USA, some countries of Europe at the end of XX ct. Groundless growth of financial resources in a private sector without an adequate increase in the real sector of economy, violation of classic principles of public economy, namely considerable increase of money amount in the circulation without its financial providing, ineffectual state financial control became the reasons of the global world financial crisis at the end of 2007 year. Despite of the efforts of international financial organizations and governments of the countries this crisis presently has not been overcome yet [1].

II. TERMS OF NATIONAL STRATEGIES FORMATION.

Every country is at a certain level of social and economic development, that is why when forming the strategy the purpose, aims and tasks should have certain differences, but it is necessary to take into account separate constituents which are forming criteria. Such criteria include the state of an internal and external environment, in particular, an internal environment comprises natural, labour, production potential, and in an external one it is necessary to take into consideration globalization tendencies, political and economic power of a country, social and economic ties with the international organizations, in particular with the financial, neighboring countries.

It's also necessary to take into consideration the world dynamics of economic processes which with respect to some country has an objective character and is stipulated by certain development phases or so-called technological cycles.

III. METHODOLOGY OF FORMING OF DEVELOPMENT STRATEGIES.

Presently the conception of steady development has become popular, although some doctrine positions of this conception were initiated at the beginning of the 90-ies of XX ct. At the beginning of the second decade of XXI ct. the conception of steady development is grounded from the point of view of physico-biological, social, ecologicaly-economical, economically-ecological approaches.

The proper theoretical construction that is doctrine, theory, conception which then will be realized in a specific development model must precceed a breakthrough change of a public system. Japan experienced this model in the 70-ies, "Asian Tigres" that is Taiwan, Hong Kong, South Korea in the 80-ies, China in 90-ies of XX ct. passed this way. The mentioned countries have a steadily functioning social system now. New approaches for the formation of development strategies are being developed. In particular, ukrainian scientists M. Fomina and V. Prykhod'ko offer the system-synergetic approach that includes modern achievements in science [4, p. 43].

The use of this approach will allow forming the proper development strategies for some countries most complexly, taking into account their current and future public systme state.

Considering the actuality of this problem in EU in March of 2010 new European strategy of economic development was approved – "Europe – 2020: the strategy of a clever, stable and all-embracing growth" . This strategy provides for three main factors of development, clever growth: development of economy, based on knowledge and innovations; stable growth: forming of economy, based on the purposeful use of resources, ecology and competition; all-embracing growth: increase of the level of population employment, achievement of social and territorial consent.

IV. ALGORITHM OF STRATEGY FORMING

The use of this algorithm will allow from the scientifically grounded point of view forming national strategies of development. Realization of the formed strategy must take place with the use of own of intellectual potential of a country.

V. CONCLUSIONS

Forming of the development strategy of every concrete country is an extraordinarily responsible task. It is foremost necessary carefully to weigh potential possibilities of some country for acceptance of the grounded decisions. As European experience testifies, if concrete parameters are not grounded the strategy is doomed to non-fulfillment. The situation with the previous European strategy of development in 2000-2010 is the confirmation of this.

In the development of national strategy intellectual potential of the country foremost must be involved, attracting scientific schools and specialists. An important role in the strategy development belongs to the political power of the establishment to create the necessary conditions for the strategy development and further consolidation of all the segments of population for its implementation.

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Importance of middle class for entrepreneurship development in Ukraine

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Keywords **– middle class, social group, entrepreneurship development, entrepreneur, SME.**

I INTRODUCTION

One of theoretical, methodological and applied problems of economic science is middle class features disclosure and explanation in the modern society. Research importance is conditioned by doing a considerable contribution to entrepreneurship development of this social group in the all developed countries.

II SPECIFIC FEATURES OF MIDDLE CLASS

Middle class in Ukraine, its members' activity and cultural displays will determine directions and successfulness of entrepreneurship development. Taking into account that middle class in Ukraine is still forming; especially current are research processes of its becoming, structuring and obtaining specific features in comparison with other population groups. The main goal of research is disclosure of importance of middle class for entrepreneurship development in Ukraine. The market mechanisms of economic development, found in the Ukrainian economy reformation, determine the necessity of middle class forming in society, as base of entrepreneurship. It provides innovations implementation, personnel competence level rising, and also maintenance of society stability. A term "middle class" is used widely enough, although its clear determination and proper theoretical ground does not exist until now. Such uncertainty of looks is conditioned by the different approaches to consideration of society social structure and economic development level in different countries (f.v.). Examining middle class from the economic point of view, it is important to find out the limit of economic material well-being (by property and income). According to this limit it is possible to rank to this class and analyze middle class influence on entrepreneurship development. Middle class is a totality of social groups that occupy in the society stratification system intermediate position between more lower class (poor) and higher class (rich). In the developed countries middle class forms the most numerous group [2]. Nowadays they are not the only criteria of middle class selection. In transitional societies it is difficult to define exactly the size of middle class, outline its personal features and tastes. Middle class forming in Ukraine, its increasing and strengthening simultaneously are the social, political and humanitarian order of society. In Russia middle class amounted to 10-12% population on the eve of economic crisis in 2008-2009. In 2008 it was 25% of Russians. These data were published, coming from an average monthly salary on a person 500-3000 dollars [3], however after the calculations of the World bank the average monthly income of a middle class representative begins with 3500 dollars. On Latvian measurements, people earning in a month from 3 to 12 living wages are rated to the middle class, i.e. 500-2000 lats or 900-3500 dollars [4]. In Ukraine people whose salary exceeds medium (i.e. 3000 grivnas or 375 dollars) belong to middle class. But at the same time the economic experts notarize: in Ukraine people must be ranked to the middle class according to their level of using consumer goods. These goods are more expensive than in Europe. Proceeding from this it is needed to apply the higher limit of the Ukrainian middle class average income – 3000 dollars per month [6].

III ENTREPRENEURSHIP DELELOPMENT

Representatives of middle class are the largest consumer group. That's why it is very important to stimulate its development. Middle class consists from 2 groups. First – entrepreneurs. Second – highly skilled specialists in different spheres. The main task of entrepreneur - to unite round itself experience and active staff, to direct their efforts for the achievement determined objects. Thus, entrepreneur is a subject that combines innovative, commercial and organizational capabilities for a search and development new kinds, methods of production, new goods and their new qualities, new application of capital. Development of SME gives an opportunity to promote material welfare of population due to the profit receipt and new workplaces creation, to facilitate employment. Also increasing the quality level and quantitative expression of basic socio-economic living standard indicators in order to form an influence on middle class. In recent years in society there is active and irreversible process of private property mechanism assertion, expansion of corporate and private sectors in economy. However SME, especially small innovative enterprises, promote middle class creation. All-round support of young specialists' initiative is the confessed way in the world practice. They are hard-working, good educated and skilled, are able to create powerful middle class in Ukraine. SME is a driving force of entrepreneurship development in the whole world.

IV CONCLUSION

The main tasks of Ukrainian government are creating favourable conditions for effective enterprises functioning by simplification such procedures: opening a new business, getting special permits, decreasing taxes-and-duties and also their quantity (f.v.). The more people have a good job with competitive salary or own business the more representatives of middle class are in the country. They spend a lot of money for consumption different goods and services, traveling, education. In such way middle class stimulate further entrepreneurship development.

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Risks assessment small and medium-sized enterprises in Latvia

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Keywords **– classification of risks, risks matrixes, questionnaire of small and medium-sized enterprises.**

I. INTRODUCTION

The goal of the research was to study the economic and financial risks impact on small and medium-sized enterprises' development in Latvia. It is important for small and medium-sized enterprises to create an efficient economic activity in both - economic growth and economic slowdown, as well as to maintain enterprises' financial stability. Small and medium-sized enterprises will perform activity optimization for decreased total costs.

The enterprises need to assess the risk dynamic of financial instability and this risk impact on small and medium-sized enterprises' development, because it is important for enterprises to extend commercial activity and to open a new structural subdivision.

II. CLASSIFICATION AND ASSESSMENT OF SERVICES SECTOR RISKS IN LATVIA

The authors have researched economic activity of services sector enterprises in Latvia. From 2005 to 2008 total turnover indices of Latvian services sector enterprises have increased. The highest value was found at the first quarter of 2008. From the second quarter of 2008 sector has started to decline, reaching lowest rates in 2009. From 2010 total turnover indices has begun to increase.

From year 2007 till year 2010 the authors studied medium financial indexes of trade services enterprises in Latvia and did the economic analysis [11]. The authors have assessed risks by using the special coefficient method. Indices of the special coefficient method are liquidity, profitability, solvency and circulation (table 1.).

TABLE I

ASSESSMENT OF LATVIAN TRADE SERVICES SECTOR RISKS DYNAMIC

[UNPUBLISHED DATA OF CENTRAL STATISTICAL BUREAU OF LATVIA 2012]

Title of indices Type of risk	D	2007	2008	2009	2010
Indices of liquidity					
The coefficient of total liquidity The risk of liquidity	$\frac{D_d}{D_{in}}$	1.18	1.14	1.06	1.12
Indices of circulation					
The coefficient of circulation of stocks The risk of circulation of stocks	$\frac{D_{in}}{D_{in}}$	8.22	6.80	6.11	8.43
The coefficient of circulation of total capital The risk of circulation of total capital	$\frac{D_d}{D_d}$	2.66	2.12	1.74	2.29
Period of debt collection (days) The risk of debtors	$\frac{D_{in}}{D_{in}}$	43	54	65	51

The symbols are adopted for the table 1:

D - The symbol of risk dynamic; D_{in} - level of risk increases; D_d - level of risk decreases.

III. RISKS MATRIXES – RISKS ASSESSMENT TOOLS

The authors have used their own created algorithm of identification, classification and assessment of enterprises' risks [5].

Important stages of risks assessment:

- Make the SWOT analysis of services sector;
- Get to know with the surveys of the major risks in the world;
- Classify and assess risks in order to create risks matrix;
- Assess risks by using the special coefficient method.

The risks matrix is a quantitative assessment of risks. The authors have arranged risks by their size of possible losses for enterprises. For each type of risk has been assessed its probability of realization. The size of the risk characteristics (losses) are divided into – low risk, medium risk, high risk, acceptable risk and critical risk. Scale of risk size is from 1 till 10. Most of the authors classified Latvian services sector's economic, financial risks size are from medium till acceptable. The probability of risks realization is from 0.2 till 0.6.

IV. QUESTIONNAIRE OF SMALL AND MEDIUM-SIZED ENTERPRISES

The authors familiarized themselves with Henschel T. research work. Henschel T. has studied small and medium-sized businesses' risk management framework, and risk identification and classification problems of enterprises in Germany [10]. The authors have carried out the questionnaire of representative small and medium-sized enterprises about the economic and financial risks impact on enterprises' development in Latvia.

The authors have created classification of Latvian services sector's economic and financial risks in the period from 2011 to 2012. Among those risks included in questionnaire, the economic risks are marked with letters from E1 till E7 and the financial risks are marked with letters from F1 till F14 (in total – twenty one).

The major target of research is to establish in activity of small and medium-sized enterprises:

- For how long period budget plan they have got ;
- Who from staff makes the budget plan and risks assessment;
- Assessment the economic and financial risks impact on services sector enterprises' development.

35 representative small and medium-sized enterprises completed this questionnaire.

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The methodology of statistical modelling using for decision making in road safety

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Keywords **– Road accidents, economic losses, statistical distribution, modelling, Monte-Carlo method.**

I. Introduction

The geographical location of Latvia is extremely favourable for the development of the transport business, since Latvia has ports capable of receiving and serving all classes of ships, as well as an extensive transportation network of railways and highways connecting the ports of Latvia with the CIS countries and the EU (see Fig.1). Roads are an important component of Latvian transport system with the total length of 20,310 km [3].

Fig. 1. The Scheme of Main Roads of Latvia.

After the global financial crisis, export of Latvian goods has resumed stable growth which is slightly faster than before the crisis thus allowing reaching the pre-crisis level of export of goods. Overall, in 2010 it increased by 30% in actual prices in comparison with 2009. Export and import of goods continued increasing rapidly also in 2011-2012 [4]. As result of growing export and import the freight traffic and goods turnover on Latvian roads in 2010-2012 has been increasing. In 2011, growth was observed in all key sectors of the economy. It was relatively high in transport and communications, construction sector, as well as in trade services. However, it should be taken into freight traffic by Latvian road (see Table 1).

TABLE 1

Freight Traffic by Latvian Road in 2010-2012

Freight traffic by road, total, thsd t					
Total by road vehicles registered in Latvia					
Years	1st quarter	2nd quarter	3rd quarter	4th quarter	Total
2010	8763,3	11645,7	13889,6	12510,1	48818,7
2011	10231,3	12756,1	16622,8	14326,1	55947,3
2012	10166,1	-	-	-	

Losses on roads have big social and economic value for each country.

The forecast for high-income countries, current and projected trends in low-income and middle-income countries foreshadow a big escalation in global road crash mortality between 2000 and 2020. In economic terms, the cost of road crash injuries is estimated at roughly 1% of gross national product (GNP) in low-income countries, 1.5% in middle-income countries and 2%-3% in high-income countries [5].

II. The Algorithm of Investigation of Road Accidents in Latvia

For investigation of road safety of Latvia is necessary to realize such modelling steps:

- recognizing and identifying of the problem;
- collection and analyzing of historical statistical information;
- statistical model construction;
- modelling using constructed model;
- validation and calibration of constructed model;
- finishing modeling and results comparing;
- decision making process.

For statistical modelling of annual road transport accidents, authors used mathematical model:

$$\sum_{i=1}^{R}\left[\sum_{j=1}^{M}\alpha\left(V_{ij}\right)^{\beta_1}\left(N_{ij}\right)^{\beta_2}+\sum_{j=1}^{M-1}\gamma_{ij}A_{c_{ij}}^{R}S_{ij}\right], \qquad (1)$$

where α, β_1, β_2 – coefficients for model of road accidents in Latvian cities (towns). γ_{ij} – coefficient describing factor risk for the the j^{th} section of the i^{th} route of traffic, i=1,2,…,R; j=1,2,…,M-1 (see Fig.2).

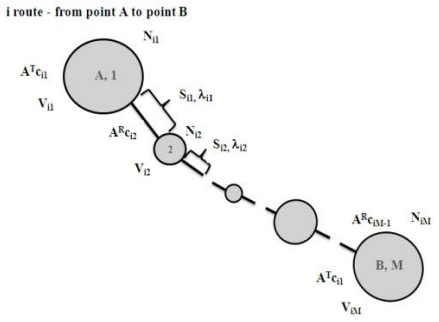

Fig. 2. The Scheme of the i^{th} Route of Road Traffic between Points of Populated Areas.

Using the statistical information and statistical modelling according to equation (1) paper authors have received statistical distribution of general economic losses of Latvia $\mathbf{C_{Total}}$ for two scenarios – rapid and slow development of Latvian GDP.

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Risk management improvement under Solvency II framework

Darja Kaļiņina (*Riga Technical University)*, Irina Voronova (*Riga Technical University*)

Keywords **– Risk function, Operational risk management, Solvency II directive, Basel II framework, Solvency.**

I. Introduction

Insurance in one of the most explosion areas in every country's economics that requires more sophisticated and sensitive risk analysis in order to ensure stability of an insurance company's development and activity.

Solvency II framework that establish new rules for insurance companies' solvency assessment across all European Union requires to evaluate current risk function with the purpose to improve it.

The goal of the research is to investigate the improvement possibilities of risk management under Solvency II regime.

The object of the paper is risk management. Therefore, the subject is the improvement of risk management, according to the Solvency II Directive requirements.

II. Solvency II framework

Solvency II framework is based on the three pillars where each pillar fulfills its own function: quantitative requirements, qualitative and supervision requirements, disclosure requirements that mean prudential reporting and public disclosure.

The main purpose of the new regime is to establish common risk management system and risk measurement principles for every insurance and reinsurance company in the European Union.

According to Solvency II directive requirements risk management function should cover at least following main areas: underwriting and reserving, investment, liquidity and concentration risk, asset and liability management, reinsurance, operational risk management.

Also the authors investigate and analyze the risk management function areas significance evaluation after Basel II framework implementation in banking sector. The point is that Solvency II requirements were based on Basel II framework rules, the main difference is the sectors' unique features. Also some risk measurement and management definitions are specified.

The authors will identify and analyze the general requirements of operational risk management under Solvency II framework.

III. Operational risk management

Operational risk is a change in value caused by the fact that actual losses, incurred for inadequate or failed internal process, people and systems, or from external events (including legal risk), differ from the expected losses.

The point is that operational risk management is the process of identification, analysis, assessment, organizing, planning, leading, controlling, elimination and evasion of operational risk events in order to minimize occurring probability and reduce possible losses or near miss.

According to the Fifth Quantitative impact study operational risk management can be performed by the standard formula, standard formula and partly internal, standard formula with undertaking-specific parameters, full internal model, and simplification 'method'.

Solvency Capital Requirement calculation approach according to standard formula is divided to the separate modules: operational risk, market risk, life underwriting risk, non-life underwriting risk, credit risk, market risk and health underwriting risk.

Solvency Capital Requirements according to the standard formula presented in Figure 1.

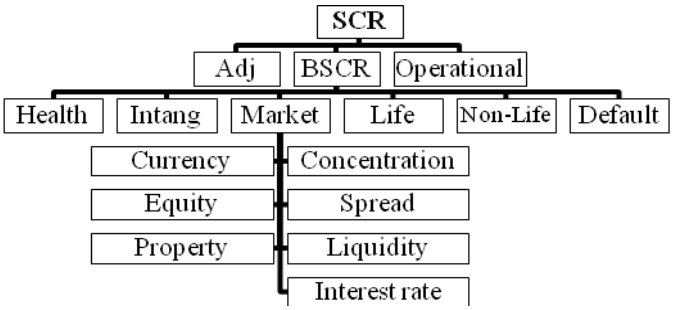

Fig.1. Solvency Capital Requirements standard formula

The authors concentrated on operational risk management standard formula and partly internal model general requirements.

In order to prepare the operational risk management standard formula and partly internal model it is needed to analyze following points: validation standards, documentation standards, statistical quality test, calibration standards, Profit and Loss attribution, and risk's map preparation.

The point is that the main purpose of operational risk management model preparation and implementation under Solvency II framework is to demonstrate, improve and implement operational decision making strategy in insurance processes.

IV. Conclusion

The authors' suggested approach of operational risk management improvement under Solvency II framework will enable every insurance company to manage, improve and control every insurance company's business processes within its development towards the sustainability, solvency, and development.

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Assurance of Business Viability through Equity Sufficiency

Nadezhda Koleda (*Riga Technical University*), Natalja Lace (*Riga Technical University*).

Keywords **– Business viability, equity sufficiency level, adjusted financial leverage effect, costs allocation by assets centers, fair value of assets profitability.**

I. Introduction

The viability of business is defined by its long-term survival – its ability to have sustainable profits over a period of time. The situation in the world economy stipulates the necessity for a strong management of business viability. Each year the problem of losses increasing, equity insufficient level and solvency of Latvian companies is getting more and more serious. The statistical data shows that the average rate of the equity to total assets during the past 10 years has been fallen by half and amounted to 28% in 2010. In average 2% of active enterprises are facing the problem of legal insolvency - the most vital business issues of 21st century. The sufficient level of equity is the most critical factor for company's viability and legal solvency. The authors of this paper suggest the approach to monitoring the equity sufficiency level by means of: 1) adjusted financial leverage effect; 2) fair value of assets profitability. The aim of the research presented in the paper is to develop the approach to management of the equity sufficiency level, which can be applied towards the solution of particular problems of business viability.

II. The Insight into Practical Issues of Equity Sufficiency Management

In the course of scrutinizing the scientific literature, authors have considered that equity management principles in most of the scientific resources are limited either to multi-criteria optimization of capital structure (Zopounidis 2010, Zubkov 2009), either to increasing of economic value added (Moriss 2001), either to various measures of leverage (Rajan 2005, Modigliani&Miller 1963). Suggested approaches are taking into consideration the risks, profitability, inflation, taxes and other factors which impact viability, but it was not found any literature where equity sufficiency is mentioned.

III. Methodological Approach to Assurance of Business Viability through the Equity Sufficiency

In the paper authors suggest theoretical methodology for assurance of business viability through the equity sufficiency level (Lace&Sundukova, 2008) based on of financial leverage effect. The authors consider that the applying of standart financial leverage effect for equity and capital structure optimisation is very limited due to: 1) the impact of intangible assets on income and profitability of company is not taken into consideration; 2) debt rate is average percentage rate which is not distributed according to short term and long term liabilities; 3) applying of financial leverage effect doesn't assume the evaluation of equity sufficiency level.

The authors suggest the algorithm to improving the business viability through the equity sufficiency by means of adjusted financial leverage effect (Fig.1):

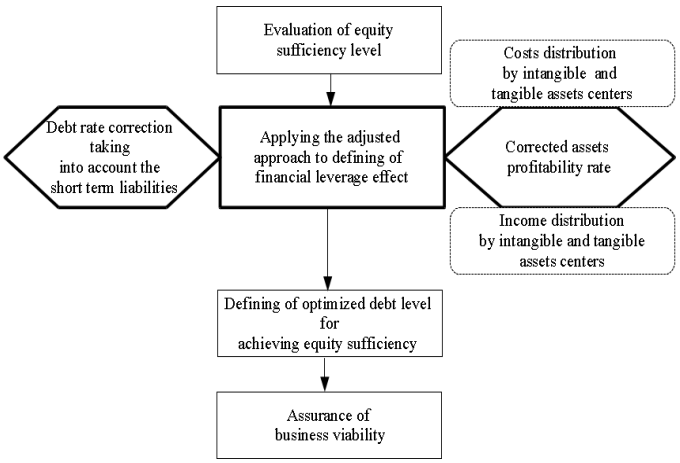

Fig. 1. Algorithm of assurance of business viability through the equity sufficiency.

The suggested calculation approach to the adjusted financial leverage effect is presented below (3):

$$DFL_a = (1-TR)*(\frac{PBT-(I_{int}-C_{int})}{A}*100-\frac{IP}{L_{st}}*100)*\frac{D}{E}. \quad (3)$$

where
DFL_a –degree of adjusted financial leverage, %;
TR - income tax rate, relative value;
PBT – profit before taxes, Ls;
I_{int}- income from using the intangible assets, Ls;
C_{int} – costs for using the intangible assets, Ls;
IP- interests payments, Ls;
L_{st}- short term liabilities, Ls;
A – assets, Ls;
D – debts, Ls;
E-equity, Ls.

The applicability of adjusted approach to defining the financial leverage effect is proved by results of analysis of statistical data on Latvian companies. Results presents very strong correlation (R=0.86) between adjusted financial leverage effect and equity profitability.

Suggested approach allows defining such debts level, which can provide the equity sufficiency. It can be considered as an effective tool for controlling and achieving company's equity sufficient level, for increasing equity profitability, choosing the best possible alternatives of capital structure in line with business viability.

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Financial assistance instruments to Latvia in the secondary materials management sector

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Karlis Kruzs (*University of Latvia*)

Keywords **– sustainable development, secondary materials, waste collection, recycling, financial assistance instruments.**

I. Introduction

The research paper is devoted to the issue – financial assistance instruments to Latvia in the secondary materials (waste) management sector.

Development of the secondary materials market and improvement of the waste management is one of the priorities of the European Union. According to the Roadmap to a Resource Efficient Europe presented by the European Commission, in 2013/2014 the European Commission will stimulate the secondary materials market and demand for recycled materials through economic incentives and developing end-of-waste criteria within the European Union. In order to reduce total and landfilled packaging amount and increase of the reuse and recycling of packaging waste the European Parliament and Council Directive 94/62/EC on Packaging and Packaging waste regulates the recycling and recovery rate of total produced packaging amount: at least 60 % by weight of packaging waste must be recovered or incinerated at waste incineration plants with energy recovery and between 55% and 80 % by weight of packaging waste must be recycled. Additionally following targets for materials contained in packaging waste must be attained: 60 % for glass, paper and cardboard packaging; 50% for metal packaging; 22.5 % for plastic and 15 % for wood packaging must be recycled.

In last ten years a great work is done to develop the secondary materials management in Latvia. Nevertheless several improvements are necessary: implementation of the packaging deposit system and development of the separate waste collection. Although in Latvia the waste recycling capacity has increased recently, it is still insufficient and should be increased. Therefore there are many business possibilities for the recycling enterprises.

However the fulfillment of the EU requirements in the secondary materials management sector requires considerable financial resources of the municipalities and companies. Therefore the co-financing of the financial assistance instruments is necessary.

II. Purpose, research methods and conclusion

A. Purpose

The purpose of this paper is to research and analyse the financial assistance instruments, e.g. European Union Structural funds and Cohesion fund, Climate Change financial instrument, European Economic Area and Norwegian financial instrument etc. to Latvia in the waste separate collection and recycling sector, as a result to point out the main positive aspects and problems of the co-financing possibilities in the waste management sector as well to provide the recommendations for further improvement of the programs supported by the financial assistants instruments in the waste management sector.

B. Research methods

The main research methods include the study and analysis of legislative acts and programming documents, e.g. operational programs of the EU funds, literature and internet resources as well as data analysis on programs implementation and financial absorption in the waste management sector.

C. Conclusion

The authors conclude that there is no united support program especially for the secondary resources recycling. The entrepreneurs can apply for the co-financing of the different financial assistance instruments which are not directly related to the recycling. The research authors consider that such united supporting program will contribute to the developing of the secondary materials recycling sector.

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The integrated model of migration theories

Vilmante Kumpikaite (*Kaunas University of Technology*), Ineta Zickute(*Kaunas University of Technology*)

***Keywords* – migration, theories of migration, classification of migration theories, Push and pull model.**

I. INTRODUCTION

Migration processes were analysed recently by Cekanavicius and Kasnauskiene (2009), Kumpikaite (2009), Kaminska and Kahancova (2011) and others. However, it is very important and actual during rapid globalization influence on labour market, economics and organization. Such globalization impact was analysed by Kryk (2009), Tvaronaviciene and Kalasinskaite (2010), Ciarniene and Kumpikaite (2008) and others.

A lot of analysis is done for defining the causes of migration. Migration processes were analyzed by de Haas (2007, 2010), Borjas (1994. 2008), Doeringer and Piore (1971), Harris and Todaro (1970), Hartog (2000), Haug (2008), Jennissen (2004), Lee (1966), Mabogunje (1970), Ohlin (1933), Ravenstein (1889), Roy (1951), Runciman (1966), Sipaviciene (2006), Sjaastad (1962), Smith (1776), Wang (2010), Ciarniene and Kumpikaite (2011) and others.

Analysis of scientific literature shows that there are a lot of migration theories created up to this day. Unfortunately, it is not enough to analyze different theories separately. Despite a huge interest, discussions and analysis of the migration process, there are a problem of integrated and complex migration model lack. Such integrated model, which includes various migration theories, could to reveal overall view of migration process. It is understandable that it would be difficult to propose overall single migration theory of migration causes. However, the purpose of this article is not to propose such single theory. The aim of the article is to combine migration theories in to one integrated model, which could to reveal reasons for migration wider and deeper.

Methods used in this paper are scientific literature analysis and graphical representation of data.

II. MIGRATION THEORIES

A lot of migration theories have been created up to this day. This article includes theories which are mostly found in the scientific literature. These summarized theories are given in Table 1.

Many studies are done to determine the causes of migration. Quite popular and prevalent was the Push and pull theory, developed by various researches: Ravenstein (1889), Lee (1966), Altbach (1998), Mazzarol and Soutar (2002) and many others (cited by Wang, 2010). These theories were supplemented with new push or/and pull elements.

III. INTEGRATED MODEL OF MIGRATION THEORIES

It is understandable that it would be difficult to propose overall migration theory of causes, which could fit in all cases. Furthermore, such theory would be useless because, as de Haas (2010) said, we need to stay at very universal statement "most people migrate to improve their wellbeing". However, the purpose of this article was not to propose such single theory. Various consistent patterns and correlations can be seen in the migration's movements. After classifying and summarizing these aspects, it is possible to understand causes of migration "deeper". All analyzed theories according to their features, similarities and period were grouped in to 4 groups of theories with interrelationships. Also, all this information is summarized in to one integrated Push and pull model and given in Figure 1.

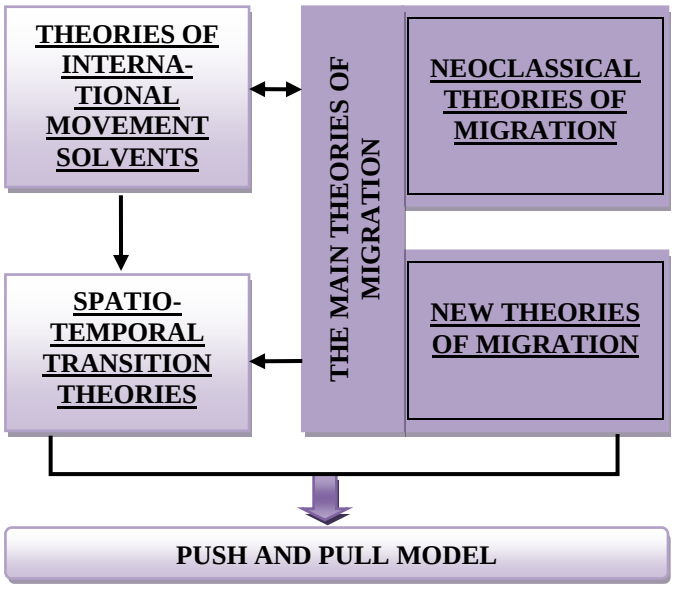

Fig. 1. The integrated model of migration theories

IV. CONCLUSION

In order to propose the integrated model of migration theories, it was necessary to characterize various migration theories. Thus, Economic equilibrium, Heckscher-Ohlin, Todaro and Harris-Todaro, Human capital, Dual labor market, Self-selection, Early decision-making, Family migration, Relative deprivation, Motivation decisions, Rational expectation, Consumption, Network, Cumulative causation, Migration systems, Zelinsky, Skeldon, Migration hump and Push and pull theories were analyzed.

All above mentioned migration theories were classified in to Neoclassical and New theories of migration, Theories of international movement solvents and Spatio-temporal transition theories groups. Theories groups were associated with interrelationships and summarized in to one integrated Push and pull model.

Thus, it can be said that most migration theories can be combined together. Push and pull model of discussed migration theories could be one of suggestion how to integrate theories in to one model. This integrated model of theories could to reveal reasons for migration wider and deeper. Proposed model can be used as integrated and complex model seeking to understand migration theories and the main migration reasons based push and pull motives deeper.

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Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
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The Role of Social Networks for Business Development

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Keywords **– social capital, social networks, entrepreneurship, opportunity recognition.**

I. INTRODUCTION

The development of information technologies gave the public wide opportunities in many areas of activity. The rapid development of the Internet technologies helped people not only to form intercommunication, but as well to organize electronic communities. Social networking is one of elements of the electronic community. Participation in social networking is not only a modern trend, but also a form of business. The new Information and Communication Technologies gave rise to radical modifications in the relationship of the customer and manufacturer in many sectors of economics. Publications in the business press speak of the fact that new technologies, such as the Internet, are becoming more and more important for entrepreneurs because they use them to gain access to markets, information, technologies and other resources. Participants in virtual communities (social networks) may be involved not only in the generation of ideas for new products, but also in the testing and distributing of the product to the end user. Through social networks a new company can establish cooperation links in certain industries more quickly. Networks and contacts provide the entrepreneur's reputation. These and other issues related to the capacity of information technologies and their impact on enterprise development are the scope of this research.

The relevance of the topic of this research is explained by the capacity of information technologies to intensify entrepreneurial activities that have a positive effect on the improvement of the economic situation in the country. There is a tendency that the development of new and existing companies which are being formed today is largely related to the ability of the enterprise to use the opportunities offered by the e-environment.

The *object* of study is social networks. The *subject* is the influence of social networks on the development of entrepreneurial activities.

The *purpose of this research* is to study the facts and previous studies of the influence of social networks on the development of entrepreneurial activities, to elaborate a model of this impact and assess potential for identifying business opportunities of participants of social networks that are popular in Latvia.

The theoretical and methodological basis of the research is formed using the main ideas of theories on social capital and social networking, on business development and on the role of social networking in the development of business; the theories have been worked out by R. Amit, J.S. Coleman, A. Damodaran, M. Granovetter, R. Putnam, J.W. Rivkin, L.A. Rezulli, O. Sorenson, T. Stuart, J.A. Schumpeter, H. Westlund.

The authors used specialized publications as well as the authors' knowledge and experience. Quantitative and qualitative methods - monographic or descriptive methods, analysis and synthesis and survey were used for achieving the goal set.

II. MAIN RESULTS

1. A conceptual model of the participation of social networks in business development has been elaborated. The model combines three basic ideas of the impact of social networks on entrepreneurship and business development: 1) a social network is designed as a business and is characterized by a definite business model, 2) social networks provide all the necessary information and conditions for the creation of new businesses, 3) working companies promote their new products, services and technologies in the market through social networks.

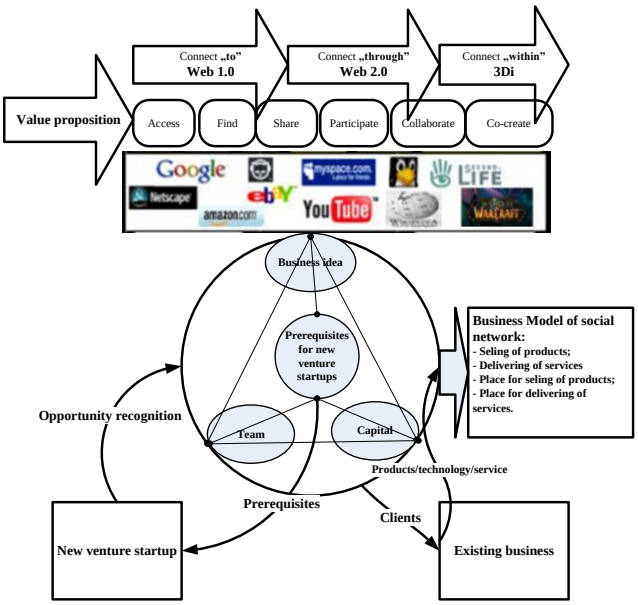

Fig.1. A conceptual model of the participation of social networks in business development

2. A model for identifying new business opportunities with the help of social networks has been elaborated. Based on the model, the authors have developed a questionnaire for the survey of social networking participants with the aim to evaluate their potential for business opportunity identification.

III. CONCLUSIONS

- The participation of entrepreneurs in social networks increases the competitive advantage of existing firms.
- Social networks provide informative support for mobilizing resources needed for the creation of new businesses.
- Members of social networks that are popular in Latvia, demonstrate definite potential for identifying business opportunities.

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Company's Financial Strategy Development

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Keywords **– Business'strategy, Financial strategy, Financial position, Company's market value, Income method**

I. Introduction

Business strategy is a complex management plan, which has to secure company's market position, provide coordination of all the efforts, consumer attraction and meeting customer needs, as well as provide successful competition and achieving the global targets. The main component of financial management is financial strategy, which includes establishment of sustainable system of financial activity's targets and indicators, as well as determining priority tasks for present perspective.

Correctly selected financial strategy increases the business value for the owners, namely the optimal ratio of the equity and the borrowed capital allows minimizing cost of capital, while at the same time it enables the company to secure itself with financial resources.

The objective of paper is to examine conceptual basics of the company's financial strategy as a process of company management aimed to improving company's financial position and increasing the company's market value.

Generally accepted quantitative and qualitative methods of research in management science were used, including induction and deduction, analysis and synthesis, logically constructive and statistical methods, economic mathematical simulation, description and display methods of numeral information.

II. Financial strategy and company's market value

Business 'strategy is the selection of company's development directions, markets and methods of competition, as well as the management of the business. Strategy development includes accurate research of all the possible directions of development and activity, selection of the general direction and markets to be acquired, meeting the needs, defining methods of competition, resources to be attracted and business patterns [1].

Establishing strategically important decisions is foremost related to attracting the financial resources or the quality of the business financial management.

The financial strategy has to comply with the business risk and the needs of funding the business plan, while taking into consideration the business targets, financial necessities, factors of implementing the dividend policy and, of course, the market conditions.

Main goals must be gained as the business financial strategy is implemented:

1. Securing the business with the necessary finances or business stability and liquidity.
2. Securing profitability and acquisition of a normal profit.
3. Meeting the material and social needs of enterprise's employees and owners.
4. Maximizing the business market value.

During development of the financial strategy, the interests of both owners and other interested parties have to be always considered:

1. if the overall target of the company corresponds with the targets of management strategy, financial strategy and the financial management, the value of the enterprise increases,
2. internal financial relations in the enterprise depend on external conditions in many ways. The higher is the management level, the stronger is the dependence and the necessity to register the external factors [2],
3. financial management as such and financial strategy as a tool of financial management encourages the implementation of interests of the owners, personnel and society,
4. external environment's conditions determining the complexity of the company's actions in the market and the uncertainty of the results [3], determine new approaches for financial management, like developing new strategic layouts.

III. Increasing the company's value as an objective of financial strategy

As an empirical example the description of the joint stock company X (one of the leading Latvian pharmaceutical company) and its specificity is given. Company's X financial ratios are described and performance analyzed, as well as the company's market value is calculated using income method and its comparison is given. Value concept is characterized by not only the company's operational efficiency, stable financial position and risk factors, but also the company's development potential and future prospects.

Using joint stock company X as an example, the authors conclude that the company's market value can be increased using the correct financial strategy.

IV. Conclusions

1. Financial strategy is the main component of the company's financial management, including establishment of financial target and indicator system for a long term as well as defining priority tasks for nearest perspective.
2. The main risk factors of decisions made by management during development of financial strategy are following:
   - incorrect choice or non-adequate definition of the strategy's target;
   - incorrect evaluation of company's strategic potential;
   - incorrect forecast of external and internal environment's development in a long run.
3. Authors recommend the company X:
   - to develop and implement the company's value based programme,
   - to reduce investment in working capital, to reduce costs of capital,
   - to expand product range, developing and patenting new drugs,
   - to carry out targeted marketing and sales activities in existing markets, as well as expand market,
   - to invest funds to upgrade production facilities, using the Latvian Investment and Development Agency and European Regional Development Fund co-financing.

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Actual problems of SME development in Ukraine

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Keywords – small business, middle business, government regulation, corruption, shadow economy.

I. Introduction

The process of small and middle business (SME) forming in Ukraine is characterized by contradictory tendencies. Positive progress (employment, income) trends are connected with socio-economic politics which is not directed on their forming and maintenance in Ukraine.

Unlike large business that became priority in Ukraine, concentrated to the mass consumer with the standard production approaches, SME concentrated on the production of unique products and services and such that are unprofitable to large business.

At terms, when large business becomes more advantageous for state, SME becomes more attackable without state support.

Therefore a select theme is actual and needs a deep research.

II. General provisions

To small and middle businesses in Ukraine it is possible to rate over 90% enterprises and companies. However their real payment in GDP is only close 14%. In Europe this indicator is considerably higher. In Denmark it is 80% of national product, in Italy - 60%, and middle payment of such enterprises in the economy of West Europe - 63-67%. In spite of income increasing of Ukrainian small business, beginning from 2000, its share in GDP has not grown [1]. It is possible to assert that enterprises of this sphere have not yet taken the proper place in the structure of Ukrainian national economy. Without an institutional structure creation of national economy, that provides the substantial increase of SME role, it is impossible to realize the capabilities of private economic subjects to develop and carry out their own effective economic strategies.

What does generate such situation? To our opinion, it is system contradictions that deform an institutional environment in relation to development SME.

Motive forces of such contradictions are:

1. Organizational weakness of small and middle businesses;
2. High level of shadow economy in country;
3. Non-economic levers of SME development (corruption);
4. Low quality of SME management;
5. Structural deformation of small and middle businesses.
6. Low products competitiveness in the production of which economy on scales is important, thus – competition from large companies.

Specific institutional factors gain importance, in particular - public opinion in relation to entrepreneurship and attitude toward businessmen from the publicly-mass consciousness point of view, state attitude toward this sector of economy.

On such conditions SME development will lead to the risks increasing, what can show up as in the unproductive use of financial resources, reduction to the competitiveness of entrepreneurial activity, in limit nature of tax stimulation of business, so in a threat to the anthropogenic and ecological safety, related to the productive processes, storage and use of mine-out products; structural deformation of skilled potential, distraction of skilled and capable labour force, failure to comply with requirements of job safety which leads to human potential loss.

Existence of these risks certifies complication and complexity of regulation SME development.

Firstly it is needed to work out the clear and transparent mechanism of government and business cooperation. In this direction Ukraine does the first steps only. This mechanism must be considered through cooperation between state, organs of local self-government, businessmen, science and civil society as partner relations.

In the conditions of financial crisis development of these relations has become yet more actual, because neither the state would be able to execute the functions without potential and possibilities of private business nor private business would not be able to develop, implementing new technologies and innovative approaches without state support.

Recently the Law “About development and state support of small and middle enterprise in Ukraine” has been passed. Among basic directions of public policy in the field of SME development are provided small business entities involving in implementation of research engineering, socio-economic programs, realization of products (works, services) supply for state and regional necessities. State sponsorship ensuring of SME is provided by adoption government programs of crediting, grant of guarantees for the receipt of credits, partial indemnification of interest rates on credits and others like that (16 provision in the law [3]. In Ukraine the National program of assistance to development of small enterprise on 2012 has been ratified. It testifies to the positive changes in the mechanism of cooperation between the state and private sector.

III. Summary and propositions

With the aim of adjusting and development the civilized dialogue between the state and SME in Ukraine it is necessary:

- to form a corresponding institutional environment by force of: normatively-legal and methodical providing of its development taking into account the world practice;
- to adapt already the well-known in the world practice models of mutual relations of the state and SME to Ukrainian realities;
- to decrease regulator barriers to SME;
- to provide transparency in administration of taxes and cost related to the observance of tax legislation;
- improvement of adjusting and supervision in a financial sector, improvement of access to financing;
- to combine the state and business efforts for economy transparency, for overcoming of corruption.

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The Audit of Going Concern Assumption and Risk Assessment

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Keywords – **International Audit Standards, audit of financial statements, going concern assumption, models of bankruptcy prediction.**

I. Introduction

According to International Standards of Auditing (ISAs) with assumption about going concern it is considered that an enterprise continues its activities in the foreseeable future [1]. According to International Accounting Standards (IAS) 1 definite requirements management's assignment is to evaluate enterprise ability to continue its activities. In its turn, auditors, following ISA 315 definite risk evaluation procedures assess whether there exit any circumstances or events which can create serious doubts about enterprise ability to continue its activities.

The aim of the study was to research which additional instruments auditors may use in evaluating the ability of an enterprise to continue its activities within the going concern assumption. The study object is going concern audit. The study subject refers to the methodological aspects of the evaluation of going concern. To achieve the set aim the authors exploit the following research methods: comparative analysis, synthesis and ratio-making method. In addition, data multi-factor analysis was conducted. Calculations and data processing have been done by using MS Excel.

The authors analyse the features which cause doubts about the ability of an audited enterprise to further operate. The authors also research the relationship between bankruptcy prediction models and going concern evaluation. Two models which conform to conditional probability group and precision assessment have been built up.

II. Monitoring and evaluation of going concern assumption

European Commission's Green paper on Audit policy: Lessons from the Crisis [2] points out that so far audits have been based on historical information. It is shown how important it is for auditors to consider and evaluate the volume of information presented by an enterprise about the future and taking into account this preferential information volume which auditors themselves should provide make economic and financial prediction. The latter is especially valuable to be applied within the going concern assumption. Many enterprises also do not prepare financial statements indicators analysis but if it does happen the main calculated indicators are liquidity and profitability.

As for future-oriented analysis, at least for large enterprises listed on stock exchange so far it has been done by share analysts and credit rating agencies but the auditor's potential in this field has not been engaged sufficiently. Let us emphasize that the aim of auditing procedures is to:

- gain sufficient and relevant audit evidence which prove the going concern assumption as a result of prepared financial statements,
- relying on the gained audit evidence to make conclusions about the existence of substantial uncertainties connected with such events and circumstance which can cause significant doubts about the ability of an enterprise to continue its activities,
- determine how this situation can affect the auditor's report.

The authors of the going concern assumption suggest using 3 level algorithms. At the first level relying on enterprise management and leading specialists' opinion about the ability of an enterprise to continue its activities are assessed factors and information which can cause serious doubts about this ability. At the second level by exploiting analytical procedures including bankruptcy prediction models are assessed hidden features of financial and economic situation in an enterprise and its impact on the ability of enterprise to be going concern. At the third level by using analytic hierarchy process (AHP) is conducted total evaluation of following continuity principle and was prepared the judgement about the realization of the going concern assumption. The determination of bankruptcy probability is of utmost importance in the overall assessment of gong concern.

III. The Link between Bankruptcy Prediction Models and the Going Concern Evaluation

Carrying out the obligatory audit of financial statements it is reasonable to produce diagnostics of bankruptcy probability. Accordingly Green Paper's set goal has been achieved – future-oriented analysis has been done, concerned persons have been provided with added value as well as the possibility for an enterprise to continue its activities have been assessed.

Foreign scientists worked out bankruptcy prediction models on the basis of financial statements information, being prepared in compliance with their national accounting normative acts and accounting standards. Therefore it is necessary to critically evaluate the direct application of these prediction methods in the analysis of the financial statements of Latvian enterprises. The authors carry out the evaluation of the application of two research models in Latvian enterprises [3]. Levels of precision have been calculated for each model.

IV.CONCLUSION

The going concern assumption plays an important role in the creation of truthful and comprehensible idea in forming the financial stability of an enterprise and future development prospects.

The diagnostic techniques offered by the authors make it possible for auditors to carry out audit procedures designed to gain sufficient and appropriate evidence in order to work out grounded conclusions on the basis of which the auditors" make their opinion.

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How to manage customers

Rositsa Nakova

Abstract: The main goal of the article is to give new metoth.

Keywords – Choose up to four key words or phrases and locate them in alphabetical order just after the abstract of your paper, separated by commas. The scientists from the fields of electrical engineering, communication technologies, computer sciences and other similar fields can use a list of suggested keywords from http://www.ieee.org/organizations/pubs/ani_prod/keywrd98.txt

I. Introduction

This document provides instructions for preparing manuscripts for publishing in *The Scientific Journal of Riga Technical University*. The document is also a sample of layout for the manuscripts submitted for publication.

Full text of all articles published in The Scientific Journal of Riga Technical University is included in EBSCO information products. Articles from selected series of the journal and abstracts of all articles published in The Scientific Journal of Riga Technical University are also included in ProQuest and in VINITI information products.

Manuscripts should be in their final form when they are submitted so that proofs will require only correction of typographical errors. It is very important that the authors observe precision and correctness of language. The authors bear responsibility for all language mistakes.

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The Editorial Board decides if the manuscripts for the particular volume of RTU Scientific Journal should be only in English or may be in other languages.

II. Extended Summary

The Editorial Board may ask the authors to prepare an extended summary of the publication. The extended summary should be prepared in English as a separate file and sent to the Editorial Board (versions in Latvian and Russian are also welcome). The size of English version should be about 1800 characters (no spaces). The summary should not be a repetition of the abstract from the beginning of the paper.

III. Manuscript Reviewing

The submitted articles are peer-reviewed. The Editorial Board of each series of *The Scientific Journal of Riga Technical University* asks two experts of the respective field to review manuscripts. The Editorial Board to the request of the author provides anonymous copies of the reviews. If the author is asked by the Editorial Board to revise the manuscript it is reviewed anew.

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Significance of the promotion of innovation economics

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***Keywords* – innovation economics, labor productivity, human capital, creativity.**

At the beginning of 2007 the National Governors Association (NGA) of the USA revealed a new strategic initiative - Innovation America. That was the first significant sign that the world is entering a new period of competitiveness growth.

Innovation economics is an economic doctrine that reformulates the traditional model of economic growth so that knowledge, technology, entrepreneurship, and innovation are positioned at the center of the model rather than seen as independent forces that are largely unaffected by policy. Central goal of economic policy should be to spur higher productivity and greater innovation.

The crisis has created a great reset: it is possible to transform our economy and society and create entirely new economic growth and prosperity era. Nowadays the main force for the ensuring the competitiveness is the human capital, intellect, its development and return on it.

Latvia development is very much dependent on what happens in the external environment. The economy of Latvia is small and open, with one of the lowest labor productivity (productivity index per hour worked – 46.7 in 2010, assuming that the EU = 100) and innovativeness indicators in the European Union. In Latvia the process of more rapid growth of the labor productivity is threatened by the low level of creativity. In 2011 Latvia with the Global Creativity Index of 0.520 was ranked 34th in the world (Sweden was ranked in top with 0.923). In the internal environment increasingly important problems are caused by population structure, as the number of people over the working age and dependency ratio (average number of population under and over working age per 1000 of working age population) rises. According to the Central Statistical Bureau of Latvia in 2011 the number of retirement age population per 1000 of working age population was 1.5 times higher than the number of children and adolescents.

Global development of innovation economics will significantly accelerate the rate of labor productivity growth and the inequality of competitiveness. In the near and especially in far perspective the development of innovation economics is a powerful threat to the growth of welfare of the population of Latvia: going forward, but slowly, Latvia will more and more fall behind. To prevent this, it is necessary to look for the means to activate the process of innovation economics also providing high added value per employee.

As the growth of the economy and at the same time the growth in the living standards of population basically depends on the entrepreneurs' performance results and the competitiveness of their products in the international market, new business motivation methods are required.

This will involve:

- considering the importance of labor productivity, its increase, thus the processes of value added creation, should be determined of the national priority.
- the introduction of dynamic recording of new jobs at the national, regional and branch level, including jobs where the products with high added value are manufactured, and publication of the results at least once every half-year;
- the introduction of a subsidy system for new jobs where the products with high added value are manufactured in order to promote entrepreneurs;
- the prevision of activities in the strategic development program for the business structure changes and wiser attraction of large investors;
- the development of the movement of inventors and rationalizers in Latvia;
- human capital should be focused on high technology fields;
- investments in human capital are needed, inter alia increasing in the country and companies the number of persons with doctor's degree;
- wisdom management process would require its own standards to be bent on. The achievements of Nordic countries could be one of them: the number of patent applications in high technologies per million inhabitants. So for Latvia for short-term landmark the indicator of Norway could be chosen (4.1), for the medium term - the indicator of Iceland (7.7), but for long-term - Finland's indicator (37.5);
- for the promotion of creativity development the ideology of positivism has to be cultivated in the country and the companies;
- comparative information actions have to be taken to reduce skepticism and nihilism prevailing in the society, as nowadays the objective positivism, the faith is a value that creates value.

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Research of the effect of the Arbitration Court of the health system and health insurance of St. Petersburg for the organization of medical care in the city

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Keywords **- health care, the Court of Arbitration, the patient, medical organization, medical insurance organization.**

I. INTRODUCTION

The court of arbitration, being an instrument of self-regulation of the business community in the sphere of health, affects the socio-economic and legal life of the city.

Its main task is to resolve arising from civil- legal relations of economic disputes or disputes, which may arise in the future between the subjects and participants of the health insurance system and health care system of the city. [1]

So far, all researches are mainly dedicated to the formation of the arbitration proceedings, as well as issues in the area of science of the arbitration procedural law. For the assessment of the socioeconomic impact of the activities of the arbitration courts is impossible to do without sociological research. Meanwhile, this scientific direction in the field of research of the arbitration proceedings not developed. In Russia there is no representation even the approximate numbers of courts of arbitration, and on the "area" of their distribution by region of the state. Existing sociological research of distribution and operation of the arbitration courts held only in separate regions and in some spheres of the economy. [2]

The aim of the research is to reveal the basic factors which determine the effectiveness of the work of the Arbitration court at the organization of health care in St. Petersburg.

The object of research is the results of the work of the Arbitration court of health insurance and health care.

To achieve the objective were used the following methods: questionnaires, quantitative and qualitative methods, including the method of sociological research and descriptive method.

III. METHODOLOGY

The subjects of civil-legal relations in the sphere of health care and health insurance are the insurance medical organizations, medical organizations, and patients.

By analyzing scientific literature and the results of research, the authors have identified indicators characterizing socio-economic importance of the Court of Arbitration for health of Saint-Petersburg:

- the number of appeals to the Court of Arbitration;
- the reasons of appeals to the Court of Arbitration;
- satisfaction with the decisions of the Court of Arbitration;
- the number of amendments proposed by the Court of Arbitration in the current legislation in the sphere of health care and medical insurance;
- awareness on the activities of the Court of Arbitration in the sphere of health care.

Assessment of the socio-economic significance of the court of Arbitration in the health sector was conducted by the authors on indicators for each subject of civil-legal relations in the sphere of health care and health insurance.

The results of the study showed that in the Arbitration court of appeal mainly medical insurance organizations and medical institutions. Treatments of patients are of unique character.

The main essence of disputes (claims) is illegal collection of funds and recovery of moral damage caused by the poor-quality medical assistance, violation of the rights of the patient. [3]

Studies have shown that it is in the practice of law enforcement brilliantly revealed the contradictions and shortcomings, which exist in the current legislation, including in the health sector. However, today the St. Petersburg Arbitration court of health insurance and health care do not exhibit the legislative initiatives to improve the delivery of health care in St. Petersburg.

V CONCLUSIONS

Thus, we can highlight the following directions of activity of the Arbitration court of health insurance and health care to improve its socioeconomic importance to the organization of health care in St. Petersburg:

- it is necessary to develop system of measures for informing patients, medical insurance institutions and health care organizations of work of the Arbitration court of health insurance and health care in St. Petersburg;
- the experience gained by the Arbitration court by the health insurance and health care, should be the basis for new legislative initiatives to eliminate gaps in the legal regulation of activities of the subjects of civil legal relations in the sphere of health care and medical insurance;
- conducting sociological research on the activities of the Arbitration court of health insurance and health care should have a regular character.

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Differential equations with delay in dynamical model of a financial system

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***Keywords* – financial model, differential equations with delay, interest rate, investment demand, price index.**

I. Introduction

For several decades research into differential equation has been helping us to understand and deal with practical problems in a range of scientific fields. The past decades have seen increasingly often complex practical problems which cannot be adequately described by ordinary differential equations. They are primarily models whose solution leads to so-called differential equations with delay or, in general, differential equations with deviating argument. The aim of this article is to present a model of a financial system which analyses the impact of a change in input parameters on the development of interest rate, the investment demand and the price index curve by the use of analytic and synthetic methods, dynamical modelling and solving the system of delay differential equations. .

II. Dynamical model of financial system

A. Dynamical model

In article [3] the authors present a dynamic model of finance, composed of three first-order differential equations. They authors have come up with a financial model which describes the time variation of three static variables: the interest rate *x*, the investment demand *y*, and the price index *z*. The model is represented by three-dimensional ordinary differential equations:

$$\begin{aligned} x'(t) &= z(t) + (y(t) - a)x(t) \\ y'(t) &= 1 - by(t) - x^2(t) \\ z'(t) &= -x(t) - cz(t) \end{aligned} \quad . \quad (1)$$

where *a* is the saving amount, *b* is the cost per investment, and *c* is the elasticity of demand of commercial markets. It is obvious that all three constants (a, b, and c), in model (1) are non-negative.

B. Dynamical model with delay

By adding time-delayed feedbacks to system (1) we can obtain the following new system. (2)

$$\begin{aligned} x'(t) &= z(t) + (y(t) - a)x(t) + \\ &+ k_1 [z(t) + (y(t) - a)x(t) - \\ &(z(t - \Delta_3) + (y(t - \Delta_2) - a)x(t - \Delta_1))] \\ y'(t) &= 1 - by(t) - x^2(t) + \\ &+ k_2 [1 - by(t) - x^2(t) - (1 - by(t - \Delta_2) - x^2(t - \Delta_1))] \\ z'(t) &= -x(t) - cz(t) + \\ &+ k_3 [-x(t) - cz(t) - (-x(t - \Delta_1) - cz(t - \Delta_3))] \end{aligned} \quad . \quad (2)$$

The modified system is described by DDEs where k_i (i = 1; 2; 3) is the feedback strengths and Δ_i (i = 1; 2; 3) is the delay times. For the $k_i = 0$ or $\Delta_i = 0$ system (2) is equivalent to the system (1).

C. Solution of a dynamical model with delay

Publication of so-called Tbilisi School of Functional Differential Equations [1] contains a general theory allowing solutions to not only the above mentioned questions but also many others; the application of the theory to the above mentioned types of differential equations with delay argument, including the description of the construction of a required solution is dealt with in [2]and all the sources quoted in it.

Unlike traditional models, the new model, which allows for values of specific variables in previous periods, i.e. so-called model with delayed arguments, expresses the dynamics of the model of a financial system more precisely. This has allowed us to study the impact of the length of the delay in particular variables (three parameters, marked delta) and the degree of the adequate strength of the feedback (parameters k). The methods used to solve the dynamical system have also enabled us to change the six mentioned parameters and to study the impact of the changes on the solution of a dynamical system.

III. Conclusion

When modelling complex economic issues we often have to face the fact trade-offs between variables are chase in time. The dynamic character can be captured by including delay exogenous and endogenous variables in specifying the structure of a model.

Another way to include dynamic processes in models is to see time as a continuous variable and to describe dynamic models by means of differential equations.

The new model of financial system allows for the influence of previous periods, thus leading to the system of differential equations with delay. Its solution required use of modern methods of the theory of functional differential equations.

It is to be expected that the procedure for solving the dynamic economic model, described above, that uses contemporary mathematic methods of so-called "Differential Equations Theory" with delayed argument, can be successfully used for both modelling further concrete economic relations and for economic models in general.

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Personnel Turnover as Indicator of Human Resource Management

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Keywords **– employee turnover, human resource management, organizational loyalty, job satisfaction.**

I. Introduction

Indicators of employee turnover are used for effectiveness measurement of organization's general management and, in particular, human resource management. Since the beginning of the 20th century, in the fields of psychology, sociology, management and economics there have been carried out a lot of studies of employee turnover. In these studies the importance of employee job satisfaction and organizational loyalty are stressed. Often it is considered that the level of employee job satisfaction and organizational loyalty is the determinant in decision to stay or leave the organization, therefore it has close correlation with employee turnover. However, this assumption does not always gain the theoretical and practical approval.

II. Employee Job Satisfaction and Organizational Loyalty Correlation with Turnover Intentions

In psychological studies of employee turnover the influence of job satisfaction, loyalty and other factors is studied mostly in relation to employees' actual voluntary turnover or to turnover intentions. These two methodological approaches, in spite of seeming similarity, provide essentially different results. It is more easily to study the influence of various factors on employee turnover intentions, and expected effect of studied factors is usually proved.

A. Job satisfaction

The lower is level of employee job satisfaction the more decisively employee declares about possible leaving the organization. In addition to that, the critical factor is just overall job satisfaction, not the satisfaction with some of job aspects – with job itself, wage, social relationships etc.

B. Organizational loyalty

The lower is level of employee organizational loyalty the more decisively employee declares about possible leaving the organization. This correlation is strengthened or, contrariwise, weakened by factors, for example, as employee's job position in organizational hierarchy, causes of loyalty, full or part-time employment, including types of part-time employment.

III. Employee Job Satisfaction and Organizational Loyalty Correlation with Actual Voluntary Turnover

Nevertheless, employee turnover intentions do not always transformed into real leaving the organization. It is more reliable to look at the origin of the employees' actual turnover. At present time there are many evidences discovered the weak correlation of employee job satisfaction and organizational loyalty with actual voluntary turnover. Besides of this, the correlation between job satisfaction and voluntary turnover is weaker than the correlation between organizational loyalty and voluntary turnover. Such outcomes are believable if the effect of other factors is ignored.

In the analytical reviews of the employee turnover studies, published the 21th century, it is mentioned that the incident of the dissatisfying employee leaving is yet depends on such factors as unemployment level in corresponded geographic area and occupational market, employee's education level, cognitive abilities, psychological well-being and length of service in the workplace. There are assumptions that the behavior of dissatisfying employee is also determined by cultural and national factors as well.

IV. Employee Turnover Research in Latvia

As to employee turnover in Latvian organizations there are many matters that should be studied, verified and specified. The available articles, concerned the theme of local employee turnover, are devoted to reality of one of the regional community or organization, or are based on opinions of several experts. Pointing out the causes of employee turnover, it is most often mentioned the low wages and "feature of occupation", for example, job of sellers, waiters, auxiliary workers where employee perceives such job as temporary. In addition to these causes, the some organizations' executives and personnel managers recognize that employee leaving is speeded by doubts about job stability, neglecting of promises, poor management style, ineffective internal communications, hard or stressful work, insufficient motivation and lack of development possibilities.

V. Importance of Human Resource Management in Employee Turnover Reduction

The local experts' conclusions and results of foreign studies affirm that human resource management activities do not guarantee reduction of employee turnover to optimal level. However, the appropriate personnel selection, induction of newcomers, programs of mentoring, improvement of management communication with subordinates, formation of fairness politics and climate, practices of personnel development and engagement, using of long-term stimuli in personnel motivation (e.g. plans of personnel replacement and succession, revision of compensation according to length of service, funds of pensions) can weaken employees' thinking about leaving.

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E-Commerce Development in Lithuania

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Keywords **– e-commerce, consumers' behaviour,**

I. Introduction

The fast development of information technologies has enabled, and in some cases, forced organisations to review their business models and transform their internal processes in order to make use of the opportunities provided by e-business for reducing time and money costs. The majority of researchers examine the advantages of electronic business, including e-commerce, and point out substantial opportunities for small-sized enterprises [3, 6, 12, 17]. In 2011, Lithuania ranked 22nd by the volume of e-commerce among the EU countries with 11% of individuals purchasing online compared to the total number of the population, while the EU average amounts to 34%. Therefore, although the number of e-commerce users is continuously growing, the penetration of e-commerce in Lithuania lags considerably behind the EU average.

The aim of this article is to carry out an analysis of the development of e-commerce in Lithuania and to identify some peculiarities of e-consumers' behaviour.

Research methods: comparative analysis of scientific literature, statistical data processing methods.

II. E-commerce in EU countries and in Lithuania

The share of individuals purchasing over the Internet in the EU-27 makes up 34% of the population. In 2011, most online purchases were made by residents of the United Kingdom (64%), whereas the residents of Romania (4%) and Bulgaria (5%) purchased the least. In 2011, products and services for personal needs were ordered online by 11% of all Lithuanian residents aged 16-74. It should be noted that as much as 54.7% of Lithuanian residents aged 16-74 searched for information about products and services over the Internet in 2011, which is twice as much as in 2005 and shows the potential of development of e-commerce in the country.

In the business sector in 2011, 98.1% of enterprises used the Internet, 67.7% of enterprises had a website or a webpage. The majority of the enterprises used information technologies in communicating with state institutions (98%) and banks (93%). However, only 33.2% of enterprises purchased products/services online, and even less (24.7%) sold products/services in 2011. It may be claimed that enterprises still make insufficient use of the possibilities offered by the Internet in the area of commerce, although the number of enterprises using the Internet for the sale/purchasing of products and services is steadily growing (Fig 5).

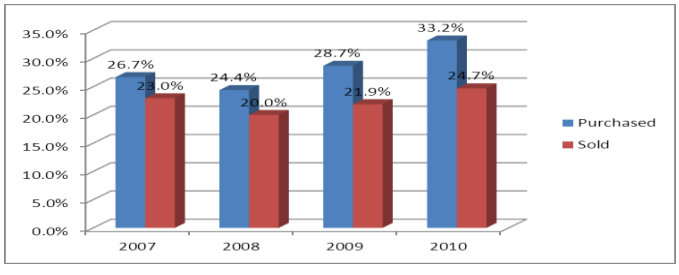

Figure 5. Changes in the percentage of enterprises using the Internet for the purpose of selling and purchasing products/services over 2007-2010

III. Analysis of Results of the Consumer Research

The aim of the survey is to identify consumers' attitudes towards non-traditional ways of purchasing and the type of products which are most popular and which are desired. The survey was executed using the Lithuanian Web portal for surveys (www.apklausa.lt), sample size was 187 [16]. A typical respondent is aged 25-30 years, is high school educated and earns moderate income, uses the Internet daily and purchases online on average 6-7 times per year. The most popular items are tickets to entertainment events (15%) and travel tickets -14% (Fig 6).

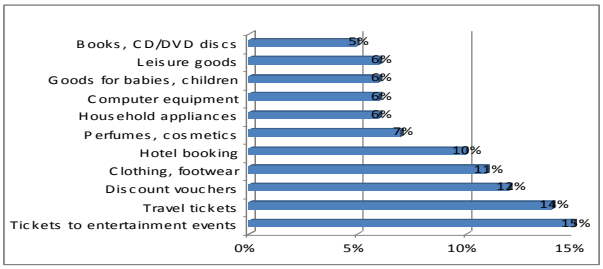

Figure 6 Products purchased online

In response to the question about the kind of e-shops lacking in Lithuania, the respondents ranked first the shortage of e-shops selling holiday packages (18%) and second – the shortage of e-shops of clothing and footwear -16% (Fig 7).

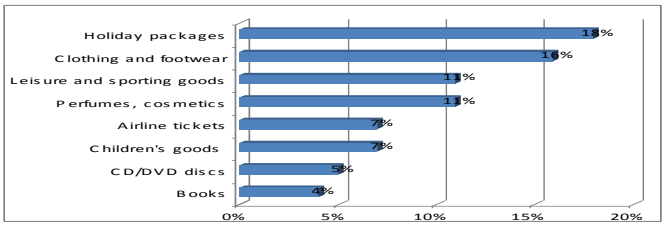

Figure 7 Shortage of e-shops in Lithuania

IV. Conclusions

In 2011, the share of individuals purchasing over the Internet in Lithuania made up 11% of the population. 33.2% of enterprises purchased products/services online, and 24.7% sold products/services. It may be claimed that the opportunities offered by the Internet in the area of commerce still are used insufficiently.

The most popular products for personal use are tickets to entertainment events (15%) and travel tickets (14%). Existing e-shops do not sufficiently meet the needs of Lithuanian e-consumers, because in the opinion of the respondents, there is a shortage of holiday packages (18%), clothing and footwear (16%), perfume and cosmetics shops (11%) etc.

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Internet Marketing Tools for Higher Education Institution

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Keywords **– e-marketing tools, education institutions.**

I. Introduction

Internet marketing is becoming more and more relevant issue for all types of businesses or other non-profit seeking activities and all these activities are facing the true reality - if you are not on the Internet – you are nowhere. But just the fact of being on the Internet is not enough. Proper tools and techniques have to be developed to address target audiences that most probably have different interests, tastes and preferences.

Talking about higher education internet marketing, we first of all focus on educational institutions' web sites that are the prime gates to the most important customers of education – potential or current students. Educational institution's web site itself as a communication channel is able to perform such actions as attract, inform, serve and pull the community, that is why it is important to execute a research in order to find out which internet marketing tools are the most suitable to perform the above mentioned actions.

The purpose of the paper is to analyze set of internet marketing tools and investigate the current students' opinion on the use of internet marketing tools that are or are to be used in educational institutions.

II. Internet Marketing Tools

Internet marketing is a much broader concept, which not only mentions marketing of goods or services online, but also integrates the rest of marketing objectives. D. Chaffey [2] explains that internet marketing is achieving marketing objectives by applying digital technologies. These digital technologies include Internet media such as web sites and e-mail as well as other digital media such as wireless or mobile and media for digital television such as cable and satellite. Strauss and Frost [16] suggest that internet marketing refers to the use and application of electronic channels in marketing operations such as planning and executing tasks, allocating resources, promoting, pricing in order to foster the communication between a company and customer and help to reach mutual goals. Ph. Kotler *et al*. [14] states, that it is a form of direct marketing using dialogue information and Internet technologies, which create two-way communication systems and connect buyers and sellers.

The number of internet marketing communication tools is constantly growing every day and there is no common agreement how these tools should be named and what amount of them used. Internet marketing communication tools could be organized in four major categories suggested by [16]. These are: internet advertising, marketing public relations, sales promotion and direct marketing:

Internet advertising - online ads, e-mail advertising, sponsorships, affiliate marketing, SEM, mobile advertising;

Marketing public relations (MPR**)** - web site, virtual communities, discussion clubs and forums, online events, press releases, podcasts, online buzz;

Sales promotion - **s**ampling, contests, sweepstakes, games;

Direct marketing - e-mail, permission marketing, viral marketing, text messaging.

III. Students' Attitudes towards Marketing Tools

In order to find out the opinion of current students about higher education institutions' web sites and the effectiveness of internet marketing tools that are being used the survey was executed (sample size was 252 respondents). Respondents were students of VGTU and MRU universities.

Internet usage. Research revealed that even 53% of respondents spend more than 5 hours a day browsing the internet, the second highest score of 31% spend 3 to 5 hours on the Internet daily. It means that 84% of respondents spending more than 3 hours daily on the Internet (Fig 1).

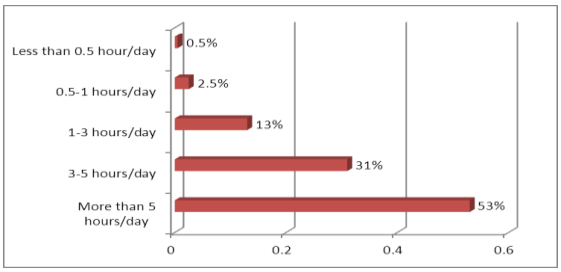

Fig 1 Internet usage, daily

It was found out that 70% of all respondents use the Internet for leisure time needs. The second most popular answer indicated that the Internet is being used for studies (68%).

Relevance of online services. In order to increase the effectiveness of a study process and facilitate it an educational institution may consider relocating some of its services from the form of physical to online delivery. The most relevant on-line services are displayed in Figure 4.

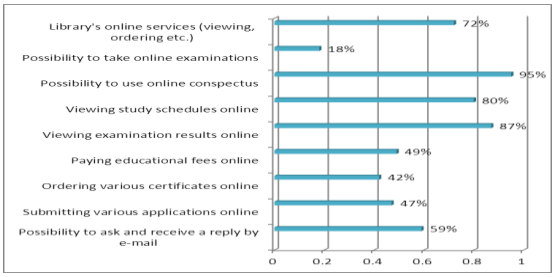

Fig 4 Most relevant educational institution's online services

IV. Conclusions

Research revealed that 84% of students spending more than 3 hours daily on the Internet. The most relevant on-line services for students are: possibility to use conspectus and library's services, viewing examination results and schedules.

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Particular characteristics of financial disbalances in EU countries

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Keywords **− Eurozone countries, crisis phenomena, Maahstryhstski criteria, the balance of payments, financial disbalances.**

I. INTRODUCTION

The European Union in the early second decade of the XXI century continues to be a leader in the production of the global GDP, its share reaches 25%. The global financial crisis had a major impact on GDP growth, and its fall in 2009 was 3.7% as compared to the year of 2008.

During 2010-2012 the rates of the GDP growth in some countries did not exceed 2% per year.

Such low rates obviously do not provide the renewal processes. It has become a significant problem of social development causing these disbalances.

II. THE ECONOMIC NATURE OF FINANCIAL DISBALANCES

The nature of financial disbalances is considered by scientists through different theoretical and methodological approaches.

According to another theory, the theory of macroeconomic regulation, the conditions of dis-balance appear in the result of expansion of the monetary integration during the creation of a free trade zone.

The macroeconomic balance can be achieved as the result of such a state of the economic system, when the optimal allocation of capital and labor in the common market of goods is provided.

III. ANALYSIS OF THE CAUSES OF FINANCIAL DISBALANCES

Financial crisis is not a new phenomenon in the development of the economic systems. Thus, E. Bergman had analyzed the nature of financial crises since 1825 [7].

It is clear from the table, the longer the growth rates the shorter will be the recessions.

An essential condition of financial disbalances is the lack of public debt and private debt. Analysis of these types of debt during the first decade of the XXI century in EU countries did not show persistent patterns of correlation between these types of debts. For example, the Irish rate of public debt to the GDP remained low during the crisis period, but increased during 2007-2010, almost four times in Spain before 2005-2007 and was characterized as a surplus, but during crisis, the budget deficit significantly increased. A characteristic feature of these two countries was significant indebtness to the private sector.

IV. MEASURES TO REDUCE FINANCIAL DISBALANCES

As it has been already noted, the main cause of disbalance is the violation of the principles, rules, etc. of functioning of social-economic system.

Owing to scientific research of scientists and specialists now some legal documents have been developed o facilitate the optimal functioning of the economies of some countries.

These documents are as follows:

- Maastricht criteria;
- rules FATF;
- Stability and Growth Pact;
- decision of Heads of the "Big Eight" states (G-8);
- laws of separate countries.

Let us find the essence of some of them.

The following indicators must be followed according to Maastricht criteria:

- ratio of budget deficit to the GDP for a year should not exceed 3%;
- the public debt to GDP must not exceed 60%;
- ensuring price stability, in terms of inflation, it should not exceed more than 1.5 percentage points, three best indicators in the EU;
- interest rate on bank loans should not exceed 2 percentage points in the three most successful countries of the EU;
- during two years the exchange rate in a particular country should not go beyond the established mechanism of the exchange rate of the Member States.

V. CONCLUSIONS

To avoid financial disbalances EU countries and other leading countries belonging to the "G-8" a series of strategic measures must be applied. Among them are: to develop systematic programs of leading world economies development with adequate directions of counterwork to challenges of globalization, promote the application of susceptible standards for model Maastricht criteria, the leading countries must take responsibility for the development of less developed economies, in particular using the international financial institutions such as IMF and International Bank for Reconstruction and Development.

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Model for selecting the optimal fire insurance system

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Keywords - fire insurance, compulsory insurance, insurance funds, insurance model, residential sector.

I. INTRODUCTION

The purpose of the authors research is to work out and prove the selecting the optimal fire insurance system in Latvia. The object of research is fire insurance. The subject of research is the methodology of fire insurance system selecting. A model for selecting of the optimal system of raising and usage of fire insurance funds for residential sector is proposed by the authors to considering. This model defines the stages of decision-making, offers a component system for assessment of various systems of raising and usage insurance funds.

II. ANALYSIS OF FIRE INSURANCE SYSTEMS

Fire insurance is one of the main methods of fire risk management and a measure of economic incentives for improving fire safety facilities of insurance, thereby increasing the level of fire safety in the state. It defines the high social importance of fire insurance. Historical and international insurance practice has developed various systems of raising and usage of insurance funds, which vary according to the following criteria: 1) level of funds raising - public or private; 2) the nature of insurance - voluntary or compulsory; 3) kind of insurance, which includes the definition of insurance risk, insurance objects and other necessary and terms and conditions defined by the insurance legislation.

The analysis of the statistics of the numbers of fires in Latvia conducted by the authors demonstrated that on average within the period of 2001-2011 out of total numbers of fires in residential and industrial sectors fires in a residential sector made up 73%. Currently, fire insurance in Latvia is voluntary, although discussions about the introduction of compulsory fire insurance are continued for many years.

III. FIRE INSURANCE IN RESIDENTIAL SECTOR: ALGORITHM of SYSTEM SELECTION

Currently, there is no Standard algorithm for assessment of various systems of fire insurance and the decision-making process on the implementation of a system at the national level in Latvia.

The model for selecting the optimal fire insurance system has been developed by the authors. The model consists of the following steps (fig.1).

The first step is the identification and assessment of the possible form of fire insurance: public or private, voluntary or compulsory. The second step is the evaluation of fire insurance systems, using the 3-level system components developed by the authors. The 3-levels system consists of social, administrative and insurance components

The next steps are: analysis of strengths and weaknesses, Assessment of the economic efficiency of various systems of raising and usage insurance funds, decision-making, decision realization and results monitoring and analysis.

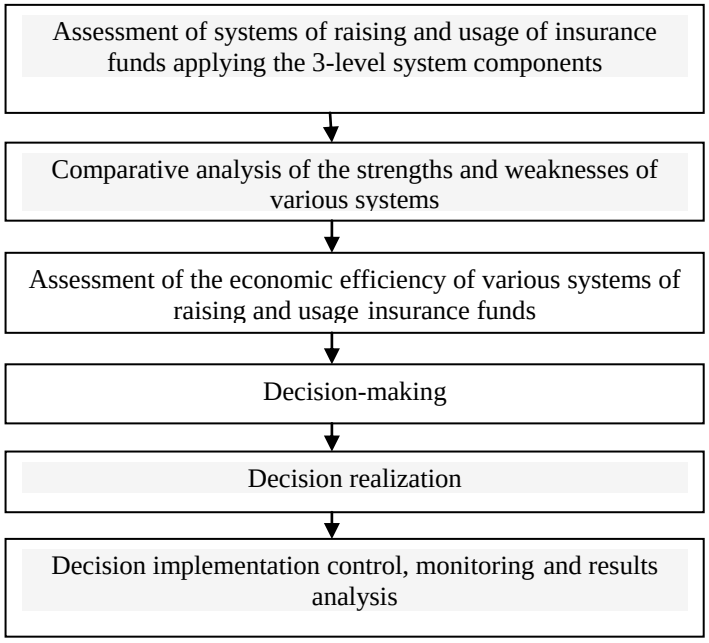

Fig.1. Model of decision-making about the selection of optimal system of raising and usage insurance funds.

IV. CONCLUSION

Realization of the proposed model for selecting the optimal system of fire insurance will allow to increase the efficiency of raising and usage of insurance funds of various levels.

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The Role and Place for Coaching among Other Targeted Interventions

Angelina Rosha (*Information Systems Management Institute)*

Keywords **– coaching, targeted interventions, change, multidisciplinary.**

I. Introduction

Coaching is becoming increasingly popular in today's business environment, more and more organisations are using coaching as a means of improving performance, managing career, attaining organisational and personal goals. However, there is no consensus as to what coaching means. Thus, the research questions are: what are distinctive features of coaching and how is coaching different from other targeted interventions?

II. Coaching. Brief History

The term 'coaching' appeared in the English language in the first half of XIX century, the reference was found in the literature and periodicals. From around 1830, 'coaching' was used as Oxford University slang which meant 'tutoring for academic attainment'. The principles of academic coaching then moved to sport.

Popular science literature traditionally links the appearance of the business coaching to Timothy Gallwey's (1974) book *The Inner Game of Tennis*, and John Whitmore's *Coaching for Performance* (1988) and his GROW model. However, academia acknowledge and affirm the multidisciplinary roots of coaching and consider coaching as a unique synthesis of such disciplines as learning theories, adult development, behavioural/social sciences, leadership and management sciences, communication techniques, which in combination creates its own knowledge base.

III. Definition of Coaching

In order to identify the distinctive features of coaching, 12 definitions of recognized researchers, institutions and coaching societies, have been selected and analyzed.

TABLE I

THE USE OF FEATURES IN THE DEFINITIONS

Features	Total	Features	Total	Features	Total
process	10	partnering	4	inspirational	1
change	6	potential	2	thought-provoking	1
individual	6	learning	2	evocative	1
professional	6	short-term	2	expertise of the coachee	1
development	5	specific skills	2	focus for the future	1
improvement	5	awareness	2	leadership development	1
goals	4	facilitating	1	feedback	1

Most researchers define coaching as a process, half of them indicate that coaching aims to achieve change and is used for individual and professional purposes. However, there is no unanimous decision what kind of process coaching is.

IV. Coaching and Other Targeted Interventions

To identify distinctive features of coaching, it is important to distinguish coaching from similar activities.

TABLE II

COMPARITIVE TABLE OF THE TARGETED INTERVENTIONS

Targeted Interventions / Features	1	2	3	4	5	6	7	8
used to develop high-potential performers	x	x						
aimed at personal problems					x	x		
typically applied to specific present-moment work-related issues	x							
focuses directly on a business's content skills or technical skills				x				
seen as a benefit for high achievers, key people and those with great potential	x							
seen as remedial					x	x		
helps a person change in the way they wish	x							
concerned mainly with achievements in the present and the future	x	x	x					
involve understanding and working with past experience						x		
a senior colleague gives advice and provides a role model		x						
deals with the client's mental growth	x							
reliefs from mental pain						x		
is likely to be targeted on specific skills for immediate results							x	
allows employees to develop those skills themselves	x			x				
provides expertise				x				
only indirectly affect individuals				x				
the client is the expert	x							
passes knowledge								x
assists in managing the process of dispute and conflict resolution			x					

1 – coaching 3 – mediation 5 – counselling 7 - training
2 – mentoring 4 - consultancy 6 – therapy 8 – teaching

There are more differences than similarities between targeted interventions. Each intervention has its own aim, is delivered by experts with different qualifications and different relationships with the individual. Coaching is considered as present and future oriented intervention, it is focused on high potential development; in this case, it has some common features with mentoring. However, expertise is a key distinctive feature between coaching and mentoring.

V. Conclusion

Coaching is the topic which is discussed from different perspective; there is no unified approach to the definition of this field of study.

Among other targeted interventions, coaching is positioned as beneficial, self-development, work-related intervention. However, in practice coaching and mentoring are often used interchangeably.

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Intelligence as Main Way to Ensure Universal Sustainability of Country's Development

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Keywords **– sustainability, regional development, business intelligence assets, investment, resource allocation.**

I. Introduction

In a constantly changing multinational environment the development of country or region needs to be sustainable. Thus there is a need to provide some essential conditions to assure the development sustainability for every country or region. Along with distinguishing country (regional) sustainability subsystems, there is a need to stress an important characteristic of all the subsystems – the intelligence, or in other words, adequate and sound use of resources assigned for every subsystem.

II. The Necessity for Country Sustainability

A. The Origin and Definition of Sustainability

Sustainability, as orientation of activity towards the today's needs satisfying, leaving for future generations the possibility to satisfy their needs as well, is the main concept of science capable of finding the solution for the mentioned problem (Clark, Dickson 2003). The concept should match its prototype in every subsystem of sustainability.

Sustainable development retained the knowledge of management and economic science, which has endured the experiments of the reality, and revealed the created credo of thought and activity – *to sustain ability for that which leads us to the future*. The concept of sustainability dominates in the management of scientific cognition and universal knowledge formation.

B. Country development sustainability analysis and management trends

In this paper we will use the universal concept of sustainability, which was proposed by the authors for the 1st World Sustainability Forum (Rutkauskas *et al.* 2011) and for the 7th International Scientific Conference "Business and Management–2012" (Rutkauskas, Stasytyte 2012), intended to investigate the development sustainability. Fig. 1 presents a slightly modified scheme, disclosing the content of the mentioned concept.

Four of the earlier mentioned subsystems – subsystem of ecological sustainability, subsystem of social-demographic sustainability, subsystem of economic sustainability and subsystem of political sustainability – are practically included into every detailed enough case of development sustainability. The subsystems of technological and creative sustainability are quite rarely analysed as subsystems of independent development. The subsystem of religious development sustainability hasn't found its official recognition during quite a long time period, but it is also an important component of development sustainability.

A subsystem of investment development sustainability, which is actually very rarely mentioned, requires a distinct presentation and broad discussion, which will be presented in the paper. It assumes an exceptional function – to mobilize resources necessary to maintain the main functions of the mentioned subsystems and strengthen their interaction.

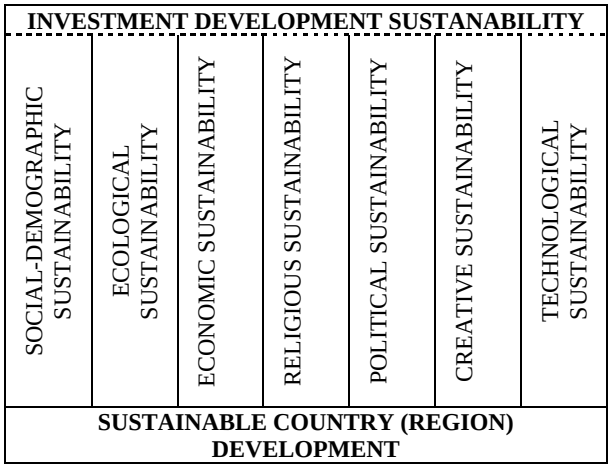

Fig. 2. The scheme of country (region) development sustainability analysis

III. Addressing Business Intelligence in Development Sustainability Management

A. The Need for Business Intelligence

Taking into account the scheme of country (region) development sustainability analysis, presented above, it is worth noticing that in order for all sustainability subsystems to function properly there is a need for their wise management. This can be reached with the help of intelligence qualities, possessed by the users and creators of each subsystem and developed by the processes taking place in the subsystem.

B. Business Intelligence Assets

Business intelligence can be properly analysed by distinguishing its assets. Talking about business intelligence assets, we can note that business intelligence is a means for adding value in production or service delivering process. Commonly it is accepted that business intelligence activity can be applied to the following business purposes in order to drive business value: measurement, analytics, reporting/enterprise reporting, collaboration/collaboration platform, knowledge management (Rutkauskas et al., 2011).

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Developing competences of managers to direct intellectual capital

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Keywords - intellectual capital, competences of managers, case-study, cross – cultural communication competence.

I. Introduction

At present one of the peculiarities containing in every product and service is presence of knowledge component. It means that intellectual work, knowledge, experience, competences, creative capability of employees are becoming factors for creating extra cost, competitiveness and economic development of a company. That is why the key goal of a company is intellectual capital management. The company needs well-educated, creative, competent managers, who are good decision-makers, who are able to be of great benefit to a company in order to be successful, profitable and have competitive advantage.

II. Vital Competences of Managers to Run the Company Successfully

According to the Educational Standard in Belarus managers by the end of education and training must develop the following competences to the level that equips them for managing staff successfully. A range of competences for managers is grouped into three key management areas: understanding business organization, managing resources, managing people [29].

III. Method Case – Study is Modern Technology in Business Education for Developing Competences of Managers

Case-study method is widely used in business education abroad. It is considered one of the most effective tools for making-decision teaching. This problem is very urgent today in Belarus. And many researchers are engaged in it.

IV. The Developing Vital Competences of Managers by Means of Foreign Language Studying

A. Mastering Cross –Cultural Communication Competence Won't be Successful Without a New Up-to-Date Concept

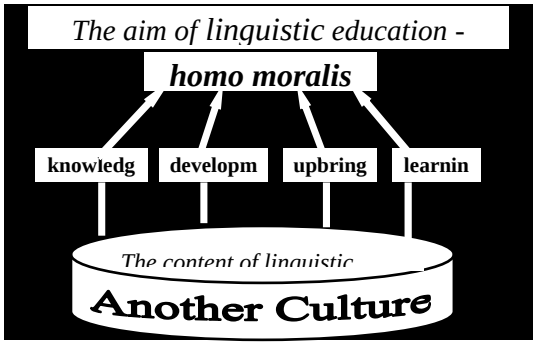

Fig. 2. "Mechanism of mastering a cross-cultural communication competence".

B. Methodological Basis of a New Up- to-Date Linguistic Educational Concept

Methodological basis of this concept is communicative interaction. It means that a content of linguistic education is based on discussion of actual economic cases.

C. Case Study for Improving Cross-Cultural Communication Competence and Developing Other Vital Management Competences

This method is very popular in education of managers. It is realized through activity that imitates professional sphere. This method allows teachers to make the process of developing cross-cultural communication closer to reality by plunging students into the atmosphere of their future profession. Other active methods integrate into organizational framework of case-method.

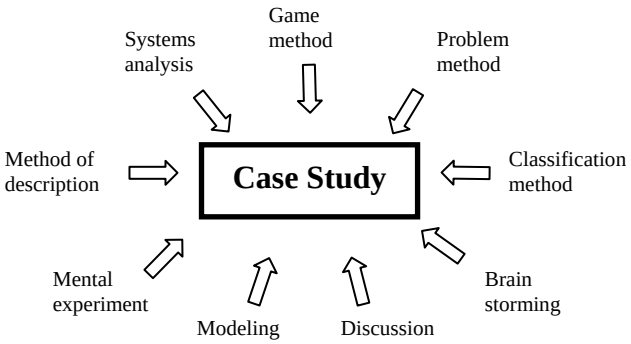

Fig. 3. Integration of active teaching methods into an organizational framework of a case-study method.

D. Evidence of Given Recommendations

The results of the analysis of cross-cultural communication skills of students after using and not using the above recommendations are presented in Fig 4.

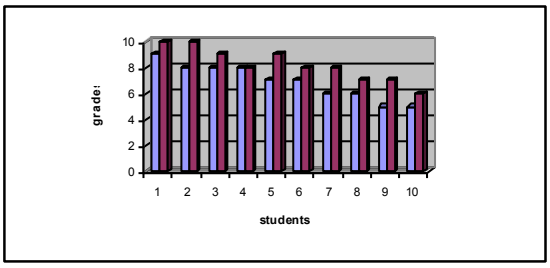

Fig. 4. The results of the criteria "Communicative skills in speaking and strategic skills" of the first group of students before (light column) and after (dark column) the application of the author's recommendations.

V. Conclusions

Experiment and analysis of the research work described in the article prove the reliability of case-study method in the process of developing vital competences of managers, necessary for direction of intellectual capital.

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Competition factor for Manufacturing Companies

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Keywords **– strategic planning, strategic theory of the company, industry development.**

I. Introduction

For Latvia and European Union research for small and medium enterprises (SME) is extremely important. SME's contribution to the EU's prime economic objectives is acknowledged and well documented in both the Lisbon strategy for economic growth and more and better jobs and its successor Europe 2020 strategy. In 2010, there were almost 20.8 million SMEs in the EU of which the biggest share – 19.2 million (or 92.1 percent of all EU business) – were micro-firms with less than ten employees, moreover in Latvia it is 99,5% in 2009. As in previous years, the share of large businesses, i.e. non SMEs, remains marginal in terms of the number of enterprises (43,000 or 0.2 percent of the total).

II. Identifying Strategy

Sustainability issues are too complex and interconnected to be managed by small and medium companies. Usually only large companies could afford such complex and sophisticated strategy system. The current trends of strategic management will in the future stress individual and organizational capabilities to learn and innovate. (Huff 2000; Rynes et al. 2001). However, there are a number of other factors that limit small firm growth. This is because small companies have scale, scope, and learning liabilities and disadvantages relative to large companies. Small companies used to produce a small volume (scale) of a few products (scope) and typically have a limited capacity for acquiring knowledge (learning) (Nooteboom, 1993).

Small companies differ from large firms in that they are often 'resource poor' (Welsh & White, 1981) and therefore require different approaches to strategy, especially in the early stage of a companies' existence when the two most important issues are survival and growth (Aldrich & Auster, 1986). Smaller and younger companies both have limited resources that are also less valuable than those possessed by larger and older firms. Smaller and younger companies pay lower wages and offer lower returns to their employees (Oosterbeek and Van Praag, 1995; Van Praag & Versloot, 2007), they employ individuals with lower levels of human capital (Troske, 1999), and realize lower levels of capital-skill complementarity (Troske, 1999) than larger and older firms do. This relative scarcity of resources in small and young companies makes them more vulnerable to external threats and internal missteps than larger and older firms (Moore, 2001).

Author analyses the role of strategy for manufacturing industry based on hypothesis that growing role of strategy and its sophistication for specific company could led to a better performance through building hardly reachable value of chain. (Figure 1) The sectors author is examining are in metal manufacturing. We are starting from the innovations themselves and then moving to more general levels of analysis, that is to the industry and national levels. Paper`s concern is to characterize the evolutional pattern of strategy and innovation.

Author expects that the findings of strategy evolution will indicate that the company's behaviour is in correlation with strategy company implements when managing innovation and transformation and role of strategy within company or industry. In particular, paper is concerned with how local companies manage and implement strategy evolution. The findings at this stage indicate that despite the increasingly international nature of R&D and globalization, national companies continue to implement more simple low-cost strategy and to maintain secondary supplier`s or followers role.

Competition and strategy analysed as a new system to be integrated in order to implement crucial issues needed for strategic management to help small and medium organization to create and sustain competitive advantages. It has to include long-term objectives, which are responding to client requirements comparing to competitors, ability to innovate products, quality, and efficiency. Traditional cost leadership strategies should be analysed as minor strategy element from strategic management for achieving sustainable development.

In this paper the importance of innovative activity as important instrument to compete on the world market is proved. This conclusion was confirmed. The results of the standard model show that innovation and highly qualified human resources would be a method to reach the international technological standards of the world market.

In paper the results of the standard strategies in the existing literature are analysed and it was found that they are very similar to those of other studies and, and more important, it seems that the existing differences could be interpreted. This paper confirms that the least innovative companies have the lowest growth probability; this relationship is reflected by the number of studies and has no contradictions.

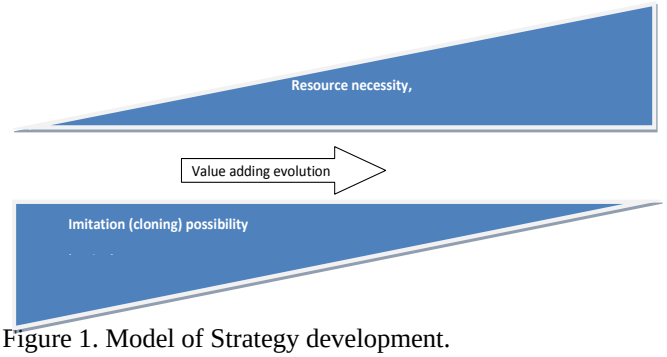

Figure 1. Model of Strategy development.
Source: Author`s presented model

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Corporate Governance in the Czech Republic: Selected Research Results

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Keywords **– Corporate Governance, Research, Czech Republic, Processing Industry.**

I. Introduction

Corporate governance seems to be the crucial issue of nowadays. Much of the current discussion on corporate governance has oriented on practical problems, including corporate fraud, the abuse of managerial power and social irresponsibility (Letza, Sun, Kirkbride, 2004). Corporate governance in the Czech Republic is such that companies are very reluctant to pass on good governance model, recommended by international standards and it often leads to reduced performance and competitiveness in the market compared to foreign companies. The aim of the paper is to present the selected research results related to the current situation of the corporate governance in the Czech processing companies.

II. Conceptual Framework

There have been many opinions of different authors in the theoretical and practical sources analysis. In the past decades the various instruments have been introduced, involved in the corporate governance, either the reports discussing the risks and deficiencies of the companies and the codes of the good governance and management, the recommendations, setting the objective of more efficient governance and management of the companies. Besides the improvement of the effectiveness and company performance their objective is also to protect the owners, shareholders, creditors and other stakeholders. These recommendations contain the best practices, empirically verified codes of conduct (decision-making, target identification), facilitating the company to enhance higher efficiency.

Definition of Corporate Governance

Corporate governance is defined by many of authors. Important publication in the field of corporate governance has been the work by authors Berle, Means (1933) where they analyzed the impact of corporations and theirs managers influence not only on the venture but on the entire company.

III. Data And Empirical Results

Empirical research was done in the Czech Republic. The questionnaire was constructed on the theoretical knowledge of the huge of current international and domestic sources and was intended for the survey of the "Performance of the company: environmental, social, economical and corporate governance". The sample (79 processing companies) was used from the Czech database of the companies according to Classification of Economic Activities (CZ-NACE) - see in Table 1.

IV. Discussion And Research Implication

The rankings of competitiveness of Czech Republic are lagging behind and one of the causes is also the poor corporate governance practice. There is often criticized vague judiciary, lack of regulatory interventions; there are criticized links of municipalities with the private sector and rampant corruption. Freedom of corporate governance is impossible without compliance with legal requirements such as legal, economic, environmental and social, i.e. also ethical standards.

TABLE I

RESEARCH SAMPLE

		Classification of Economic Activities (CZ-NACE)	Frequency	Valid Percent
Valid	C *	10-11 Manufacture of food	8	10.3 %
		13-16 Manufacture of textile and leather	9	11.5 %
		20-23 Manufacture of chemical	8	10.3 %
		24-25 Foundry production	11	14.1 %
		26-33 Manufacture of Electrical engineering, Medical products	30	38.5 %
	(D+ E)*	35-38 Electricity, gas, water and waste processing	12	15.4 %
		Total	78	100.0 %
Missing		System	1	
Total			79	

*C Manufacturing
* D+E Water supply, Waste management and Remediation Activities

Questions of the following research in the area of corporate governance concern about well-governed corporation and good practices (Klirova, 2008; Klirova, Kavalir, 2009; Krivogorsky, 2011), principles of good corporate governance (ethical approach-culture, society, organizational paradigm; a decision-making process is in place which is based on a model reflecting the above giving due weight to all stakeholders; stakeholders are treated with equal concern - albeit some have greater weight then others; accountability and transparency: to all stakeholders). In connection with the professional and scientific sources, results of research and the requirements of the environments it is now in the centre of the company performance monitoring necessary to establish key indicators of Corporate Governance (Kiernan, 2007; Kocmanova, Nemecek, 2009; Hrebicek, Stencl, Trenz, Soukupova, 2011; Chvatalova, Kocmanova, Docekalova, 2011; Simberova, Kocmanova, Nemecek, 2011).

V. Acknowledgment

The paper is written in the framework of research project "Construction of Methods for Multifactor Assessment of Company complex Performance in Selected Sector" supported by Grant Agency Czech Republic (GACR) Reg. Nr. P403/11/2085 ".

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Direction of innovation marketing development in Latvia

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Keywords **– Innovation, marketing, direction, development, Latvia.**

I. Introduction

Innovation marketing is a perspective area. Innovation marketing creates the possibility for new services and goods. The objective of the paper was to study the innovation marketing process in Latvia. The tasks in order to reach the objective were: (1)to identify the concept of innovation marketing, business research and technological environment and their main economic indicators, (2) to carry out analysis of the factors influencing innovation marketing process in Latvia, (3)to carry out analysis of indicators characterising innovation marketing effectiveness in Latvia.

II. Contents of the Research

This is the first research on the analysis of the factors influencing innovation marketing process in Latvia. The author has carried out an extensive evaluation of the informative material, identified the innovation marketing problems in the Republic of Latvia and proposed problem solutions.

The object of the present research paper is marketing. The subject of the research paper is analysis of the innovation marketing process in Latvia and the solutions of its problems.

Theoretical study methods are reported, such as analysis of innovation marketing, business research and technological environment, study of correlation between innovation marketing factors and business environment.

Empirical pilot methods are observation for the purpose of studying mutual influence between innovation marketing factors and business environment, contents analysis of innovation, study of documents regulating innovation in Latvia, economic and statistical analysis of the business results, economic and statistical analysis of innovation and innovation marketing, study of public and non-governmental institutions data of innovation marketing in Latvia.

Research Basis are innovation, innovation marketing, business and its environment and the main characteristics of innovation marketing and business environment in Latvia.

The research period was from the year 1991 till year 2011, separate themes have been studied for a shorter period of time or by way of comparison.

The scientific novelty of the research is the analysis of innovation theory and policy and study of innovation marketing effectiveness in the Republic of Latvia, evaluation of the legal aspects and peculiarities of innovation marketing development in the Republic of Latvia and identification of interconnection between business environment and innovation marketing development in Latvia, definition of the innovation marketing process and presentation of its theoretical and practical interpretation, system of innovation marketing indicators, analysis of modern innovation marketing, exposition of innovation marketing problems in Latvia.

Apart from statistical, non-published information of public and non-government institutions and new information acquired by the author, this paper includes study data and conclusions from other research works carried out and published in Latvia in the works by (in alphabetical order) Bolsakovs S., Spica I., Treimane G.,Vedla A. etc. The selected approach and development of research methods have been influenced by the works of scientists from other countries, among them in particular (in alphabetical order) Bessant J., Pavitt K., Tidd J., Timmons J.A. etc.

Research Hypothesis - Innovation marketing effectiveness changes according in the changes in business research and technological environment, thus innovation marketing problems can be solved by improvement of business environment as a whole.

The first chapter of the paper includes reported analysis of innovation, marketing management of innovation, business research and technological environment theory. The second chapter of the paper gives the analysis of factors influencing innovation marketing process in Latvia. The third chapter presents the evaluation of the indicators characterising the innovation marketing effectiveness in the Republic of Latvia by carrying out manifold comparative analysis, identifying the innovation marketing problems and advances problem solutions.

The Main Results and Conclusions of the Research: (1) Changes in the innovation marketing process are associated with changes in the business research and technological environment; (2) Based on the analysis of the business research and technological environment and the authors pilot studies, the developed system of indicators of business research and technological environment enables to evaluate the effectiveness of innovation marketing in Latvia and to identify problems of innovation marketing in Latvia; (3) Solution of innovation marketing problems in Latvia is based on study of business research and technological environment and innovation marketing management mechanism.

III.Objects

The Key objects are innovation, management, innovation marketing, business research and technological environment, indicators characterising innovation marketing effectiveness.

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Stakeholders and Human Resource Management: Socially Responsible Strategy

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Keywords: **Human resource management, stakeholders, corporate social responsibility.**

I. Introduction

To keep up with new tendencies in society and market, companies tend to optimise enterprise management and tie it to corporate values and philosophy.

As human resources (HR) are one of the core elements of the company, HRM should be appropriate.

This paper aims to give an overlook to the differences between HR and stakeholders' definition and management in socially responsible companies.

The main methodology used is an analysis of the theory bases merged with case overview of the theory implementation in practice.

Afterwards, the research results can be applied within further researches on stakeholders and HR management in companies with strategic corporate social responsibility.

II. Human Resources and Stakeholders

Human resource management serves a number of stakeholders; they are employees as well as other people who are directly and indirectly involved in the performance of a company.

Every company has its own human resource management aspects, they are primarily dependent on stakeholders, and, secondly, on the stakeholders' needs and expectations.

Nowadays entrepreneurs are aware of the fact that human resources are more than just resources; they are the company's "assets". In the 21st century HRM strategy choice should be carried out more carefully in order to impact the company's long term perspectives and maintain the competitive advantage on the market. There are investments in HR needed more than it was before.

The main focus of the company should be based on the identification of the HR, staff and stakeholders. It helps to set up the management goals for each group.

The personnel is a part of a company's HR, and, in a way is a stakeholder. The main difference between these three terms is the company's attitude, relations and interaction with them. HRM is needed to manage HR and staff as a whole. Stakeholder management is related to HRM; however, it requires additional forces.

III. Social Responsibility and Company Strategy

Strategies oriented towards social responsibility require additional resources to manage stakeholders and reach strategic goals. It is important to outline sustainability aspects while implementing these strategies. Sustainability aspects are a part of the HRM system. HRM process and socially responsible strategies are executed at the same time. HRM helps making sustainable decisions; this explains the aim of the strategic corporate social responsibility implementation.

First of all, the company defines stakeholders and establishes a contact with and between them. It is assumed that there are two major types of stakeholders: the ones that are influenced by the corporate actions, and those, who influence the company itself. It is important to take this assumption into account.

Secondly, company should identify interests and needs of each stakeholder as well as related challenges. This can serve as an efficient action for stakeholder loyalty enhancement as a part of the sustainability in relationships between company and its stakeholders.

If relevant, the next step would be HRM guideline change and adaptation to sustainability principles. Afterwards, in order to reach corporate goals an action plan should be created. It is required to find the appropriate methodology to evaluate the fulfilled points of the plan and company related performance. This will unveil HRM influence and impact on entrepreneurship in general and achieving sustainability goals.

IV. Conclusions

HRM and stakeholder management become one of the strategic management elements of the socially responsible companies. Structured and perceived HRM and stakeholder management give firms an additional competitive advantage. Internal and external resources and stakeholder management is important, because there is a bilateral influence between a company and its stakeholders.

In case of strategic corporate social responsibility implementation the company needs to find a balance between productive performance and responsible action. Therefore, HRM is an actual element for the enterprise, which focuses on sustainable future. However, it should be pointed out that strategic social responsibility implementation is possible mainly for the big companies, which have a lot of specific stakeholders. They need knowledgeable staff and unique HR to maintain the competitive advantage, i.e. HRM and stakeholder management need to be customised accordingly.

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Information technology and managing Organizational change

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***Keywords* – Information Technology, Organizational Change, Management, Business Processes.**

I. Introduction

In organizational change conditions the application of the information technologies is crucial for their rational management. In the modern business they define significant percentage form the driving mechanism of the market economy. This is because the computers find application in all fields of the industrial production. Therefore they influence significantly the business activity of a number of organizations. As a result of this the later influence their processes as well. With regard to the conducted organizational change this tendency finds approbation in two directions. First, the information technology is a tool to change the business processes in the organization by the adaptation of modern and effective high technology products. Second, through the implementation of the computer technologies in the business the social component of the organization (i.e. the people) is also affected. In this direction they influence the working process as well because most organizations changed the ways of its realization. This is why the managers today have to handle the organizational changes at one hand and to implement advanced information technology on second. The integration of the latter is aiming to optimize the business processes and to increase the organization competitive power. From this point of view the purpose of the present publication is to disclose the main directions of information technology application in organizational change.

II. Forms of Managerial Influence in the Management Process

The institutional framework for the management and the effective use of power requires the study of certain issues which motivate managers to possess it. Managers have different motives which are determined by their intentions for using it.

Research [3, 8, 9] outlines the various aspects of their importance which are characterized by the following:

- Managers require power to achieve their goals. Even when managers have good ideas they can not realize them without using power. This means that they have to communicate with more powerful individuals or groups, which is a prerequisite for creating conflicts. This in turns leads to a greater possibility of not achieving their goals.
- Managers need power to reduce the uncertainty or frustration of employees. In this case they use power to create positive attitudes towards work in their staff. The effective use of power is a prerequisite for ignoring people's negative emotions, mistrust and also limiting their resistance.
- Managers need power to generate even bigger power. When they have formal power and access to the organization's resources, managers aim at increasing this power. This would result in greater influence on staff and would eventually allow them to use it for a longer period. Having in mind these motives, managers invest in power and naturally expect adequate returns [3]. Some managers empower other employees in the desire to achieve greater influence in executing power (and taking decisions).

The empowered are expected to support their manager which would help him to achieve his goals and strengthen his position. For this reason, many for the managers who have hold their positions for long periods are surrounded by people who have been delegated authority. These people would be loyal to their manager and would facilitate the implementation of his/her ideas (through the decision - taking process). A problem may arise from the lack of correct judgment as to whom managers could delegate authority. Obviously not everybody makes a good professional partner and often some people lack qualities that would enable them to use power. Another aspect of investing in power is when managers use financial stimuli. When employees are satisfied with their payment they are more willing to cooperate with the managers, i.e. acknowledge their power, rather than oppose them.

- Managers need power to satisfy personal ambitions and achieve personal objectives. Work refers not only the professional interests of managers but also to their ego. This is a natural process of human psychology since individuals always aim at (consciously or not) receiving positive assessment from others, which in turn would lead to good self-assessment. Often managers are well-accepted (seemingly) by their employees not because they are good professionals but because they have power. This satisfies managers but does not reflect their actual competences. This creates the understanding that managers have motives for power when they would like to conceal personal (character related) or professional shortcomings. Power compensates egocentrism of individuals (managers) by giving them privileges to influence the right of choice of others (subordinates) or to restrict their development.

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Information Interpretation Possibilities in Municipal Solid Waste Management

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Keywords: waste management, environmental impact assessment, economic activities.

I. INTRODUCTION

Human beings may take individual and social responsibility for the environment as well as carry out preventive actions for it conservation and protection. The relationship between environment and economic development was first placed on the international agenda in 1972, at the UN Conference on the Human Environment, held in Stockholm. A first step for state government is to adopt adequate strategies and policy plans at the national level and above to ensure that environmental considerations are integrated into all policy sectors.

II. MUNICIPAL SOLID WASTE MANAGEMENT IN LATVIA

There are many environmental problems which depend on human economic activities. One of the most important is growing amount of municipal solid waste in the World. Similar situation unfortunately is in Latvia. Concerning EU and Latvia environmental policy there are 11 new municipal waste landfill disposals [1] built in Latvia at last years. Average waste landfill disposal can be used approximately 20 years, than a new one must be built. For this reason a place, optimal from environmental as well as socio economic point of view must be chosen. There is important necessity providing decision makers with objective information about potential “hot points” of municipal solid waste.

III. INFORMATION POSSIBILITIES IN ENVIRONMENTAL IMPACT ASSSESSMENT PROCEDURE

There are many information sources for decision makers, for example Central Statistic Bureau data basis. Nearby there are some information sources which has no used before. For example collecting and publishing proposed (economic) activities data in environmental impact assessment (EIA) procedure is environmental institutions obligation. Environmental impact assessment is the process of identifying, predicting, evaluating and mitigating the biophysical and socio economical effects of development proposals prior to major decisions being taken and commitments made [2]. In Latvia EIA started in 1999 and is applied to economic activities as defined under the law On Environmental Impact Assessment. The main goal of EIA is to provide decision makers with objective information about economic activity impacts on biophysical and socio economical spheres.

IV. MUNICIPAL SOLID WASTE DISPOSAL LANDFILL PLANNING POSSIBILITIES

EIA economic activities data basis consist of 4791 occurrences from year 1999 to 2011 incl. Data basis represents wide spectrum human economic activities, for example house building, infrastructure, waste landfill disposal building projects etc. There is possibility for data analysis, which lies in following classification criteria:

a) territory (statistical region, city, parish);
b) type of economic activity;
c) date of economic activity.

As the results of data analysis show, *Pierīga* statistic region consist 44,3 % of all economic activities. The minimum economic activities are in *Latgale* statistic region, which comprises only 8,3 % of economic activities. House building, infrastructure development projects are mainly located in *Rīga* and *Pierīga* statistic regions, which consists average 83 % of all which means these are the potential main points of municipal solid waste generation in Latvia. Analysis results can be used as information source for new municipal solid waste landfill disposal place location possibilities in the further.

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Measuring Bank Value Based on Key Performance Indicators

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Keywords **– Bank value, performance indicators, regression analysis.**

I. Introduction

M&A activity in the banking industry has been at the unprecedented level over the last twenty years. This, in turn, increases the importance of professional bank valuation. The method of Discounted Cash Flow (DCF) is the most appropriate one for measuring the value of a financial institution. Considering the limitations in the technical applicability of the DCF in emerging markets, the authors suggest estimating the value of Latvian banks, using a regression model that involves bank performance indicators.

II. Research Description and Empirical Results

While conducting the previous research in the field the authors developed a regression model for measuring bank value, using financial data of 2010. The model can be expressed by the equation (1):

$$Vbank = 3{,}693 \times NII + 2{,}038 \times P, \quad (1)$$

where P – provisions for doubtful loans, 000' LVL;
NII – net interest income, 000' LVL.

In the current research we estimated the value of Latvian banks, using the data from financial reports of 2011. Research objects are 17 Latvian banks. The difference between the banks' empirical value, based on average P/B ratio for CEE banks, and the estimated function value is significant in the most cases. Besides, the estimated function value is higher than empirical value. It means that banks are overestimated, applying the developed model.

Considering the significant gap between empirical and model-estimated value, the authors conducted the iterated correlation analysis, using the latest data. SPSS 19.0 was used as a software tool.

TABLE I
Correlation between bank value and financial indices

Financial indicator	Pearson correlation	Sig.
Return on equity	,343	,178
Return on assets	,409	,103
Cost-to-income	-,275	,286
Net interest income to total income	,383	,129
Non-performing loans to total loans	-,277	,283
Provisions for doubtful loans	,974	,000
EPSI	-,337	,185
Net interest income	,973	,000
Net interest margin	,393	,118
Interest income to interest expenses	-,056	,832

The analysis yielded the same variables as previously, which have statistically significant correlation with bank value: (1) provisions for doubtful loans (P), and (2) net interest income (NII). The developed model is expressed by the equation (2):

$$Vbank = 4{,}019 \times NII + 0{,}894 \times P \quad (2)$$

The model is statistically significant (sig. F = 0,000). R^2 = 0,986, indicating that 98,6 per cent of the variability in the bank value is explained by this model. Both regression coefficients are statistically significant (p-value = 0,000). The variance inflation factor (VIF) = 9,753 < 10 indicates that there is no multicollinearity. The gap between the empirical value and function estimated value of Latvian banks is presented in the Fig. 1. In most cases the gap does not exceed 30 per cent.

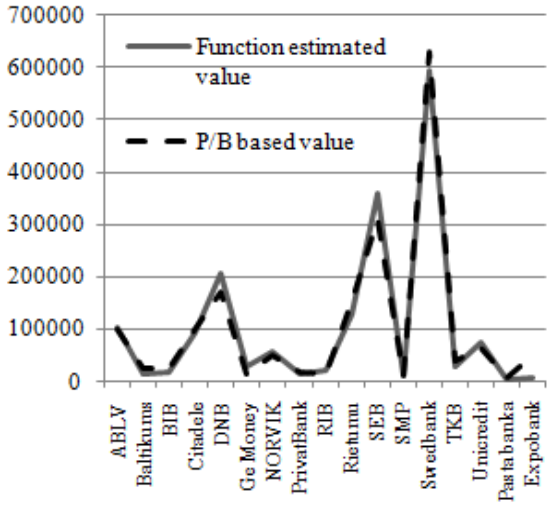

Fig. 1. Empirical (P/B-based) and function estimated value of Latvian banks.

III. Conclusions

Application of the regression model for measuring bank value is a good alternative to other methods. The authors' developed model has a high statistical significance. However, it differs from the model that was developed in the previous research. It points to the fact that measuring the value of banks, using such kind of models requires frequent adjustments of the model's formula in order to receive the reliable results.

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Insurance as a Financial instrument of Private Well-Being Latvia

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***Keywords*- three-tier pension scheme, endowment pension plan –life insurance, endowment life insurance, well - being.**

I. INTRODUCTION

The Annual Report by the European Commission to the European Council of 2001 identifies ageing population and its social and economic challenges to growth and prosperity to be among the most pressing challenges of the 21st century in Europe, points out serious infrastructure gaps in understanding individual, population and financial well-being ageing. *Object* of the research: provision of private well-being in Latvia. *Topic limitation*: the research deals with the provision of financial resources for private well-being within the three-tier pension scheme and endowment life insurance in Latvia. *The objective* of the research is to identify the option of endowment life insurance as a financial instrument of social insurance in Latvia.

II. RESULT

Crisis in context of demographic crisis, with emphasis on the aging population, can be a serious risk for stability of the social insurance system now and in future. Voluntary retirement savings using life insurance services or making contributions to private pension funds can secure people against decrease of income after retirement and retain their desired standard of living. For this reason, each individual should assess opportunities for provision of private well-being, particularly upon retirement. The well-being of the population can be defined in different ways. It could involve the income level, the education level and the purchasing power, as well as the health condition. The pension system is one of the most important elements of social insurance.[19]

III. DISCUSSION

In each country, the social system and well-being have its own national characteristics, for example, Latvia has had its three-tier pension scheme since July 2001, which combines the provision of well-being for each individual in old age, as well as solidarity between generations.[10] Co-existence of all three tiers ensures stability of the pension scheme and provides for private well-being, as it spreads the possible demographic or financial risks inherent in each of these tiers. The planned amount of capital could be much higher, in 2010, the amount of capital was supposed to be 5 times greater than the actual amount (f.v.). Tier 3 should compensate for the potential shortfall in private funds/ Changes in average monthly gross and net salaries from 2000 to 2010 lead to increased number of participants in private pension schemes (f.v.).The amount of gross premiums written for life insurance has also increased (f.v.). The demand relationship, including the insurance demand relationship, in the market economy is governed by the law of demand. The price is an essential factor, yet it is not the only factor that can influence demand.[14] Buyers can also be motivated by other non-price factors and indicators.

TABLE 1

Voluntary Private Pension Scheme Retirement Tier 3, Endowment Pension Plan - Life Insurance, Endowment Life Insurance indicators Latvia market

Indicators	Retirement Tier 3	Endowment Pension Plan - Life insurance	Endowment Life insurance
Tax relief	YES	YES	YES
Life-long Annuity from the maturity value	YES	YES	YES
Two components of tarif	NO	NO	death risk and endowment
Technical rate of interest on premium	Depends on the saving policy	Depends on the saving policy	Fixed % amount
Surplus interest gain on premium	NO	NO	investment return
Disability benefits	NO	NO	Accident insurance

In contrast to Voluntary Private Pension Scheme Retirement Tier 3 and Endowment Pension Plan –Life insurance, as a part of well - being system, endowment life insurance also includes insurance on death. (Table 1) The tariff of endowment insurance is constructed from two components: one of these is a pure endowment – a savings fund without any death risk. The second component of the policy is a death risk if the insured dies during the term of the policy and before the pure endowment has matured, the sum insured will be available. The accident insurance can be the part of the insurance police. The benefit is payable when the insured is unable to perform certain "activities of daily living".

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Impact of information resources on the development of national production

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Keywords **− production function, information resources, information industry, information system, national production.**

I. INTRODUCTION

In reality of the XXI century in today's globalized world to ensure efficient production along with materialized resources - raw materials, energy, labor, production assets new component, information resources, is important. Now the information is considered to be the priority - strategic information resources in innovation. Modern production of goods and services on a global scale is characterized by growth rates of updated equipment and technology, and therefore the level of knowledge and ways of transmission must grow exponentially.

II THE ROLE OF INFORMATION RESOURCES IN REGULATION OF DYNAMICS OF ECONOMICS OF SOME COUNTIRES

Information use provides the interests of a society as a whole, which is the foundation of economic growth. At present the current state of civilization is called the information economy. The information society is characterized by the importance of information for the development of national production and on this basis social progress goes on. In all the developed economies, the production and consumption of information is getting signs of the strategic resource. The increase of added value in economies of the countries is now going through the available information about new technologies, equipment management techniques and marketing of their further use.

III. CLASSIFICATION OF THE INFORMATION SYSTEM COMPONENTS

Complication of the contemporary production is the need for innovative direction in its development objectively requires the formation of the perfect information system of a society.

The information system is understood as a component of the social system that includes monitoring research, production, processing, use and storage of relevant information with technical, intellectual means of printed, radio, telecommunication and electronic content for use by public authorities, business and social structures, population.

The need for such a system in a society is determined by the challenges of globalization, the development of modern production, the necessity of the real economy and infrastructure in obtaining of accurate and complete information.

IV. FORMATION OF INFORMATION RESOURCES AT THE NATIONAL LEVEL

To ensure the dynamics of national production governments are obliged to organize the effective functioning of the national system of information and access to information for all its users. The formation of the society is to know: all segments of populations from the ruling political elite to ordinary citizens should know. To realize this goal it is necessary: to form the foundations of a democratic society, because only in such a society information can be freely received and disseminated, provide the necessary funds, including budget, to ensure free access for all users and provide industrial and technical base within the international division Proceedings of the National competitive information technology and resources, organize training and retraining of personnel required, to ensure information security.

V. EVALUATION OF INFORMATION IMPACT ON THE ECONOMY

In economic literature there are different approaches to assess the impact of information resources on economic growth. The factors, indicators of development, forecasts of international expert organizations, the calculations of individual scientists are taken for the basis. American economists have developed a spatial model using the parameter of "intellectual capital" to include the cost of his education, publication of scientific literature, commissioning educational institutions, etc. [7].

$$Y_t = K_t^{\alpha} lk_t \left(\bar{A}(t) Lt\right)^{1-\alpha-\tau}, \quad (1)$$

where: lk_t - intellectual capital, $\bar{A}(t)$ - factor NTP, $\alpha + \tau < 1$ - ratios.

VI. CONCLUSIONS

Carried out research confirms the high importance of the role of information and its growing influence on the development of national production. According to the study the following conclusions can be made:

1. In reality of the XXI century information along with the other components of the production process is getting increasingly important.
2. Nowadays information is formed in a separate area of human activity, thereby increasing the volume of information industry.
3. Any country that wants to take now or in the future leadership in the global division of labor must permanently at the state level give this specific resources special attention.
4. To determine the effectiveness of information resources in producing it is appropriate to apply special approaches.

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Business Development Project Planning: Business Model Analysis

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Keywords **– business model; business development, project planning, feasibility study, consulting.**

I. INTRODUCTION

This paper is devoted to project scope planning for a business development project. This wide class of projects has a significant risk: the project may affect negatively the current business model and its viability in future. Project goals and methods should be convergent with vision of future business model transformations. Different groups of the project and business stakeholders may have different visions and interpretations of current situation. This paper is based both on the authors' practical experience and study of relevant publications. Research methods include case study (one of the authors participated in 10 business development projects) and generalization. Here we would like to present a step-by-step algorithm of analyzing current business model and generating project alternatives. This process delivers inputs for further project scope planning.

II. UNDERSTANDING BUSINESS MODEL IN THE CONTEXT OF PROJECT MANAGEMENT

The term "business model" has a lot of definitions and interpretations [1-3]. We define business model as a set of roles and relationships, which are carried by the entity to get profit and positive cash flow within a certain structure of interests [4]. Understanding that industries and structures of interests (motivators) may change, we suggest that roles and/or relationships should be changed too in order to continue to use the company resources for generating added value. Otherwise leaders of the company have to support the current framework of interests. Company top-management and owners should be pro-active to be able to meet upcoming challenges. Vision of needed business transformation is essential here. Here we focus on ensuring a long-term viability for a business. This may be achieved through a chain of consequent changes (projects for business model transformation). We believe that understanding of "business model" as an object of transformation may come also from understanding of business diagnostics process.

III. BUSINESS MODEL ANALYSIS

Having generalized own experience of participation in business development projects, we propose the following logic of planning such projects (Figure 1):

1. Data collection and systematization:
   - collection and systematization of information related to internal structures and processes;
   - models of interactions with external environment;
   - gathering information about behavior of the industry leaders.
2. Creating interpretations of the current status of the business in question:
   - the corporate interpretation;
   - the external experts' interpretation;
   - business models of the industry leaders.
3. Comparative analysis of the current business model with business models of industry leaders.
4. Elaboration of vision of possible/needed/inevitable transformation of the current business model.
5. Setting up or revising the project goals.

This model of the diagnostics process may be applied at different phases of the project life cycle, especially when the project scope or project product should be revised. The sections (aspects) of analysis:

1)business activities;
2)value chain;
3)business margins;
4)marketing strategies and tactics;
5)supply chain;
6)geographical location of the company units;
7)production strategies and tactics;
8)assets;
9)current and possible alliances, mergers and acquisitions;
10) type of the business entity.

So, the strategic committee needs information about the business and industry leaders. Business models of the industry leaders may be understood through gathering available reliable information and structuring it according to the mentioned aspects. We separate the processes of creating interpretations of the current status by corporate decision makers and external experts. Obtained representation of the current business model is useful also for the project scope management and project integration. The next steps: 1) to build the target business model; 2) to elaborate the project plan, which includes project activities, project quality management plan, communication management, human resources management, risk management, etc. [5].

The main recommendations: interpretations and representations of the current business model should be based on the same data set for corporate and external experts; it is important to obtain complete and independent from each other representations from corporate and external experts; new/additional essential information is enough reason to revise analysis results and solutions.

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Financial Stability of Insurance Companies: Assessment and Provision”

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Keywords: **financial stability of an insurance company, solvency, the three-prong model, Solvency II, Solvency I vs. Solvency II.**

I. INTRODUCTION

The purpose of this article is to evaluate the system Solvency II as a tool to achieve financial stability in the insurance industry. Financial stability of an insurance company means to find the optimal qualitative and quantitative amount of assets and liabilities in order to provide an insurer covering of its financial obligations in time and in full payment with current assets. It consists of a constant balancing of an insurer’s income and expenditure there income is equal to or greater than expenditure. Hereafter attention is paid to the new solvency system that will promote financial stability improvements of insurance companies.

II. IMPORTANCE OF THE SOLVENCY PROVIDING FINANCIAL STABILITY INTO INSURANCE COMPANIES

The three-prong model illustrates the three factors that interact to create sectoral solvency in order to provide financial stability in insurance (see figure 1). The third prong in the insurance mechanism is what adds significant importance to keeping the insurance sector resilient. That part is the insurance market mechanism with its underwriting cycles and adherence to improving underwriting results when the investments/financial markets are too volatile and not producing enough income to supplement underwriting losses [1].

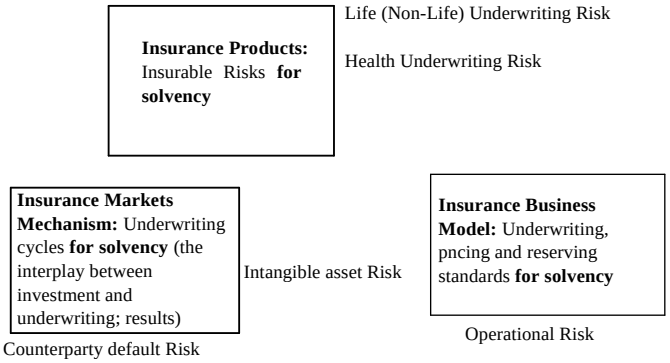

Fig.1. The 3-Prongs of Insurance Mechanism for Financial Stability Source: completed by the authors based on [1]

However, the three prongs, as shown in the figure 1, for insurance solvency providing its financial stability are integrated and equally important.

III. ASSESSMENT OF THE SOLVENCY II SYSTEM

In the 1990s and early 2000s, there were a number of initiatives to reform the regulatory capital requirements of EU insurers through a series of Insurance Directives. This led to the current framework known as Solvency I. However, companies and regulators have felt for a while that a more fundamental overhaul of solvency regulation is necessary to improve consistency and achieve a better correlation of capital requirements to economic risk. This gave birth to the Solvency II system. In 2004, the European Commission (EC) started a consultation process with CEIOPS (Committee of European Insurance and Occupational Pensions Supervisors) to begin to design Solvency II [3].

CEIOPS has acted as the key body running the Solvency II framework, issuing consultation papers on the shape of Solvency II and running a number of Quantitative Impact Studies (QIS) with the industry. If the results of QIS5, the last QIS, throw up a large number of problems or additional industry debate, it is possible that the industry carries out further quantitative studies. However the EC committed to applying Solvency II from January 2014 [3].

IV. NECESSITY OF THE GROUNDS AND IMPLEMENTATION OF THE NEW SOLVENCY SYSTEM

Rather than the current system of flat percentage capital requirements, Solvency II will employ an array of detailed insurance and market risk stress tests to determine how much capital insurance companies will need to hold. Therefore, capital requirements may vary widely depending on the degree of risk taken by different companies [3]. The basic elements of Solvency I vs. Solvency II are as follows:

- applying a total balance sheet approach (i.e. including both assets and liabilities);
- a trend towards ‘economic’ or market value based measurement of the balance heet rather than relying on existing accounting measures;
- a value-at-risk type approach to determining capital requirements;
- calibration of capital requirements to a specific confidence level over one year, generally above 99.5% [2].

V. CONCLUSIONS

Provision of insurance companies’ financial stability is stipulated by the Solvency II system that is a risk-based, economic measure of capital requirements in order to improve Eropean Union insurers’ solvency ratios.

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National Economy and Entrepreneurship

Quality Technologies and Management

Application of Quality Function Deployment methodology for improvement of study programmes

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Keywords: **– Quality function deployment, study programme, quality assurance.**

I. INTRODUCTION

There are different quality assurance methodologies applied for assessment and improvement of study programs. The aim of this paper is to perform analysis and assessment of the Quality Function Deployment (QFD) methodology application to study program assessment.

QFD methodology can be applied for identification of client needs and evaluation of client satisfaction level with the product or service. At the same time it is also self-assessment method, which can be applied for design and improvement of the study programs and processes.

II. QUALITY FUNCTION DEPLOYMENT METHODOLOGY (QFD)

There are few publications on QFD methodology in Latvia. As this methodology is not researched widely, in research papers in Latvian we cannot find a common translation from other languages of the term *Quality Function Deployment*. In Latvian publications we can find the term *House of Quality* (kvalitātes māja). The term *Qualitätsfunktionendarstellung* in German [1] is translated in Latvian as *Kvalitātes funkciju attēlojums.*

However, this translation is not widely spread and has more or less explanatory meaning. Considering the fact that the methodology is well recognized and effectively used in many countries for quality planning and assurance in manufacturing, services and other sectors, its title *Quality Function Deployment* and abbreviation *QFD* in many languages is accepted "as it is" without translation. Since the use of English version of the term does not cause any misunderstandings, the quality management professionals in different countries are using this version internationally.

QFD methodology emerged in Japan in the beginning of 1970-ties in a shipbuilding industry and very soon has expanded into other industries and sectors. In Europe it became popular in the beginning of 1990-ies. It proved to be efficient, considerably decreasing (2…3 times) the product development cycle or period of time from the market research to new product implementation into the market [2].

The method is based on so-called quality house – a matrix comprising information about client needs - "what" does he/she need, and assessment of the needs significance. The client needs are recorded in the matrix rows from top down, but the options of their implementation, intentions of planning and improvement or "how-s" are recorded in the matrix columns from left to right. The aggregated information provides for almost simultaneous research, design and manufacturing activities; at later stages these activities can include also product improvement. QFD methodology not only enables evaluation of client satisfaction level but also provides an opportunity to determine the client top priority needs, wishes, requirements and significance of those product characteristics which create client satisfaction.

Visual picture can be obtained by aggregating aforementioned information in the matrix of the *House of Quality* that demonstrates significance of each product/service characteristic for satisfaction of client needs and wishes.

III. ASSURANCE OF STUDY PROGRAMME QUALITY

The important aim of each higher education institution (HEI) is to ensure topical knowledge and skills for students in order to make them competitive in the local and international labour market. Therefore carefully arranged study and administration processes are underlying effective and efficient operation of modern university. Qualitative results could be ensured only by efficient management of actions and procedures.

Implementation of quality management system could help university to arrange all main and support processes confirming ability to provide education that corresponds to customers' (students, employers and society) needs. One of the most important quality criteria for higher education is valuable and useful study programmes.

QFD methodology allows to develop and improve content of the studies and study process according to demand of changing environment [3]. In this case development and improvement of study programmes is done by, both – academia and industry – professionals, anticipating cooperation with other study programmes and HEIs.

IV. CONCLUSIONS

Principle of continuous improvement comprises all the study processes, it relates also to initial analysis of the content of study programme as well as to continuous improvement process. Study programme should be revised and advanced in accordance with requirements for particular moment and anticipation of future demands and needs for specific professional qualification. As a result a list and content of study subjects have been revised and updated; teaching methods, logic and structure as well as content of different courses have been integrated between those courses.

Application of QFD methodology helps to improve operation of HEI. If new professional knowledge is included in study content on regular bases and academic staff is more motivate to acquire topical knowledge and skills, study process becomes more rational, effective and it could save a lot of costs for HEI.

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Conformity Assessment: Billing Methods for Water Consumption

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Keywords **– conformity assessment, water meter, public utilities services.**

I. Introduction

The aim of the paper is to show innovative approach in the field of conformity assessment through aspects of public utilities services.

Main methods used for the research are analysis and comparison of methods used in the field of public utilities services. The article examines three water consumption recording and calculation methods: billing based on the calculation of the water consumed, billing based on water meter readings and payments using prepaid water meters.

II. Billing Methods for Water Consumption

One of the most necessary everyday services is water supply. The issue of water consumption recording methodology, the credibility of measurements and water loss provisions has been raised recently.

The article reviews and illustrates the three different methods of payment for the volume of the water consumed, reveals the advantages and disadvantages of each method, and offers detailed recommendations with an aim to promote mutual discussion between the residents and house managers in finding optimal solutions for water consumption metering and billing.

A. Billing based on the calculation of the water consumed

Up to the middle of the 1990s in Latvia this method was mainly used to calculate the volume of the water consumed.

In this method the calculation does not reflect any differences and questions about the payment procedure appear. In this case do not use water meters, using water consumption calculation formula [3].

The authors have to admit that to some extent this calculation method is controversial, since it is impossible to determine the exact number of persons living in the apartment in the concrete time period.

This method is used only therefore it is possible to ensure the credibility of the formula elements.

B. Billing based on the water meter readings

To calculate the volume of the water consumed in the residential houses in Latvia, at least one water meter is being used in each household. To make water consumption estimates and monitoring, one input meter is used in multi-storey houses.

Water consumption meters have to comply with the essential requirements for measuring instruments and the overall conformity assessment requirements. The conformity assessment should provide a high level of confidence [2].

There are several types of water meters in common use. Selection is based on different flow measurement methods, the type of end user, the required flow rates, and accuracy requirements.

The majority of the Latvian population now choose to use this method; the main arguments being that this method has a relatively higher credibility, as residents have to pay for the volume of the water actually consumed.

However, unresolved issue remains on how to split the difference (losses) between the house input meter and the total amount of household meter readings [1].

C. Payments using prepaid water meters

In this case the difference is that the consumption of water is estimated in advance and the house manager is not involved in this process. Prepaid water meters facilitate effective demand management in a very cruel manner: when you are unable to afford the charge you are simply cut off.

In Latvia, this is a totally innovative method, because nothing similar to this has been tested. At the same time the authors should mention the shortcomings of this method – the fact that in order to start operating such systems there is a need for investments and the instalment of this type meters in the whole building simultaneously. It is also necessary to develop a methodology for dealing with losses, if there are any, and how they could be proportionally distributed among the households.

Latvian citizens are concerned about the payments for their water consumption in a given time period and the losses incurred within the residential house. That's why in Latvia one of the most important reasons why consumers started to use water meters in the 1990s was to reduce payment for water. After assessing each of three particular methods separately, it has to be admitted that for Latvia the first two methods are more appropriate, the third method would require investments and changes in the whole system.

The most beneficial method for consumers is billing based on water meter readings, which is relatively more expensive than the second method, however, the calculations are more accurate and the situation can be better monitored.

The most beneficial method for house managers is billing based on calculations, in this method the there is no difference between the house input and household meter readings, so it does not produce disputes with the residents on this topic.

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Quality improvement using Taguchi's model – one example from Serbia

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Keywords **- Knowledge–based system, robust system, quality loss, genetic algorithm, improvement.**

I. INTRODUCTION

The approach of Taguchi's robust design has been successfully used in many single-response process design problems. However, to date, the original Taguchi method has not proved fully functional for optimising the multi-objective problems; the sole path was relying on engineers' judgement. There are several recent approaches for multi-response design based on Taguchi static robust design, actually on the transformation of Taguchi's quality loss function [1] or Taguchi's SN ratio [2] that consider correlation among responses employing principal component analysis (PCA) to uncorrelate them.

II. TAGUCHI'S MODEL – OUR APPROACH

The developed model, that intends to overcome the deficiencies of the above methods, is composed of three modules, as follows [3]. ***Module 1: Design of experiment by expert system:*** The purpose of the expert system for the design of experiments is to generate the experimental plan by selecting an inner orthogonal array (OA), with respect to the number of control factors and levels, and an outer array with respect to the number of noise factors and levels used in the experiment. In the developed rule-based expert system, rules for the arrays selection are formed using 'If-Then' rules. ***Module 2: Experimental data pre-processing and analysis.*** The measured response values are transformed into corresponding Taguchi's quality losses (*QL*). The *QL* presents a financial measure of the customer dissatisfaction with a response as it deviates from a specified value. In general case, the quality characteristics of a product are correlated as well as the corresponding *QLs*, so it is necessary to uncorrelate them. Principal component analysis (PCA) is performed over normalised *QL* data (*NQL*) to obtain a set of uncorrelated components. Then, grey relational analysis (GRA) is used to syntheses the obtained components into a single measure with respect to their weights in PCA. GRA main function is to indicate the relational degree between the current data sequence and the ideal sequence (in this case, the ideal sequence is: $QL = 0$). The obtained grey relational grade (γ_k) is adopted as the synthetic performance measure that adequately takes into account all, possibly correlated, responses with respect to the customer specifications. The weights used for determining γ_k are based on the total variance of original responses, which maximise the objectivity of the analysis. Knowing γ_k and factor (parameter) values, it is possible to calculate the effects of factors on the γ_k for all factor levels used in the experiment. ***Module 3: Solution - process modelling and optimisation.*** In order to integrate knowledge into the processes design, artificial intelligence techniques are employed. Artificial neural networks (ANNs) are used to learn the process behaviour, to establish the relationship between the process parameters and the synthetic performance measure γ_k. By using the trained neural model, a genetic algorithm (GA) is employed to find the global optimal process parameters setting. ANN is a powerful technique to generate complex multi-response models without referring to a particular mathematical model, proven effective in various applications. The ANN model presents an objective function for GA, who, by maximising the objective function, finds the optimal process parameter settings in a continual space. In this model, GA's initial population is set in a neighbourhood of a potentially good solution - the factor effects solution. The best GA is chosen according to the maximal fitness (γ) criteria and its solution is adopted as a final.

III. EXPERIMENTAL RESULTS

The analysis of several experimental results confirms the effectiveness of the model in solving various types of multi-objective problems in process design, optimisation and/or modelling. Two case studies are presented in full paper.

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Mandatory subsequent verification of measuring instruments

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***Keywords* – regulated metrology, maximum permissible error, measurement uncertainty, calibration and verification of measuring instruments.**

I. INTRODUCTION

Economic crisis in Europe and throughout the World forces citizens and governments in a number of countries to introduce difficult and painful economic measures and Latvia is no exception. Especially this relates to saving of energy resources. When economizing resources, one has to observe some unwritten economy rules:

1) resources should be measured in order to determine efficiency and effectiveness of the savings,
2) observation of measurement accuracy is a pre-condition of fair trade practice; incorrect measurements always is a cause of unjustified benefits to one party and losses to another party.

An increased intensity of different measuring instruments usage can be observed while implementing economy measures in practice. For example, if in 1990 there were only some few hundreds of water consumption meters installed in houses in Latvia, then today they amount up to more than one million water meters.

We have to remember that such enormous increase in the number of measuring instruments enforces significance of the second aforementioned economy rule – the measurements should be accurate and confirming to the metrological requirements prescribed in the corresponding legislative acts.

II. SUBSEQUENT VERIFICATION OF MEASURING INSTRUMENTS

The EC Directive [1] is determining that measuring instruments during their use should ensure high level of metrological reliability. Therefore each member country of the European Community has an obligation to accomplish metrological control in the fields, concerning interests of society, public health, state security, public policy, environmental protection, consumer rights and fair trade.

Conformity assessment procedures in design and manufacturing are determined by the EC Directives. At the same time such functions of metrological control as subsequent verification and monitoring of measuring instruments during their usage are determined by the national legislative acts.

Thereby measuring instruments in each EC member state during their usage are verified and inspected applying different conformity assessment procedures, verification accuracy and terms; sometimes even understanding of the essence of verification is different.

III. CONCLUSIONS

In order to improve terms of subsequent verification for measuring instruments at national level, the author in the presentation is explaining the principles of subsequent verification conformity assessment [2] and presents recommendation to adopt in Latvia a single methodology on subsequent verification of the measuring instruments, determining criteria for verification accuracy and principles, how to set down terms of subsequent verification [3].

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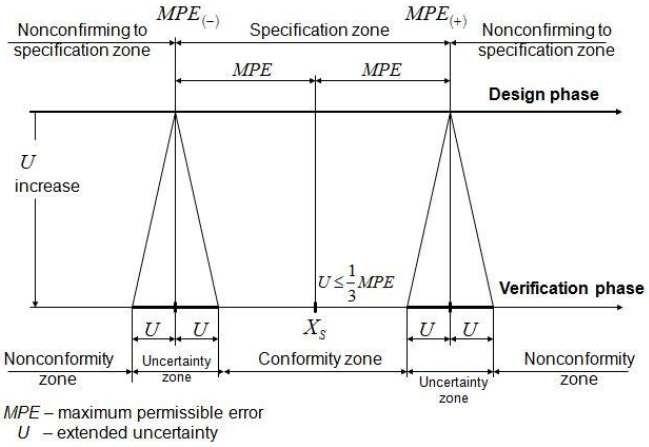

5.att. Subsequent verification of measuring instruments - determination of the level of extended uncertainty

The author considers that described additional requirements of subsequent verification methodology will be helpful for quality professionals to improve the quality of subsequent verification and their implementation will reduce a number of nonconforming and incorrect measurements thus enabling decrease in the amount of unjustified expenses of inhabitants for the use of resources.

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Assessment of Research Results Commercialization Process in Latvia

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Keywords – process management, commercialization of research results, Latvia.

I. Introduction

The commercialization of research results is an important component in innovation which is much needed in the market economy for enterprises to maintain the business and growth.

Process management approach gives the opportunity to focus on the measurable results and clearly identify the roles and tasks of stakeholders involved in the process.

The goal of this paper is to investigate process management approach, particularly in respect to commercialization of research results in Latvia and to assess current status of this process.

II. Process Management Approach

In any company or economic environment there are certain processes, regardless of whether they are identified or not. From the process management perspective, the process should be identified in the first place.

If composed correctly and managed well, the process ensures that the set of tasks is provided consistently and in a certain sequence, and that it delivers the results intended initially [1].

By identifying unconnected activities that are performed by different stakeholders towards common result and by using process management approach it is possible to improve overall performance and thus the results of activities combined in one single process [2].

Essentially for commercialization of research results which is a process happening in the field between research organizations and enterprises, process management approach gives the possibility to identify relevant stakeholders and assign tasks to them in an organized way [3].

III. Commercialization of Research Results In Latvia

In general, commercialization is the process of introducing a new product or technology into the market.

The knowledge transfer from research organizations, such as universities, independent research institutes and other higher education institutions, to businesses is an essential part of commercialization of research results when the intellectual property developed by scientific teams and individual inventors is being monetized.

Among all the research organizations in Latvia only few manage to commercialize their scientific developments. There are several major reasons for that, including lack of commercialization culture and the way of thinking; broad availability of different funds for fundamental and applied research; lack of scientists' trust in third parties to discover the essence of invention; inexistence of qualified and experienced knowledge transfer specialists; inapplicability of research results to the industry or market.

Commercialization is a process that involves stakeholders from different fields, e.g. academia, business, technology/knowledge transfer offices, financial and legal service providers. It is important that the process is not only correctly identified and described; it also requires proper management to deliver the expected results. In the case of commercialization of research results the management of it and the authority over it has to be in hands of knowledge transfer specialist or a team of such specialists.

Currently in Latvia commercialization process is not formally identified and improved. It is mainly managed either by scientists or technology transfer offices, in majority of the cases – the latter. There are 8 technology transfer offices – departments of all universities and some of the higher education institutions.

Technology transfer offices are financed by EU structural funds, the personnel is not trained systematically. The activity level in the supply side (identifying commercializable research results) has been high; however the demand side (potential IP buyers/licensees) is poorly covered. Mainly this is due to the lack of skills of technology transfer officers and non-existence of the relevant professional network.

IV. Conclusion

The commercialization process in Latvia is not yet identified and described although it exists.

Despite the potential of Latvian research organizations the commercialization of new products and technologies rarely takes place. This problem has been identified by policy makers who have allocated considerable financial resources to promote commercialization culture among scientists and entrepreneurs.

In order to achieve knowledge transfer that results in applications of scientific developments to industries and markets, there has to be a systematic actions and follow-up activities performed by relevant stakeholders. The process management approach gives the possibility to organize it.

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Qualitative factors influencing the risk intelligence audit firm's management

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I. INTRODUCTION

Quality Management (TQM) is an approach that organizations use to improve their internal processes and increase customer satisfaction. When it is properly implemented, this style of management can lead to decreased costs related to corrective or preventative maintenance, better overall performance, and an increased number of happy and loyal customers. In a Risk Intelligent organization, everyone in the organization understands audit firm's manager's approach to risk and they take personal responsibility for managing risk in their work every day. It is question: Can qualitative indicators be a warranty of good management of audit company's risk intelligence? It is possible, if external and internal benchmarking is based on quantitative indicators?

Keywords: key performance indicator, professional services risk management, q**uality control of audit firm.**

II. MAIN QUALITATIVE FACTORS INFLUENCING THE RISK INTELLIGENCE AUDIT FIRM'S MANAGEMENT

According to various authors professional service management is the system of both internal and external remedies that create environment for businessmen and employees of an audit company where they develop, share and use their and other's knowledge to achieve the best results Ciegis, R., Ramanauskiene, J., & Startiene, G. (2009 f.v.). Knowledge (capabilities, competence, experience, organization culture, informal networks of organizational relations and audit firm's human capital) create conditions of risk management culture in business Jarvis, M., & Tint, P. (2009 f.v.), Ubius, U., & Alas, R. (2009 f.v.). Knowledge organization has much better possibilities for successful work in the unpredictable and fast changing environment created by globalization processes Gudas, S. (2009 f.v.). Other authors such as Stanikunas, R. (2010 f.v.), [2], Miron, D., & Paul, A. (2010 f.v.) supply the *external qualitative factors*: criminal situation, legal acts, taxes, geographic, economic factors, customer, partner, competitor expectations, scientific progress, market supply, reputation, ecology, etc.

III. KEY PERFORMANCE INDICATORS OF EXTERNAL AND INTERNAL BENCHMARKING

Benchmarking can provide companies with the concrete baseline and comparative data they need to identify performance gaps - and ways to bridge them. Key qualitative factors for firm assessment include: revenues, profitability, liquidity, debtor control, work in progress control and growth. These areas are basic features of risk intelligence firm. ***External benchmarking*** simply refers to the comparison of the baseline cost and performance of a particular process or function. In article author summarize quantitative factors, as Key performance indicators (KPI):

TABLE 1

KEY PERFORMANCE INDICATORS OF EXTERNAL AND INTERNAL BENCHMARKING

KPI groups	Management area	Key performance indicators
Firm-wide Key performance indicators (KPI) suitable for external benchmarking	Profitability	Wages cost as percentage of total revenue; Other overheads as percentage of total revenue; Net profit per partner/director; Write-downs as percentage of total production, or per person.

To my mind [1] all the **qualititative factors** describe the ***internal environment*** of organization (ethic features, technique and technology (know-how), information, capabilities, competence, experience, organization culture, informal networks of organizational relations and audit firm's human capital, organization structure, culture, risk intelligence). Manager might then use benchmarks to argue for additional employees to help process the higher volume of activity. That would clearly not be a good result for the firm overall, because it increases the cost of running the firm while still meeting the benchmark [3]. **As result** of theoretical research ten steps to successful risk management were identified.

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Health managers' attitudes survey – implement the information communication system for registration of medical errors

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Keywords: **management, medical errors, IT, quality, patient safety.**

I. Introduction

In recent years, many international experts are working on issues of patient safety using the information technologies. However, in Bulgaria there is no system for registration of adverse events occurred, unlike many countries around the world.

Developing and implementing an information system for registration and assessment of medical errors significantly contribute to the quality improvement of medical services and reduce funds for ineffective and inefficient medical care [1]-[3].

The aim of this study was to examine attitudes and motivation of health managers for the implementation of information communication system designed for registration and reporting of medical errors.

II. Methods and material

The number of health managers that took part in the research is 104. Sociological method was used: anonymous questionnaire survey conducted by e-mail and by post.

III. Results

The established positive attitudes on the part of managers - 59.6% (62) tended to introduce an information system for registration of medical errors in their managed hospital. Table.1 shows the distribution of the respondents' opinion, concerning the results of information systems' implementation for medical errors' registration.

TABLE.1

Respondents' opinion, concerning the results of information systems' implementation for medical errors' registration

1. Creating a negative public perception for healthcare organization.	**Yes**			**No**		
	n	%	Sp	n	%	Sp
	40	40,4	4,81	54	52	4,89
2. Adverse consequences for individual career development of staff.	**Yes**			**No**		
	n	%	Sp	n	%	Sp
	42	40,4	4,81	52	50	4,90
3. Improving the quality of health services and patient care.	**Yes**			**No**		
	n	%	Sp	n	%	Sp
	64	61,5	4,77	32	30,8	4,53

The main factors influencing the intention of the health managers to implement or not the information system for registration of medical errors are: 1) the possibility of improving the quality of medical care, which has a positive impact on their willingness to implement such information system - 61,5% ± 4,77%, P <0,002, V = 0,330; 2) the negative impact that might result from information system on public opinion, influences their reluctance to introduce such an information system - 40,4% ± 4.81%, P <0,001, V = 0,329.

IV. Conclusion

The study found positive attitudes of health managers to implement an information system for registration of medical errors in hospitals. The main reasons are quality improvement and increasing of effectiveness and efficiency of medical services.

V. Acknowledgments

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Technology Transfer and Innovation

TRAILS – CCBM: Cross Cultural Business and Virtual Team Communication Training Platform

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Keywords **– Virtual Teams, Intercultural Management, eLearning, Blended Learnin, Business Communication.**

I. Introduction

TRAILS is a cross cultural business and virtual team communication training and eLearning platform based on a highly experienced blended learning methodology. It consists of analyzing, awareness and training tools. It is the result of the current research and development at the M2C Institute of Applied Media Technology and Culture Bremen and the Centre for Intercultural Management of the University of Applied Sciences Bremen. In July 2012 it wins the "Best of 2012"-Certificate of the IT-Innovation-Award from the German Initiative Mittelstand *(German Association for Medium-Size Businesses)*

II. General Regulations

High Mobility against the background of increasing global networks based on economy and media characterizes future dimensions of intercultural communication, especially in virtual working environments. Intercultural competence is considered as key qualification; in combination with virtual competencies it appears as a vital factor of success. European institutions and enterprises are instrumental in European integration and international economic actions. They lead the field in the global development and dissemination of technical products, infrastructures, services and logistics. Also in technical sectors the export of services, knowledge and methodologies rises. Recent studies of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the German Federal Ministry of Economics and Technology (BMWi) and the Federal Ministry for Economic Cooperation and Development (BMZ) point to deficits regarding know-how of intercultural networking and its implementation in technically supported virtual cooperation between global actors. This lack of knowledge transfer foils the otherwise higher-than-average professional competencies of European players. However, former approaches disregarding the current state of research have not anticipated the technical visualization of an increasing share of intercultural communication. To close this gap, TRAILS and the further research and development of the CCBM – Cross Cultural Business and Virtual Management Communication Analyzing and Awareness Tool joins and integrates applied research and development of digital tools with individually designed integrative methods of media-supported learning. Only this technical-methodological interconnection allows solving huge deficits regarding the quality of management, communication and apprehension in such a way that economic efficiency as well as sustainability in social, political and reputative concerns of global players can be augmented considerably.

III. Objects

The innovative potential of the TRAILS tool lies in the option to develop novel instruments and methodologies for analysis and learning within intercultural and virtual working environments. Examples are the Intercultural-Competences-Screening, the Intercultural-Preference-Profile, the Intercultural-Preference-Leadership-Profile, the Virtual-Team-Maturity-Model, the Virtual-Team-Competence-Analyser, das Virtual-Emotional-Leadership-Profile etc. The results of these analyses are integrated pinpointedly on several levels into new Blended-Learning-Approaches in order to tap so far idle potentials between digital media and new learning methods and to create new opportunities for application-oriented learning with auditive, visual and interactive aspects. Existing methods, e.g. the Critical-Incident-Method or the Cultural-Assimilator, are refined; via multimedia und mobilized technology they advance the learning process onto a higher level. Due to the learning platform's modular construction, its content and size can be modified and adapted to the needs of the respective target group at any time. The TRAILS tool also functions as pre-stage advisory service in favor of organizational work optimization. Within the TRAILS project, possible uses and practical applications are developed and advanced in cooperation with coaches and consultants to be utilized in a future CCBM-System. The end-user will accomplish tasks within the sectors of virtual workstreams, social navigation and intercultural acting in an optimized way. The further qualification of coaches and consultants will be supported and vitalized by the intercultural interaction between experts communicating about technical and methodological learning components. The project's future will be a multilingual, multifunctional European tool, ready for implementation all over Europe by academic training schedules and professional development programs for managers in industry, business and NGOs.

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The Impact of Intellectual Property Reward Regime on the Competitiveness of Innovative SMEs

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Keywords **– Intellectual property (IP) reward regime, competitiveness, IP strategy, knowledge-intensive SME.**

I. Introduction

The aim of this research paper is to define which type of intellectual property reward regime (IP regime) increases the competitiveness of innovative SMEs. In general IP regimes either favour creators or prioritize entrepreneurs. Particular emphasis is given to IP strategy of knowledge-intensive SMEs of small country origin due to their need of early stage internationalisation [1].

II. Control of IP and Reward Regimes

Rapid evolvement of business environment, globalization and the rise of knowledge-based economies in many countries has put a pressure on countries to revise their IP regimes to enhance competitiveness of their companies.

IP system which is designed to prioritize creators over other entrepreneurs has its advantages. It is believed that legislative guarantees for creators to receive compensation enhances creativity and leads to more innovative solutions. For instance, the current Estonian copyright system has extensive catalogue of the author's moral rights which gives an author the opportunity to control his work even after the economic exploitation rights have been transferred (sold). Pursuant to the Estonian Patent Act an inventor has the right to receive fair proceeds from the profit received from the invention (Patent Act § 13 (8)). It means that even though the inventor has transferred all exploitation rights (sold the invention/patent) he still has the right to get extra compensation.

III. Strategic IP Issues for SMEs

The value from IP is extracted by launching a product or service to the market in the interaction of an inventor, entrepreneur and investor. Conflict of interests is reduced in very rare cases when all these roles are handled by the same person.

Due to high patenting costs the acquisition of IP rights is a strategic question for most companies. In case of software, the best strategy can be the utilisation of copyright and trade secret protection. Patents are often needed to block competitors or guarantee freedom to operate. Although it is possible to get funding for knowledge-intensive SMEs even without IP, SMEs are frequently acquiring IP to attract venture capital.

Experienced venture capitalists evaluate average success rate of new technology companies even after careful screening of inventions at 10%. This leads to several issues such as who assumes the risk for the rest of 90% and what is the fair compensation to creator-inventor, entrepreneur and investor?

As demonstrated by many cases success of IP exploitation is determined by an adequate business model.

All these raised aspects complicate the evaluation of creators-inventors' and entrepreneurs' contribution to business success or failure.

IV. Empirical Research and Methodology

Determining the impact of IP regime on technology and market development, and other strategic aspects in internationalisation of SMEs provides valuable insights to facilitate strategy creation by businesses as well as for public authorities in forming IP and entrepreneurship regulations and policies. This also entailed the need to analyze how IP is managed in the internationalisation process. Case studies were used to map the main factors affecting IP strategies of knowledge-intensive SMEs from the several technology fields and markets. The case studies were based on secondary data and personal interviews. This gave an opportunity to consider the aspects that researchers had already covered about the case companies. Historical facts and general overviews were collected from previous research results and press. Additionally web-pages and annual reports of the companies were studied. Patent information was mapped using search engine esp@cenet and worldwide databases of the European Patent Office. The aspects previously not covered and newer trends were mapped. Several interpretations were determined by interviews.

V. Findings and Discussion

IP reward regime prioritizing an inventor has an adverse impact on entrepreneurship in the following aspects:

1) an entrepreneur has usually several costly projects and only few of them are commercially successful. If an inventor has, in addition to a negotiated compensation, an additional non-transferable right to claim compensation from a successful commercialization of a patented invention then the entrepreneur may not be able to cover the costs of its other projects. In this case the entrepreneur has all the risks but has to share success with the inventor.

2) it is also very complicated to determine the amount of fair compensation as required by law to be paid to an inventor since value of patented technology is often determined by a business model which is developed by an entrepreneur and as a rule a commercialized product encompasses more than one IP instrument.

VI. Conclusion and Recommendations

The authors' main argument is that IP reward regime has to be flexible and based rather on contractual arrangements than on rigid imperative legal norms.

The research results can be utilized to construct more favourable business environment for innovative SMEs by improvement of regulatory framework of IP. The results also identify possible IP management strategies within different IP regimes.

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Regional Innovation Systems and Total Innovation Management

Irena Vaivode (*University of Latvia*)

***Keywords* – Total Innovation Management , innovation at all time and in all spaces, regional innovation systems, a tri-dimensional innovation strategy model, multi-dimensional perspective .**

I. INTRODUCTION

Total Innovation Management (TIM) (a new paradigm) draws on three distinct areas of research, namely the innovation theory of the firm, the resource-based view (RBV), and the complexity theory. It introduces the theoretical framework of TIM, and presents a tri-dimensional innovation strategy model, which includes all elements of innovation, all innovators, and innovation in all times and spaces, and aims at value added and created a theoretical framework of TIM [1].

The regional context provides a set of rules, conventions, and norms that prescribe behavioral roles and shape expectations. These rules are derived from economic and socio-cultural factors such as routines, shared values, norms, and trust that facilitate localized interactions and mutual understanding during the process of transmitting information and exchanging knowledge [2].

II. TIM AND REGIONAL INNOVATION SYSTEMS

The tri-totality in innovation is: the first ‘‘totality’’ includes innovation in all technological and non-technological elements (strategy, culture, organization, institution, and market). The second ‘‘totality’’ relates to innovation by all individuals involved. The third ‘‘totality’’ is innovation at all time and in all spaces. This TIM framework emphasizing tri-comprehensiveness or tri-totality is based on theoretical frameworks [1].

The third ‘‘totality’’ (innovation at all time and in all spaces) described in detail by the ‘‘4-W’’ (when, where, what, whole) model and used for analysis of the all-time/space aspect.

I would like to analise ‘‘where’’ componenet from ‘‘4-W’’ model according the context of the regional innovation systems.

The innovation ought to take place across the global. So we identify ‘‘where’’ with a global innovation emphasis. With the rapid development of economic globalization, e-commerce, and the networked economy, the boundary of an enterprise becomes difficult to identify. With the rise of new organizational forms, such as outsourcing, strategic alliance, and virtual organization, the boundary of an enterprise transcends the restrictions of the geographical region, industry and even country [1].

In recent years, the concept of regional innovation systems has evolved into a widely used analytical framework that generates the empirical foundation for innovation policy making. The approaches that utilize this framework remain ambiguous on such key issues as the territorial dimension of innovation, i.e. the region, and the apparently important role played by ‘institutions’ or the institutional context in the emergence and sustenance of regional innovation systems. Regional institutions and institutional arrangements are factors that generate appropriate forms and practices to enhance regional innovation potential [2].

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III. KEY OBJECTS

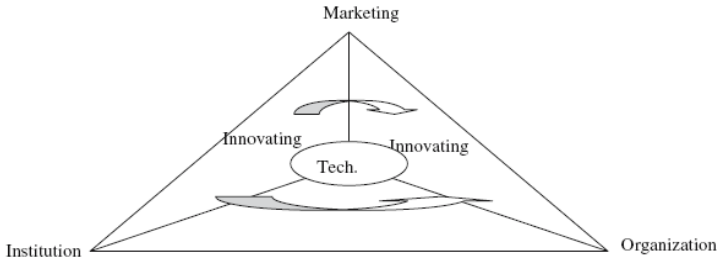

Fig. 1. All-elements innovation of TIM [1].

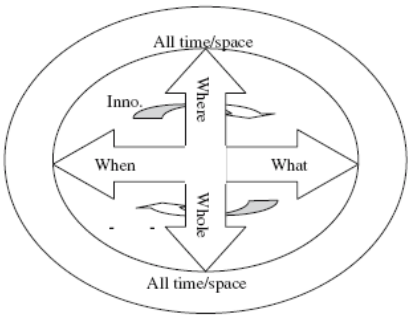

Fig. 2. All-time/space innovation of TIM [1].

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Engineering, Mechanics and Mechanical Engineering

Production Engineering

Metamodeling Methodology for Analysis and Optimization of Dynamical Systems

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Keywords **– metamodeling, multiobjective optimization, dynamical system, design of experiments.**

I. Introduction

Metamodeling - also known as surrogate-based optimization (SBO) methods for engineering design - has become popular because it allows the optimization of engineering systems requiring expensive computer simulations. The main idea is the use of simplified mathematical models instead of complex high accuracy models in the optimization process with following verification and validation of obtained optimal results. The metamodels are built using planned computer experiments and approximation methods [1, 2].

II. Metamodeling of Dynamical Systems

The use of metamodeling techniques for analysis of dynamical systems like machine dynamics and optimization of technological process has two main characteristic properties. First – the dynamic calculations are often very time-consuming, even when using high performance computers. The simulation of machine dynamics, including multi-body mechanism interaction with fluid (air or water), using modern CFD software requires several days to calculate one variant, due to the large number of finite elements and stiff differential equations. Second – the input and output factors (inputs and responses) are not numbers but functions depending on time. Therefore the metamodeling approach includes finite parameterization of input functions and responses to avoid the known curse of dimensionality. The parameterization using splines is a widely used approach for shape optimization tasks, but for the parameterization of time functions some other methods like wavelets, Fourier expansion, and fitting with special analytical functions containing finite number of parameters can be used.

III. Software EDAOpt

The Machine Dynamics lab of RTU developed the metamodeling software EDAOpt which includes all parts of metamodeling optimization tools: design of experiments, parametric and nonparametric (locally weighted polynomials and kriging) approximation and multiobjective Pareto optimization. Figure 1 shows the flowchart of EDAOpt.
The main distinctive feature of EDAOpt is the use of sequential design of experiments, optimized according to the Mean Square Error criterion [3] and modified simulated annealing optimization method [1].

IV. Examples of Optimized Systems

Examples of optimized dynamical systems include optimization of yacht dynamics, optimization of new underwater vehicle propeller shapes (Figure 2.), and optimization of concrete block vibropressing process. The software MSC ADAMS and Flow-3D were used for simulation.

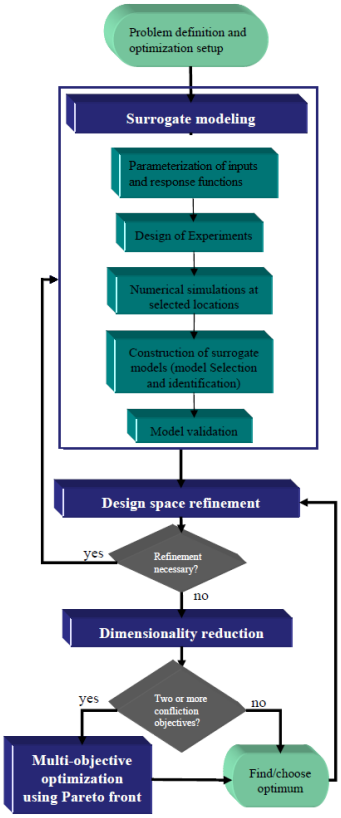

Fig.1. Flowchart of SBO

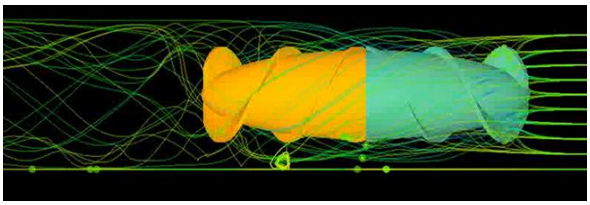

Fig.2. Flow particle trajectories around underwater vehicle

V. Conclusions

The metamodeling technique based on response parameterization, MSE-optimal experimental designs and modified simulated annealing optimization gives the possibility to optimize complex dynamical systems, taking into account the fluid-mechanism interaction.

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Design of Elastomeric Shock Absorbers with Moving Side Stop

Vladimirs Gonca and Yurij Shvab (*Riga Technical University*)

Keywords **– rubber, shock absorber, stiffness, weak compressibility, side boards.**

I. Introduction

In various fields of engineering and construction to provide the required stiffness characteristics under static loading, in order to reduce adverse events and for the given frequency response under dynamic loading rubber-metal vibration isolators (shock absorbers) of different geometries are increasingly being applied. Here we propose a method for determination of rigidity dependence "Force - Settlement" for shock-absorbing elements with absolutely rigid moving (parallel to the vertical axis z) vertical side stops being under pressure. Low compressibility of material of rubber layers is taken into account. Obtained solutions can be used to find the „Force - Settlement" dependence of cylindrical shock absorbers, as well as in projecting such shock absorbers.

II. Problem Description

In this paper we propose a design of shock absorber with rigid side boards, which can move parallel to the direction of the applied compressing force. Due to lateral movement of the stops the free surface of elastomeric layer becomes a shock absorber which changes the stiffness of shock absorber. In contrast to the shock absorbers with fixed side stops (fixed stops help to implement only the increase of stiffness in the process of loading), the moving side stops make it possible to increase or decrease initial stiffness in the process of loading. Stiffness of shock absorber can vary from hard shock to the stiffness of the shock absorber with no side stops. It must be noted that free lateral surface of the elastomeric layer of shock absorber is zero, the precipitation is only due to the weak compressibility of the elastomer and that the height of the free elastomeric layer of a shock absorber is the height of the elastomeric layer. It can be three cases of moving of side supports.

The height of the side stops does not change continuously, depending on the load (fig. 1)

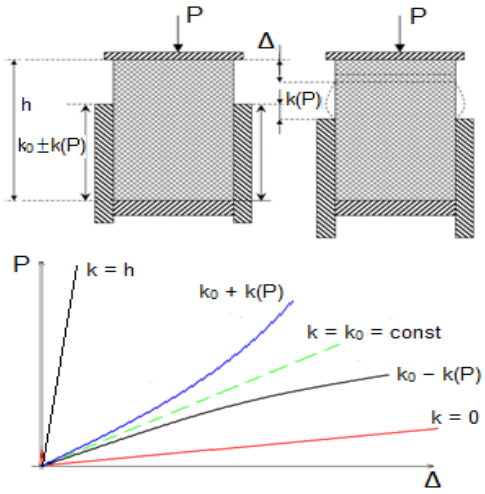

Fig.1. Dependence "force – settlement" for shock absorber with moving side stops.

III. Solution

To obtain the analytic dependence of P (Δ) "force-settlement" for small finite strains (up to 10% - 15%) shock absorber is divided into two parts: Part I ((h - k (P)) ≤ z ≤ h), where there is an axisymmetric compression. In Part II (0 ≤ z ≤ (h - k (P)) there is a volume compression. The solution is obtained taking into account the weak compressibility of the elastomer.

For the first part of shock absorber the dependence of the "Force - Settlement" P(Δ) in the light of weak compressibility of rubber the principle of minimum total potential energy of deformation applies.

For the second part of the shock absorber, assuming that the mobility of the side constraint is absolutely rigid, there is the dependence of the force - of sediment P (Δ_{II}). This is assuming that the frictional forces on the contact surface elastomer – metal, defined as in the case volumetric compression are not taken into account.

For all the shock absorber dependence "Force – Settlement" P (Δ) is dependence for the first part of shock absorber plus dependence for the second part of the shock absorber.

IV. Conclusions

The proposed method for determination of rigidity dependence "force - settlement" for shock-absorbing elements with absolutely rigid movement (parallel to the vertical axis z) ensures that vertical side stops being under pressure. Low compressibility of material of rubber layers is also taken into account. Received solutions can be used to find the dependence „Force - Settlement" for cylindrical shock absorbers, as well as in projecting such shock absorbers. One can design a shock absorber with a given non-linear („hard" or „soft") stiffness characteristics. As an example, a technique for constructing a rubber shock absorber with variable stiffness (the first example of a "soft" stiffness, the second with "hard" stiffness) can be considered. The height of the side stops depends on the applied force, and changes "step by step". As can be seen from the results, if the weak compressibility of rubber is not taken into the account, it leads to a large error when the thickness of rubber decreases.

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Innovative Technologies for Milk Production

Ivan Grinevich (*Riga Technical University*)

***Keywords* – asynchronous method of milking, milking machine «GOSMA», «DAIRS-2», «Reflex-2»**

I. Milking machine «GOSMA»

For the first time in independent Latvia new technologies for dairy animals appeared in the second half of the 20's of the last century. It was proposed to replace hand milking by mechanical milking. Some foreign companies from Sweden, Germany and the United States offered Latvian farmers their latest milking technologies. However all of them required a lot of expensive electricity, and were very cumbersome and costly. Besides, they caused various illnesses for the cows who, in turn, gave poor quality milk. Therefore, only ten of foreign milking machines were implemented. They were displaced from the Latvian market in the first half of the 30s by a local cow milking machine «GOSMA» Fig.1, a).

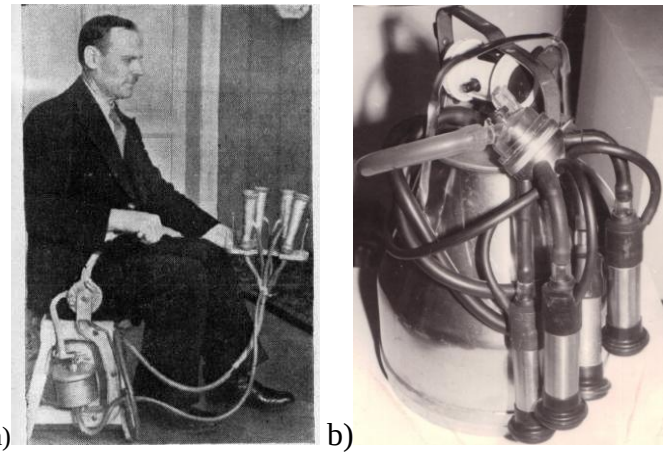

Fig.1. a) Kārlis Leja and «GOSMA», b) Milker DAIRS-2

It was a manual mechanical machine designed by a blind Latvian inventor Kārlis Leja (Fig.1, a)). Its plain unelaborated service, simplicity, and reliability allowed several hundred farms to acquire ownership and mechanized milking process before the Second World War. Moreover, it was 50 times cheaper than those that were imported. It was released in several Latvian factories and imported in Sweden.

II. The milking machine «DAIRS-2»

In the postwar period, Latvia imported trehtaktnye milking machine designs by Vasilij Korolyov (Василия Королёв) from Moscow. However, they were not widely spread for Alfred Skromanis from Riga had improved the milking machine of Kārlis Leja and invented a two-stroke milking machine. 13 factories were working on the implementation of his ideas. For quantity manufacturing of his invention a special factory for milking plants was created in Rēzekne.

A. Skromanis in person headed a research laboratory for dairy machines at Latvian Academy of Agriculture where employees continued to improve the technology of milking cows. Thus, in the late 80's «DAIRS-2» was created (Fig.1, b)) - an apparatus of an intensified regime milking, for which Alfred Skromanis received a Dr. Habil. in Technical Sciences degree at Riga Technical University.

III. Asynchronous way of milking

However, the apparatus «DAIRS-2» performed only synchronous milking, which was not enough for highly productive animals. Besides, it did not consider the index of the udder of the cow , and its pulsator was quite cumbersome too.

I offered an asynchronous method of milking animals [1]. For its implementation milking machines with short tact sucking in front teat cups (Fig.2) [2] were developed and implemented.

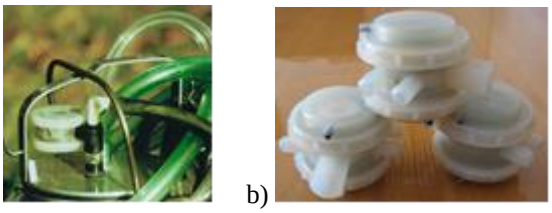

Fig.2. Asynchronous milking machine (a) [2] and series of pulsators with different modes of operation (b).

These are two-stroke machines of asynchronous action [3]. The chart of asynchronous work of front and rear teat cups, and the parameters in absolute and relative terms is shown in Fig.3.

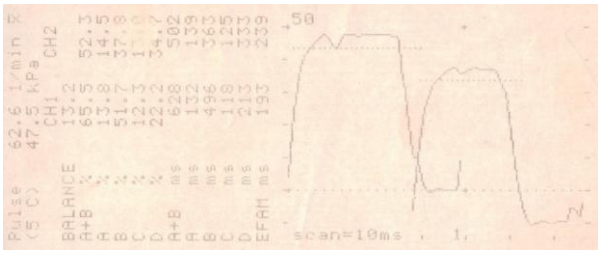

Fig.3. Diagram of the work of the milking machine. [3]

Two-stage induction pulsator got two times lighter and smaller in size (Fig.2), than «DAIRS-2», what helped to create a compact synchronous milking machine «Reflex-2" [4].

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Shape Optimization Technique of Objects Designed Using CAD/CAE

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***Keywords* – shape optimization, finite element analysis, design of experiment, metamodel.**

I. Introduction

Shape optimization based on finite element analysis (FEA) has received increasing interest in the practical design because the FEA can replace physical experiments in many engineering fields. For topology and shape optimization of structures different realizations of so-called homogenization method are usually used [1]. However, as number of design parameters can exceed million for the real objects, it is a very time consuming procedure. In the case of solid bodies it frequently produces jagged shapes that are difficult to manufacture. In this work resource- saving technique of shape optimization is discussed based on examples of different objects. In this approach shape is produced by the geometric boundaries defined as CAD based curves. Due to development of CAD/CAE software and advanced metamodeling techniques this approach has become highly effective and popular in recent years [2, 3].

II. Shape Optimization Procedure

Quality of structures usually is estimated by calculating of responses using FEA that for complex mechanical objects can be time consuming procedure. In such cases instead of full models the expedient metamodels are used. As shown in [4] parameterization of geometric boundaries it is most efficient to use the control points of non uniform rational B- splines (NURBS) polygons. The proposed procedure for shape optimization includes following: 1) planning of position of control points of NURBS for obtaining a smooth shape, 2) creating geometrical models by CAD software in conformity with design of experiment, 3) calculating of responses for a complete FEA model using CAE software, 4) creating metamodels for responses obtained in the previous step, 5) using the metamodels for shape optimization, 6) validating the optimal design using CAE software for the complete FEA model.

Further this approach is illustrated with shape optimization of real mechanical objects.

III. Examples

The objects with the optimal shape components are shown in fig.1. These components are obtained using such CAD software SolidWorks features as “extrude”, “revolve’, “sweep” and “loft”. Shapes of the components depend on corresponding NURBS curves. For definition of these curves the number of control points usually is sufficiently small. Coordinates of these points serve as design parameters. Therefore shape is controlled using small number of parameters that is important for successful optimization.

IV. Conclusions

A comparatively easy technique of shape optimization for several real objects is illustrated. Curve generation, surface generation, and mesh generation are performed using the commercial CAD/CAE software. The most time consuming step of the current technique is the calculation of responses at experimental points with FEA needed to build metamodels. The jagged forms are excluded from the search process and there is no need for excessive computational resources. The smooth easy technologically realizable shapes are obtained.

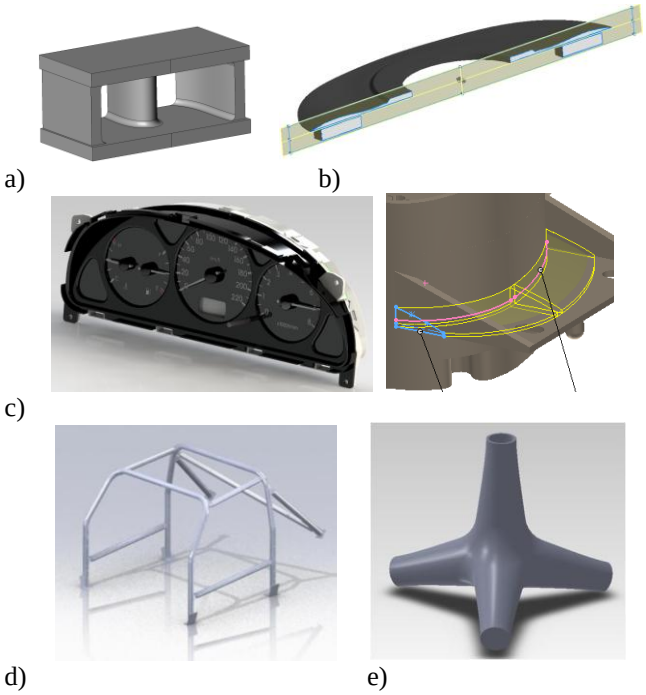

Fig.1. Geometrical models of objects with optimal shape: a) concreate block of masonry wall; b) mounting disk of railway vehicle measurement system; c) automotive vehicle gage panel and its bracket; d) safety frame of vehicle; e) tetrapod

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The Complete Bifurcation Theory for Global Analysis of Nonlinear Dynamics and Chaos

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Keywords **– nonlinear dynamics, complete bifurcation theory, chaos, rare attractors.**

I. Introduction

A new so-called *complete bifurcation theory of nonlinear dynamical systems (CBT NDS)* and its application, intended for direct global bifurcation analysis of dynamical periodic systems is presented. The bifurcation theory is established for essential nonlinear dynamical periodic systems, described by models of ODE equations or by map-based models of discrete-time equations.

II. Complete Bifurcation Theory

Our approach is based on ideas of Poincaré, Andronov and other scientists' results concerning global dynamics, structural stability and bifurcations and chaotic responses of dynamical nonlinear systems and their topological properties [1, 2].

The main idea of the new complete bifurcation theory is the fact that nonlinear dynamical systems in a given parameters and state spaces have finite number (usually not so many) of independent bifurcation groups S(p) with their own complex topology and bifurcations, chaotic behavior, and, in many cases, with rare regular and chaotic attractors (RA). For each point of parameter space it is possible to find all essential fixed points of the periodic orbits (stable and unstable). This periodic skeleton allows to mark out the bifurcation groups and to start global analysis in state and parameter spaces.

The main concepts of the complete bifurcation theory are: complete bifurcation group (BG); unstable periodic infinitum subgroups (UPI- or π- groups), responsible for chaos; complex protuberances; and periodic skeletons for a system with parameter p. For illustration of the advantages of the new bifurcation theory in this paper we use several typical nonlinear models: Duffing driven double-well oscillator, a pendulum driven and parametrical excited oscillator (see Figs.1,2). Besides we consider using the method of complete bifurcation groups for several different models of driven 2DOF systems: a flat system with one mass suspended by nonlinear springs in a plane, two masses chain system with non-unique equilibrium positions, and a simple rotor system with asymmetric suspension.

The last 2DOF systems were specially investigated for comparing two approaches: traditional analytical approximate methods (harmonic balance methods, average and many scale methods, the nonlinear normal mode's method) and the method of complete bifurcation groups and approaches of the bifurcation theory. In all considered examples we have found that the bifurcation theory's methods allow finding important unknown regular or chaotic attractors and/or new bifurcation groups with rare attractors RA. Additional illustrations of the bifurcation theory, it is possible to find in the author's and his colleague's papers where there is rather complete bibliography on the bifurcation theory and rare attractors [3-6].

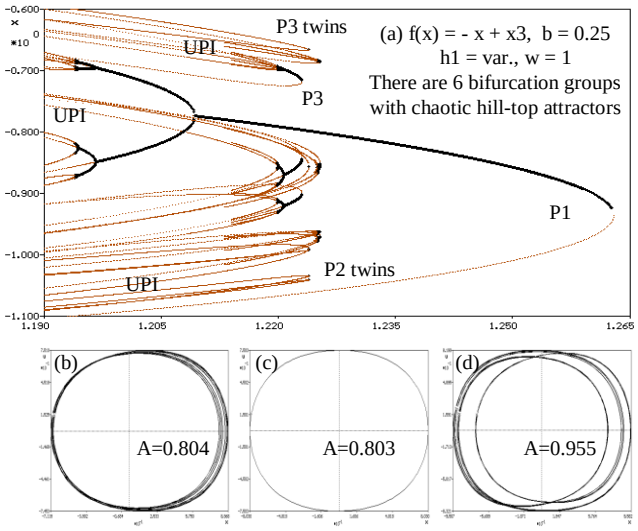

Fig. 1. Driven damped double-well Duffing oscillator. (a) Bifurcation diagrams (black – stable, reddish – unstable) with hilltop (HT) rare periodic and chaotic attractors (ChA) galore; amplitude of excitation h1 = var.; (b) asymm. HT ChA, h1 = 1.2193; (c) P1 HT, h = 1.2195; (d) HT ChA-3 rare attractor, h1 = 1.2195.

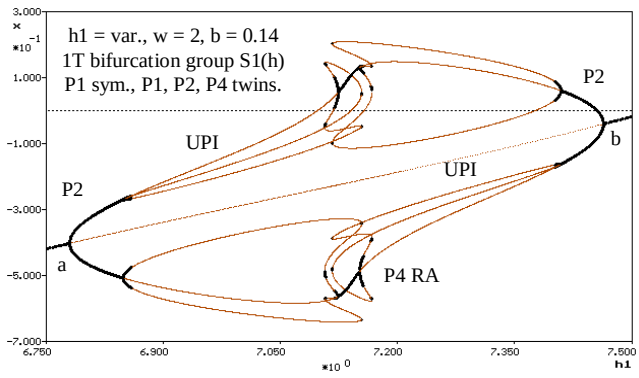

Fig. 2. Driven damped pendulum oscillator. Fragment of 1T bifurcation group (black – stable, reddish – unstable) with complex protuberance (a, b); P1-P4 stable and unstable orbits, UPI and rare periodic P4 attractors (dark dots in the middle of the figure). Amplitude of excitation h1 = var.

III. References

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Influence of Measurement Pressure on Flexible Body Contact Deformation and the Linear Dimension Precision

Anita Avisane (*Riga Technical University*)

***Keywords* – Measuring precision, roughness, linear dimensions, deformation, flexible bodies.**

I. Introduction

The common measurement error when measuring the component geometrical dimensions using universal contact measurement instruments is caused by different factors, such as error of the measurement instrument, personal reading errors, effect of surface roughness on the measuring line deviation, influence of contact deformation measurement force, and others. It is particularly important in the measurement of thin components, flexible materials and films, as well as for components with nanocoating. Flexible bodies in the meaning of this article are components of different shape and sizes made of rubber or soft plastic.

II. Contact scheme

Based on the classical theory of elasticity coherences have been developed linking the measurement force with component surface deformation [1-3].

To determine precisely the common measurement error influenced by the applied force, the surface deformation should be divided into three parts. The first part is roughness deformation. The second part is subsidence of roughness and the third part is deformation of basic material. Schematically, in the shape of spring, it is shown on Fig.1b. Thus also further on we will use symbols: a_1– deformation of roughness; a_2 – subsidence of roughness; a_3 – deformation of basic material.

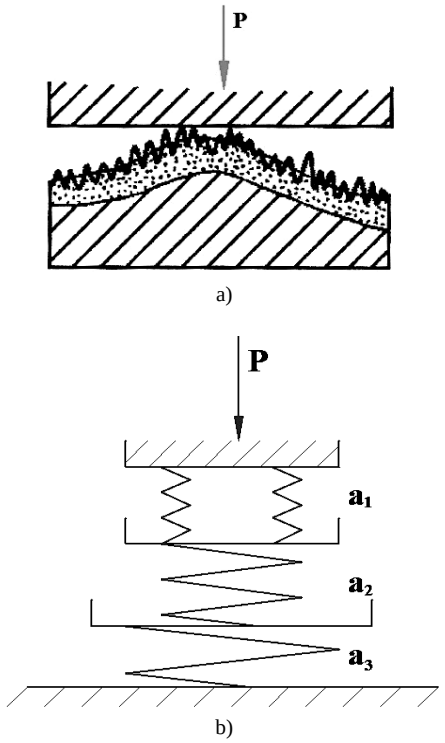

Fig.1. Contact scheme: a)common; b) in the form of springs.

III. Deformation of surface roughness

First of all it is essential to find out what are the expected deformations of roughness. Since the measurement process is characterized by small loads, small contact areas and only elastic deformations are admitted; in this article we will examine only cases when contact is elastic. Roughness deformation depends directly on the applied force and the physical and mechanical properties of material. Though the force applied in measuring is small, yet the elasticity modulus of elastic bodies is so small and therefore we can forecast that it is sufficient to influence the measurement precision

IV. Roughness subsidence

When calculating roughness deformation according to the scheme described in the previous chapter we are not yet able to assess objectively the measurement precision. At the contact of two surfaces roughness's, particularly the highest of them, under the influence of the applied force become not only deformed but they are also subsiding. The subsidence value a_2 likewise the roughness deformation depends on the size of the applied force and on material properties.

V. Deformation of basic material

For the calculation of basic material deformation we can use formulas of classical theory of elasticity. Let us assume that in our case only the normal stress is present (tangential stress is not present), then for the calculation of deformation a_3 we can use Hooke's law.

VI. Conclusions

From the above-mentioned and the surface contact analyses we can make the following conclusions:

1. besides roughness deformation the deformation of roughness subsidence also should be taken into consideration and in some cases even deformation of basic material;
2. to determine roughness deformation and subsidence we must know the geometrical parameters of roughness and its elastic properties;
3. for full deformation calculation it is necessary to carry out the eventual analyses of the above parameters along the whole contact surface.

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Analogue Modeling of Resistance Welding Process

Vera Kulakova (*Riga Technical University)*

Keywords – **Spot resistance welding, analogue modeling, calculating module.**

I. Introduction

Nowadays resistance welding takes leading position among the automated welding processes. The new challenges in resistance welding are connected with miniaturization and increasing of complexity of the machine parts. Analog modeling is one of the actual methods for elaboration of new technological solutions. The procedure of analogue modeling using calculating module VarWELD is offered.

II. Analog modeling

Resistance spot welding (RSW) concerns to types of welding with short-term heating of a joint without fusion of the joined materials. Without heating another main parameter of process is a pressing. As a result of heating and pressing the plastic deformation of joined materials leads to weld formation.

The new perspective approach for modeling of welding processes, based on process investigation, using logical functions, is proposed. This method (analogue modeling) was proposed by R.B.Rudzit [1] and was successfully used by the author earlier [2,3]. The main advantage of this method is that the application of system analysis by logical functions allows describing the causal and effect relationships between large numbers of parameters of the welding technological process. The method of analogue modeling used in this study can be easily extended to many kinds of welding processes and others manufacturing technologies. Analogue modeling is especially efficient in development of new welding technological processes and in optimization of known processes

Analysis of the characteristics of the RSW process should be done using system approach, when each characteristic is described as analogue logical function of two (or more) nearest parameters (characteristics). The kind of analog logical function is defined by tabulation and analysis of the truth-value tables.

III. Software application for examination of analogue model

The quality of RSW of copper wires with coating mainly depends on the amount of heat discharging Q during the resistance welding of wires with coating [2]. It was decided to start the analog modeling of resistance welding of wires with coating from analog modeling of the heat input during the resistance welding. The structural logical analysis scheme of Q characteristic is shown in Figure 1.

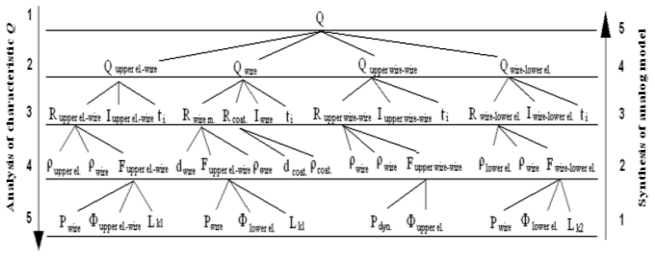

Fig. 1. Structural logical analysis scheme of Q characteristic [2].

After the analysis of the characteristic of welding process the analogue model synthesis is executed by consecutive substitutions of parameters-arguments of the subsequent step of analysis in directly determinates by them parameters-functions of the previous step of analysis. In result complicated multiparametric process considered as system of elementary physical phenomena combined by the causal and effect relationships. As a result of all substitutions, the analogue formula of Q characteristic is defined [3]:

$$Q = f\Big(\Big|\Big|\Big|\Big|\Big|\; P_{wire}/+/\underset{P_{wire-0}}{\exists}\,\Phi_{upper.\,el.}/+/L_{K_1}\Big|_{1}/+/\rho_{upper.\,el.}/+/\rho_{wire}\Big|_{2}/\cdot/J_{upper.\,el.-wire}/\cdot/t_i\Big|\Big|_{3\,4}/+/$$
$$/+/\Big|\Big|\Big|\; P_{wire}/+/\underset{P_{wire-0}}{\exists}\,\Phi_{upper.\,el.}/+/L_{K_2}\Big|_{1}/+/d_{wire}/\cdot/\rho_{wire}\Big|_{2}/+/b_{coat.}/\cdot/\rho_{coat.}\Big|_{2}^{3}/\cdot/J_{wire}/\cdot/t_i\Big|\Big|_{3\,4}/+/ \quad (1)$$
$$/+/\Big|\Big|\Big|\; P_{dyn}/+/\Phi_{upper.\,el.}\Big|_{1}/+/\rho_{wire}/+/\rho_{wire}\Big|_{2}/\cdot/J_{upper.\,wire-wire}/\cdot/t_i\Big|\Big|_{3\,4}/+/\Big|\Big|\Big|\; P_{wire}/+/$$
$$/+/\Phi_{lower.\,el.}/+/L_{K_2}\Big|_{1}/+/\rho_{wire}/+/\rho_{lower.\,el.}\Big|_{2}/\cdot/J_{wire-lower.\,el.}/\cdot/t_i\Big|\Big|\Big|\Big).$$

The calculating module VarWELD, using MS Excel software, was elaborated for item-by-item examination of various combinations of variable parameters of RSW as well as analysis of possible solutions for managing the characteristics of the process. After examination of possible situations (in these case were 131076 possible situations) calculating module choose the situations, which provide a decreasing (or increasing) of the level of output characteristic of process. As a result of analysis of chosen situations the logically verified original solution was developed. Finally the experimental testing for optimization of the parameters of welding process within the elaborated strategic solution was performed.

IV. Conclusion

Analogue modeling is especially efficient in development of new welding technological processes and in optimization of known processes. The procedure of analogue modeling using calculating module VarWELD is offered. This calculation module allows fast realization of the item-by-item examination of various combinations of variable parameters of the RSW process. After examination of all possible situations the calculating module VarWELD automatically choose the situations, which provide a decreasing (or increasing, if necessary) of the level of output characteristic of process. Chosen situations serve as a basis of elaboration of the justified strategic solution, which provide the welding joints of high quality.

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Dependence of Coefficient of Friction from Surface Micro Geometry

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Keywords **– Friction, coefficient of friction, surface roughness, adhesion.**

I. Introduction

Experimental determination of coefficient, which was done by Amonton in 1699 and Coulomb in 1785, shows that relation between tangential and normal forces is a constant value, which is not influenced by increase of force value. Bowden and Tabor [1] pointed out that real contact area and molecular forces are influencing friction between two dry rough surfaces. It means that friction forces arise not only from mechanical deformations like ploughing, but also from physical origins, which is adhesion of solids. The purpose of this paper is to create analytical model which will allow us to calculate coefficient of friction in relation to surface micro geometry.

II. Tangential Area

Within friction pair against sliding surfaces, there are tangential (friction) forces, which are interacting on a surface roughness contact area which is perpendicularly aligned to the direction of motion. Mostly in experimental research to study friction, spherical indenter is used, which is pressed in surface and there is applied motion in tangential direction.

In the same time, on the real surfaces with surface roughness's mostly has cone like forms or as it is stated by authors [4-5] they are more like ellipsoids. First of all, let's look on the contacting surface roughness's and their respective dimensions.

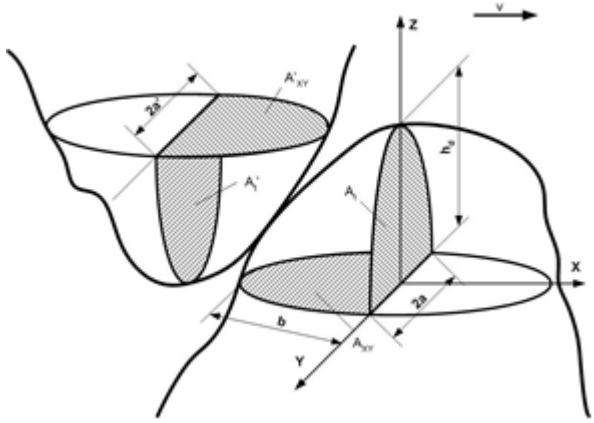

Fig. 1. Contact within two rough surface contact

In fig.1 there are show two counter bodies which are in mechanical contact and both are creating tangential force, which occurs when upper body is moved in X direction with speed *v*. In this case tangential force is acting on tangential area A_t and normal area A_{XY}. The reason, why there are only half of area used, it's because area, which located after crosscut doesn't take any load, so it can be excluded from calculations [3, 5].

III. Mechanical Component

To calculate coefficient of friction one must know also a normal force which is acting during surface contacting. In this case, we can use a ready-made formula from J. Rudzitis work [4], which is following one:

$$\boldsymbol{N = A_a \cdot k_\eta \cdot \frac{c}{(1+c^2)} \cdot [1 - \Phi(\gamma)]} \qquad (5)$$

where: coefficient $\boldsymbol{k_\eta}$ is related to elastic deformation of surfaces [4], c coefficient of surface anisotropy and $\boldsymbol{[1 - \Phi(\gamma)]}$ is Laplace transform of relative deformation level $\boldsymbol{\gamma}$.

By taking above mentioned formulas 3-5, one can find mechanical component of coefficient of friction for dry conditions with following formula:

$$\boldsymbol{f_{meh} = \frac{\pi^3 \cdot Ra \cdot \gamma \cdot e^{\frac{1}{2}\gamma^2} \cdot (1+c^2) \cdot [1-\Phi(\gamma)]}{2\sqrt{2\pi} \cdot Sm_1 \cdot k_\eta \cdot c}} \qquad (6)$$

where: Ra is average surface roughness profile deviation.

IV. Adhesion Component

For adhesion part of coefficient of friction one can use formulas from other authors [6, 7], including standardized surface roughness parameters, for example Van der Waals force calculation by using surface roughness parameter:

$$\boldsymbol{F_{vdw} = \sqrt{\frac{2}{\pi}} \frac{H_m \cdot {S_m}^2}{24 \cdot d_0^2 \cdot \pi^2 \cdot Ra \cdot \gamma}} \qquad (7)$$

where: F_{vdw} Van der Waals force, H_m is Hamakers constant and d_0 is surface separation distance.

V. Results and Discussions

Calculations were made for steel under the dry contact conditions. To simplify calculations, it was assumed that deformations which are occurring in surface contact have only elastic or plastic nature.

Comparing the friction calculation model described in this paper to the model of other authors [1-3], in this model coefficients are excluded, which are mostly determined experimentally. In proposed model, all parameters come from material physical properties and from surface micro geometry.

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Wear Calculation Models for Slide Friction Pairs

Guntis Springis (*Riga Technical University*), Janis Rudzitis

Keywords **– Slide friction pairs, wear, wear calculation models.**

I. Introduction

The issues of the service life of different articles, its prediction and factors influencing it have always been of particular importance. Friction arising in the fitting pair and component wear influence directly and essentially the service life of these components. Scientists around the world have always tried to develop methods that would help to predict more precisely how long the given fitting under definite operating environment could be exploited.

II. Various wear calculation models

Since the wear process involves many various parameters - the upper layer roughness geometry (roughness, waviness, form deviation, etc.), the physical and mechanical conditions of the upper layer, material of details of friction pairs, wear temperature, wear regime, etc., it is impossible to consider analytically all factors involved in this process and therefore wear calculations are being developed into different directions taking into consideration sets of affecting values.

The first calculation model is closely connected with the application of the theory of probability in the prediction of component service life [1]. Using this model the fitting's service life is being calculated. Here the intensity failure is $\lambda=const$ the probable non-failure operation of the fitting can be calculated by the following formula:

$$P(t)=e^{-\lambda t} \tag{1}$$

This is one of the coherences allowing to predict sudden operation failures. However the lack of this theory is that parameter λ must be found before when carrying out researches, and thus the calculation looses its purpose.

The second model is closely connected with classical laws of physics. The supporter of this model R. Holms connects the wear processes with the interaction of contacting surfaces' atoms and the following separation of atoms, thus proposing the formula for the calculation of worn material volume [2]:

$$W = z\frac{N}{HB} \tag{2}$$

where N – load affecting the components;
HB – material hardness according to Brinel;
z – atom separation probability from the surface in case it meets an atom of another body. In its turn C.D.Strong [2] notes that particles separate during the wear process according to the principles of dislocation theory, but E.Rabinovichs [2] connects the surface particle separation with the surface energy phenomena. However this model does not allow to regulate the wear process on the engineering level.

In the third calculation model the wear rate γ is linked to the friction pair's specific pressures p and relative slide motion speed v. A prominent representative of this group professor A. Pronikov offers the following abrasive wear calculation formula of a cone-type fitting:

$$\gamma_{1-2} = \frac{Pn(K_1 + K_2)}{(R-r)\cos\alpha} \tag{3}$$

where P – load affecting components;
n – number of rotations;
K_1 un K_2 – components wear resistance coefficients;
R, r – maximum and minimum friction surface' contact radius.

The deficiency of this theory is that coefficients K_1 and K_2 are determined only in the course of long-term experiment and thus there is no use to carry out the wear calculation before.

The fourth calculation model includes the characteristic sizes of the friction pair as well as physical and mechanical parameters of friction component material, and also the component surface's geometrical parameters [3]:

$$V_e = \frac{kb\varepsilon^{\nu+1}A_c R_{\max}}{(\nu+1)\alpha n} \tag{4}$$

where k – coefficient considering the actual deformed volume;
b, ν – base surface coefficients;
ε – relative approximation;
α – coefficient characterising the stress and kinematic condition on the contact surface;
R_{max} – the highest height of profile unevenness;
A_c –friction pair contour area
n – number of material destroying effects.

The imperfection of this model is the fact that non-standard roughness parameters b and ν are used, which requires additional calculation.

The fifth calculation model in addition to the parameters included in the fourth model takes into consideration the 3D surface roughness parameters and the fatigue theory regularities of the friction surface's destroying, using the probability theory approach, thus this calculation model is more preferable.

Knowing the size the volume of deformed surface roughness projections as well as number of deformation cycles leading this volume to the separation from the basic material, it is possible to determine the wear size:

$$Q_n = V_\Sigma \frac{N_{cf}}{N_c} \tag{5}$$

where Q_n – normal component operation period of volume wear; V_Σ - volume of deformed asperities of surface roughness; N_c – number of cycles leading to the crash of upper layer's projections, where a cyclic stress changing in the time has been applied; N_{cf} – actual number of cycles effected during friction process.

Making calculations according to some definite model, one must take into account different side factors which can influence the calculation results.

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Study of the Shielding Gas Influence on Welding Joint Appearance

Didzis Avisans (*Riga Technical University*), Irina Boiko

Keywords: – **Shielding gas, welding, welding joint, quality, cost.**

I. Introduction

The aim of our research was to find out the influence of the composition of shielding gas on chemical and metallurgical properties of the welding joint.

Different mixtures of shielding gas that is used in MAG welding for non-alloyed steel were examined. The mixtures that were chosen for research are mostly used in manufacturing of steel constructions in Baltic States and North Europe.

For the properties of welding joint following researches were executed: amount of spatter on the welded parts after welding, metallographic research of welding joint, chemical composition analysis, penetration. Each composition of the shielding gas provided different results for each parameter during the investigation. This brought us to the conclusion which gas mixture provides the best quality of the welding joint.

During research we found out that the choice of separate shielding gas influences the speed of welding. This parameter influences both properties, and costs of the welding joint. There is also lay-out of the components that influence the costs of the welding joint in our research work.

II. Testing of welded samples

Different types of tests were done with the samples after the end of welding:

- Visual test – test on spatter after welding;
- Chemical test – chemical analyses of the welding joint after welding;
- Penetration test – penetration performance for each sample;
- Microscopic test – test of the welding joint structure (x200).

Visual test showed that the surface with most spatter on the sample were made by welding with CO2 as shielding gas. All of the other shielding gases showed a good performance and all the samples were clean. It means that there is no need for additional cleaning of the metal parts after welding. It reduces the costs of the end product.

Chemical analyses of the welding joint were made by using the optical spectrometer PMI-MASTER PRO. After penetration test (macroscopic test) the microscopic test was executed. All samples were cut into small pieces and grinded until there were no scratches on them. By using the digital microscope and the program NEXSYSS ImageEXPERT we were able to get the pictures of the welding joint structure with x 200 (times) enlargement.

III. Results and discussion

During investigation it was revealed, that different shielding gas gives different influence on welding process, welding joint quality and also on the welding costs. Some of the most important conclusions are displayed below:

- The chemical composition and microstructure in S°235 weld metals, as well as weld penetration and Yield and tensile strength of the welding joint are influenced by CO_2 and O_2 content in the shielding gas.
- It was clearly shown that the carbon dioxide is not the best choice for the shielding gas. It showed the worst results during the welding process, more spatter, and lower welding speed. Pure CO_2 performs the worth result between all gases in relation to the composition of weld metal. A lot of important micro alloying elements were burned out from the weld metal and it makes the welding joint weaker.
- Better results were performed using Argon mixtures with CO_2 and or O_2 – good welding performance, not much spatters, good welding speed. In general, the content of micro alloying elements in the welding joint is less when the oxygen is involved in shielding gas and with increasing carbon dioxide content in the shielding gas.
- Despite the cheapest price of the shielding gas, CO_2 does not provide the cheapest welding costs. Shielding gas MISON®8 (Ar 92 % + CO_2 8%) shows the opposite results – shielding gas is the most expensive one, but the speed is the highest and costs of the welding joint are cheaper than the costs with other gases. Taking into account that other characteristics of weld metal are the best, it can be concluded, that Ar mixture with 8 % CO_2 is the best choice for S°235 steel MAG welding.

Methodology of calculation of the total cost of the welded joint is presented in the author's paper [1]. Prices of welding materials and calculated costs for the examined samples are collected in the Table 1.

TABLE I

Results of calculation of the cost of the welded joint (EUR)

	MISON® 18	MISON ®25	CORGON ®3	MISON ®8	CO_2
$Price_{w.w.}$ **Welding wire**	1.90	1.90	1.90	1.90	1.90
$Price_{sh.g.}$ **Shielding gas**	6.27	5.90	6.80	7.13	1.07
$Costs_{w.w.}$ **Welding wire**	0.11	0.11	0.11	0.11	0.18
$Costs_{sh.g.}$ **Shielding gas**	0.10	0.12	0.13	0.10	0.03
$Costs_{lab.}$ **Labour**	0.25	0.28	0,29	0,21	0,29
$Costs_{tot.}$ **Welding process**	0.46	0.51	0.53	0.42	0.50
$Costs_{w.j.}$ **Welding joint**	0.070	0.077	0.078	**0.064**	0.074

IV. References

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New Fish-like Designs of Underwater Vehicles

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Keywords **– robotic fish, underwater vehicle, vibrating tail, propulsive device, optimal control, internal gyrodrive.**

I. Introduction

Autonomous underwater vehicles are widely used in engineering for different practical purposes (research, exploring, transportation of freights, etc.). The majority of existing underwater vehicles have traditional propulsion mechanisms with screw propellers. However, various bio-mimetic fish-like robots with oscillating tails and fins have been proposed as well [1]. This paper considers the essence of two new methods for the producing of driving force [2, 3] which make it possible to increase the efficiency of vibration propulsive devices of underwater vehicles.

II. Special variation of working area of vibrating tail

A simple robotic fish model consists of two rigid bodies – a hull and a tail that are mutually connected with a pivot. In our case, the mass of the hull is sufficiently higher than the mass of the tail. Therefore it is possible to find optimal control law for variation of an additional area of a vibrating tail (in order to produce the driving force) on the basis of simplified model with one degree of freedom (Fig. 1). In this case, the tail is fastened to the stationary base with the pivot A, and the motion of the tail is described with one co-ordinate - angle φ.

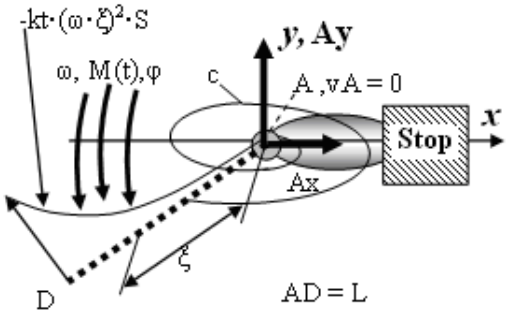

Fig. 1. Simplified dynamic model of robotic fish

Tail interaction with water is described by hydrodynamic resistance force proportional to the square of velocity in local fin's point. Elastic properties of the system are taken into account with torsion spring *c*. The external excitation is simulated with turning moment $M(t)$.

In order to realize the onward motion of the robotic fish (the motion in the direction of *x* axis, see Fig. 1), it is necessary to maintain a negative mean value of the reaction component A_x during the stationary vibrations of the fin. The search for an optimal control law for variation of area *S* of the vibrating tail, which ensures maximal positive impulse of driving forces acting on the tail, has been made using the maximum principle of Pontryagin with the aid of program MathCAD. It was shown that the optimal control action is the following: $S(t) = S_{\min}$ – for the case of the fin's motion from the neutral position ($\varphi = 0$) till its momentary stop ($\varphi_{\max}$ or $\varphi_{\min}$); $S(t) = S_{\max}$ – for the case of the fin's motion from its momentary stop ($\varphi_{\max}$ or $\varphi_{\min}$) till the neutral position ($\varphi = 0$). The proposed method for producing of driving force [2] is realized in different designs of one-tail and two-tail vibration propulsive devices.

III. Gyroscopic method for producing of driving force

Up to now gyroscopic effect has been mainly used for damping unfavorable oscillations of a body of a water vehicle or for stabilization of position of a vehicle due to external force loading. Here the opposite concept is proposed: not to stabilize, but to swing gyroscope and vehicle on which it is located. Essence of the proposed method can be explained trough the schematic diagram shown in Fig. 2.

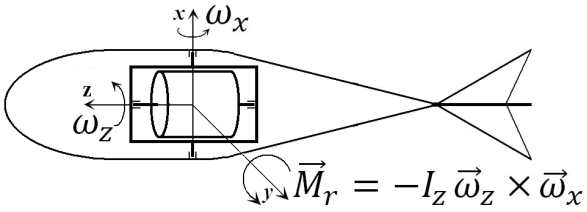

Fig. 2. Principle model of the gyroscopic propulsive device

To create translation movement of the vehicle in the direction of the axis *z*, a high speed rotation of the nutation axis *z* with frequency ω_z is excited. Simultaneously, oscillation of external frame about the precession axis *x* with the sufficiently smaller frequency ω_x is generated. In this case, in accordance with the gyroscope theory, reaction driving torque $M_r = I_z\omega_z\omega_x$ acting on vehicle body is generated. Torque M_r causes swinging of the body of the vehicle about the vertical axis *y*. As the result of vehicle interaction with surrounding water medium, a driving force in the direction of the axis *z* is formed [3]. The operation capacity of the proposed method is validated by simulation with software MSC ADAMS MD R3 as well by experiments with physical prototype.

IV. Conclusions

Two new methods for producing of driving force in underwater vehicles are proposed. The first method is based on the variation of working area of a vibrating fin during operation, while the other one lies in the equipping of vehicle with an internal gyroscopic device. The efficiency of the methods proposed is confirmed by mathematical simulation and experiments on physical models of floating vehicles.

This work was supported by the European 7th Framework Programme Project ID 231495 „Robotic Fish Locomotion and Sensing" (FILOSE).

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About Possibility to Predict Fibers Orientation and Distribution in Viscous Flow

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Keywords –fiber, viscous flow, beam, neutral axis

Short fibers as reinforcement are used in many structural applications in aerospace, automotive, machine building and civil engineering industries. Important part of fabrication technologies for such materials is base on structural element mould filling by liquid matrix with short fibers. Traditionally the matrix is viscous (polymers, fresh concrete). After maturing and demolding structural element mechanical properties are highly dependent on fiber distribution and orientation in the element body. For example, polymer matrix composite with short glass fibers or steel fiber reinforced concrete post cracking behavior and load –bearing capacity are dependent on the number of fibers crossing the weakest crack (bridged the crack) and their orientation to the crack surface [1-3]. This is why it is important to investigate this process.

Fig. 1. Large container experimental equipment for fibers flow mechanics investigation.

Single fiber motions in viscous flow as well as fibers' set motion in the flow with velocity gradient were investigated experimentally and numerically. Single fiber motion in viscous flow with velocity gradient was modeled experimentally using a small container and a large container (see Fig.1) as experimental equipment. In both cases model liquids - potato-starch solution and glycerin - fluid with known viscosity parameters (measured experimentally) were used. Viscosity coefficient values were obtained experimentally by dropping metal ball method. In experiments with small container liquid was poured into the transparent container. Single steel 50 mm long and 1mm in diameter fiber was inserted in the container middle part (with fluid) under the different starting angle to the vertical axis. In initial position the container was placed fully horizontally. Then container was turned sideways from the horizontal position for required angle α and test started. Fiber position and declination angle β at every time moment are influenced by the movement of the fluid. Movement of the fiber in the fluid was recorded by video-camera with a timer. In experiments with large container a) single fiber; b)8, 12, 16, 30, 100 fibers were placed at different places in large container, after that container was turned sideways from the horizontal position for required angle. Movement of the fiber in the fluid was recorded by video-camera with a timer till the movement end when fiber with liquid from horizontal container is filling second bottom container which is modeling the mould. Flow numerical simulation was realized using computer program

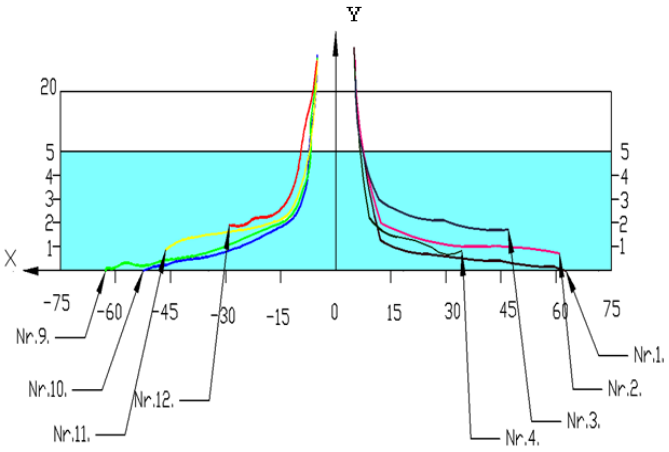

Fig. 2. Selected fibers trajectories in the flow (in the container modeling the mould) in the case when 12 fibers were at starting position located by pairs symmetrically in upper container.

FLOW-3D (see Fig.2). In the case of one fiber numerical simulations results were compared with experiments and calculations were made using Jeffery formulae. In the case of 100 fibers numerical simulations were done for steel fibers in concrete. Obtained fibers location and orientation predictions were used for fiberconcrete beams mechanical behavior simulation under 4-point loading conditions (including behavior under intensive cracking). Simulation results were compared with realized mechanical experiments.

Polymer Fiber Pull Out of Elastic Matrix

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***Keywords* –fiber, pull-out low, friction, elastic, matrix.**

Progress in polymer fibers production technologies leads to possibility use such fibers in structural applications as micro reinforcement in composite materials with polymer and concrete matrix. Comparing to another fibers (steel, glass, carbon etc.) polymer fibers are characterized by relatively large elastic deformations and pronounced Poisson's effect during stretching. Concrete prisms 10x10x40cm were made contained different amount of 3cm long 0,75mm in diameter polymer fibers. All prisms were matured 28 days and then were tested under 4 point bending conditions. Typical load – deflection curves are shown in figure.1. First peak on the curves corresponds to macro crack formation (in the weakest prism cross-section) and splitting the tensioned part of the bended prism cross-section. Beam midpoint vertical deflection is reaching tenth part of mm, fibers in material aren't loaded.

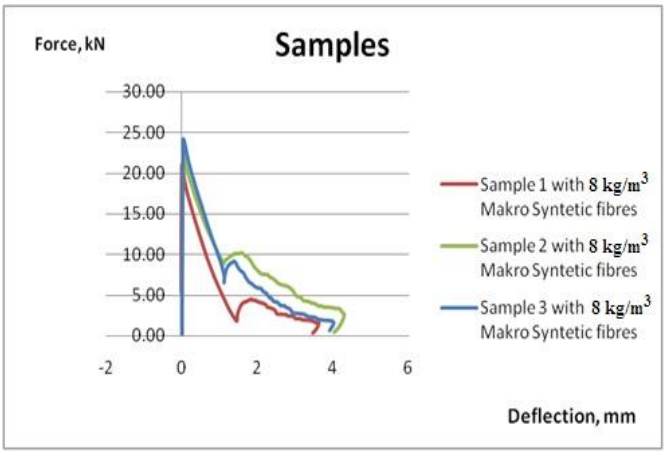

Fig.1. Load - deflection curves for fiberconcrete samples with polymer fibers content 8kg/m^3.

After that fibers in cross-section start to stretch. Debonding is growing (bond is weak and each fiber Poisson contraction is high) reaching the length dependent on each particular fiber orientation to crack surface. All fibers bridging the crack are stretched (load is increasing- second peak on the curves). After that fibers start to rupture and its' ends with friction are pulling out (curves after second peak). Relatively low polymer material Young modulus is leading to the formation of two peaks on the curves what were not recognized for materials with high modulus fibers. Single polymer fiber is embedded into elastic matrix and is subjected to external applied pulling load (numerically simulated). Numerical modeling was performed using 3D FEM approach. Fiber is deforming elastically. Experimental data analysis shown that the pull-out process can be divided into three stages- a) fiber pull-out with perfect bond between fiber and concrete matrix; b) fiber pull-out with partial debond (cylindrical crack) between concrete matrix and fiber, started from concrete matrix surface; c) fully debonded fiber pull-out of concrete matrix. All above mentioned stages investigated theoretically, using Solid Works and ANSYS software and experimentally. Figure 2 shows experimentally obtained curves for 3cm long 0,75mm in diameter polymer single fiber which was embedded into concrete in the depth of 15 mm under 30^0 angle and pulled out (10 samples were tested). Is easy to see that all fibers were ruptured inside the matrix and each fiber end was pulled out with friction. Numerical model based on FEM were elaborated for all three failure steps. Simultaneously simplified shear–lag analytical model (improving approach observed in [1]) was elaborated and executed. Simulations results were compared with performed pull out experiments. Comparison was allowed to obtain numerical values for micromechanical process- friction coefficients on the fiber/matrix interface during fiber sliding motion with friction out of concrete matrix.

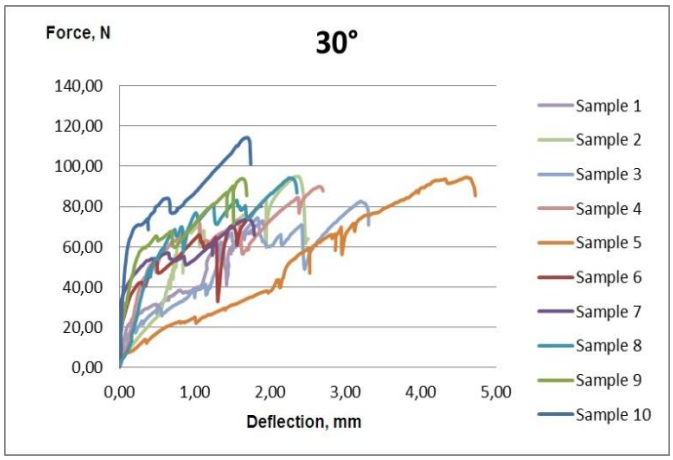

Fig.2. Load – pulled out length curves for 3cm long 0,75mm in diameter polymer fiber embedded at the depth 15 mm under the angle 30^0.

The results of the numerical modeling were compared with experimental data and are discussed.

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Inclined Single Elasto-Plastic Fiber Pull Out of Elastic Volume with Friction

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Keywords **– pull-out process, macro-cracks, FEM simulation sliding with friction.**

I. Introduction

It is well known that the main disadvantage of concrete is its low tensile strength. It has been proven by many researchers that the overall behaviour of concrete can be improved by the addition of fibers. A wide range of fibers is used for the production of fiber reinforced concrete (steel, plastic, glass, etc.). The positive effect of the fibers is not obvious until the first crack occurs in the concrete. Increasing the applied loads the matrix fracture process is initializing: micro-cracks start to open to grow and to coalescent finally forming one or few macro-cracks. The fibers are bridging the crack.

II. Fiber pull-out process

Each fiber pull-out process is starting with debonding between fiber and concrete matrix and is resulting to fiber sliding with friction out of concrete matrix. The present study is limited to the use of steel fibers.

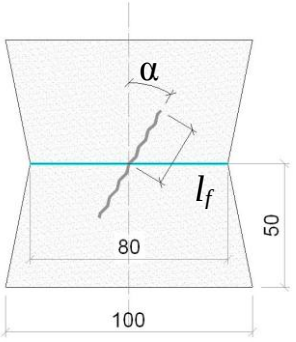

Fig. 1. Configuration of a pull-out test specimen

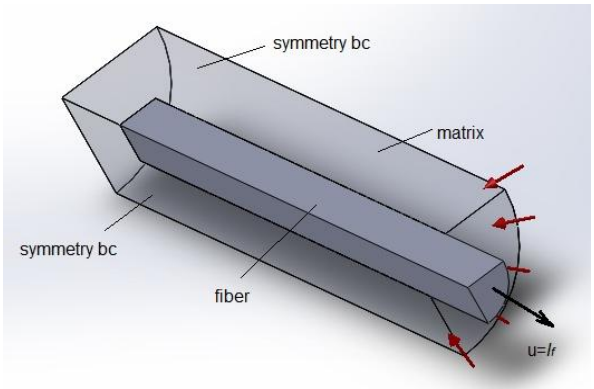

Fig.2. FEM model

Attention is restricted to systems with residual compressive stress acting across the fiber/matrix interface. Single fiber pull-out law was determined experimentally for fibers embedded into concrete at different depth and under different angle. The configuration of the moulded specimen and its dimensions are given in Fig.1. In Fig.1 l_f shows the embedded length of the fiber and α is the inclination angle of the fiber with respect to the applied pull-out load direction.

III. Pull-out process FEM simulations

The same pull-out curves were obtained numerically using FEM simulations. The interference fit problem is solved in form of a contact analysis. The complete pull-out process of fiber is modelled, during which suitable displacement is applied to the fiber end. The bonding strength between fiber and matrix is assumed to be negligible and the largest contribution to pull-out resistance is expected to occur from friction, which is magnified by the residual compression. Fiber is sliding with friction and is deforming (bending) elasto-plastically when it is pulling out of the curved channel in concrete matrix. FEM model and the boundary conditions are represented in Fig.2. The results of the numerical model are compared with experimental data.

IV. Compressive stress

The concrete matrix is forced to correspond to the given fiber diameter and a certain degree of compressive stresses are formed on the contact surface as the external load applied to the concrete matrix. The significance of residual stresses can be studied in detail through a parametric analysis. And since the experimental pull-out curves are available, the value of the contact pressure for particular cases can be found from the best fit with the experimental results.

$$p_C = \frac{2p_E}{\left(\frac{r_f}{r_m}\right)^2(1-\mu)+(1+\mu)},$$

where p_c – compressive stress acting across the fiber/matrix interface, p_E – external stress of the concrete matrix, r_f – fiber radius, r_m – matrix radius, μ - Poisson´s coefficient.

V. Conclusions

Single fiber pull-out law was determined experimentally for fibers embedded into concrete at different depth and under different angle.

The same pull-out curves were obtained numerically using FEM simulations. Fiber is sliding with friction and is deforming (bending) elasto-plastically when is pulling out of the curved channel in concrete matrix.

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Body Vibration in the Air or Water in Region of Small Velocity Amplitude

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Keywords **–wind tunnel, drag coefficient, simplification of air interaction, vibration in air or water flow.**

I. INTRODUCTION

Modern engineering often has to solve problems of interaction between fluids and solid bodies [1 – 4]. This is also basic problem in aerodynamics. Word "interaction" basically means forces and moments acting on body in fluid flow. Also, question about pressure distribution on body surface is important. It is hard to solve such problems in analytic manner so the only way to get correct and practically useful results is to do experimental research using wind tunnel, or to simulate flow using CFD software. A simplified approach to calculate aerodynamic forces analytically, using theorem of momentum exchange will be described here.

It is convenient to present resulted force with two components: Drag force (acting along flow direction) and Lift force (acting in perpendicular direction). The following equations are used to calculate these forces:

$$F_d = C_d \cdot S \cdot \frac{\rho \cdot V^2}{2} \quad . \qquad F_l = C_l \cdot S \cdot \frac{\rho \cdot V^2}{2} \quad . \quad (1)$$

where ρ – density, V – flow velocity, S – specific area, C_d and C_l – drag and lift coefficients. These coefficients depend on bodies' geometry, orientation relative to flow, and non-dimensional Reynolds number:

$$\mathrm{Re} = \frac{d \cdot V}{\nu} \quad . \quad (2)$$

where d – specific size, ν – kinetic viscosity. Typical drag coefficient dependence of *Re* for a sphere is shown on Fig. 1. accordingly to (2).

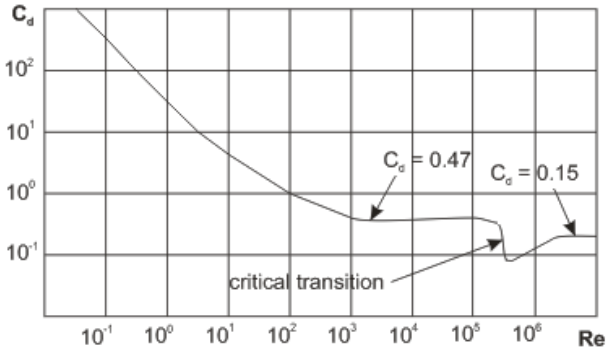

Fig. 1. Drag coefficient dependence on Reynolds number for a sphere

II. AERODYNAMICAL FORCES AT SMALL *Re* NUMBER

Additionally, we will show a convenient expression, that approximates drag force dependency on flow velocity at small Re values (about 10^3). Fig.1 shows that the drag coefficient for a sphere is constant in large Re interval (10^3 - 10^5). However, at small Re values Cd are much higher. We found that force dependency on the velocity in this interval can be well described with following expression:

$$F_d = \frac{C1}{V^a} V^2 = C1 \cdot V^{(2-a)} \quad . \quad (3)$$

Where *C1* and *a* – coefficients.

a - values at different *Re* were calculated using experimental data for a sphere, and it has been observed, that *a* is not depending on *Re*. Calculated *a* value for a sphere was about 0.9. So, at small *Re* values formula (3) can be used instead of (1). This can be useful when analyzing small vibrations in fluid environment.

III. RESULTS OF MODELING

Some graphics of vibration motion modeling by harmonica excitation are shown in Fig. 2. – 3.

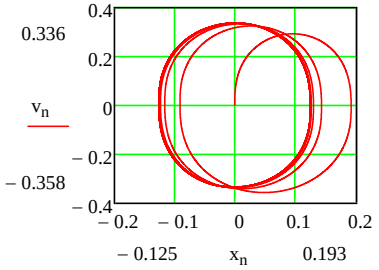

Fig. 2. Motion in phase plane

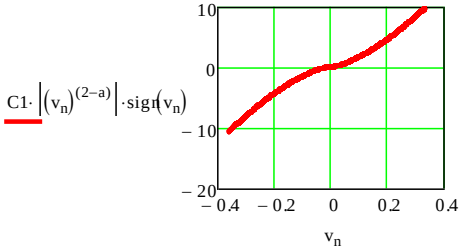

Fig. 3. Resistance force as velocity function

IV. CONCLUSION

Simple theoretical approaches like described above are not usually used, because they do not consider many conditions of a real fluid motion. To obtain correct results, this simple theory must be backed up with additional experiments.

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Engineering, Mechanics and Mechanical Engineering

Heat Power and Thermal Physics

The Industrial Capacity Absorption Heat Pump Heating Systems

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Keywords **– absorption heat pump, efficiency of CHPs, condensing economizers, waste heat conversion.**

Heat suppliers and scientists are looking for new and sustainable alternatives to increase efficiency and reduce heat and electrical energy production costs. Due to instant natural gas price increases and application of excise duties, the heating bills are becoming more and more expensive. Efficiency improvements of existing known district heating equipment, like boilers, condensing economizers and scrubbers are almost maxed out. All kinds of heat pumps, as vital and alternative supplement for traditional heating sources, becomes as a new generation of cheap and sustainable heating for large communities. The first industrial capacity absorption heat pump in Latvia is installed in one of the biggest *CHP Imanta.*

Research on suitable applications for large scale heating pumps are going on since the end of 2010, when equipment was commissioned. Studies in depth have been executed for applications in geothermal, district cooling, waste water treatment and steam and water boiler waste utilization. The *Imanta CHP* technological water heat removal with heat pumps allows increasing efficiency above industry benchmarks and availability of plant in high ambient temperature conditions. Selection of equipment, process design and implementation of project has been held in a close cooperation with RTU scientists.

Applications of large heat pumps in Nuclear power plant heat removal process with the waste heat conversion in district heating can give sustainable cheep heat source for big cities. Future research is also dedicated to develop efficient new operational regimes for district heating return temperatures above 47 °C. Already obtained results from existing installation allow increasing efficiency of CHPs at least by 2%, and facilitating developing new concepts of future low carbon heating for areas with medium and cold climate conditions.

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Heat and Mass Transfer During the Lyophilization Process: a Review

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Keywords **– lyophilization, heat and mass transfer, freeze drying, reverse thermodynamic cycle, cascade refrigeration system**

I. Introduction

Lyophilization is a process commonly used in production of pharmaceuticals, food industry, medical treatment and nursery, biological research. It serves for a long-term preservation of materials and objects.

Overall the process can be reduced to two simple thermodynamic terms – sublimation and the triple point of water or other solution that has to be removed. After four main steps the amount of moisture should be reduced till 2-5%. They include: primary treatment, freezing, primary drying, and secondary drying. All stages, excluding the first, are completed by a single unit. The material undergoing the drying can be put in vessels or vials, or just poured into the chamber. The choice of package depends on whether a raw material or final product is dried.

The lyophilization unit consists of a chamber and elements forming a vapor compression refrigeration system, often - a cascade. The environment inside is a vacuum or a state close to vacuum.

II. Main Complications of Lyophilization

Comparing to many other refrigeration methods used in the industry freeze drying is rather new. Its use became regular during the WWII. The main complications or possible sources of drawbacks of the process can be solved in a complex or one by one. The first problem is based on the level of sterility of the material, personnel, unit, and vials. Any inclusions, not to mention dirt, can harm the material and ruin the drying. The second problem is to retain the necessary temperature regimen inside the chamber while huge masses of heat are removed. Changes in velocity of removing affect the temperatures and the material can be harmed. Control of temperature values is done by automation, but it should be calibrated in dependence on the chemical structure and the porosity of the object. It is important to create heat and mass transfer models for almost all materials used in pharmacy. It is a priority as they are produced often in small amounts and have a very high cost. For example, many drugs for cancer treatment are undergoing lyophilization to obtain particular therapeutic properties. The third problem deals with the moisture removed and collected inside the chamber. In case it is removed with intrusive methods or slower than it forms the heat balance of the chamber is affected. [1, 2, 3]

It can be stated that the freeze drying effectiveness and velocity varies in different points inside the chamber considering the most possible heat and mass transfer aspects inside the chamber. Measurements done with thermocouples or other sensors complicate the model of heat transfer. [3,4,5]

III. Practical Assignment

On the first stage of the research of the lyophilization process and for further creation of a mathematical model of heat and mass transfer a real unit was used. It was chosen by a plant in Latvia. The process itself was described from the thermodynamic point of view. Performance, effectiveness, heat amounts were determined and evaluated from different aspects. The work included several stages. Firstly, the choice of the cooling agent was verified with calculations and several features of CoolPack software. Isceon 89 (currently applied) proofed to be one of the most appropriate agents to reach the nominal temperature ranges and values (up to -80°C) with a very effective compressor. Possible substitutes with similar effectiveness on the compressor belong to the same group of agents – Isceon group. Secondly, the coefficient of performance of the unit was determined trough the amount of heat removed from the chamber and dissipated in the environment from the condenser. It was determined that the amount of heat produced as a side product that currently becomes waste is enough to be accumulated during the cycle of drying and can be used for any other purpose – hot water, vapor production, heating. The possibility to use different accumulation liquids – water and ethylene glycol, is calculated and the construction of the tank is offered.

All activities completed so far were done taking in account standards of quality of the final product, process, unit and method of measurement. There are several organizations that from different perspectives regulate questions considering lyophilization. One of them is the US Food and Drug Administration (FDA). The most recent activity in this scientific area is OPS Process Analytical Technology – (PAT) Initiative. The goals of this initiative are following – to control the manufacturing, completed under the current quality system, remembering that quality itself should be built-in.

Conclusions of the work and further analysis are presented in the full-text article.

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Sustainable Management of Landfill Gas for Energy Production. Trends for Latvian Landfills

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Keywords **– Landfill gas (LFG), quality and quantity of LFG, Municipal solid waste (MSW), methane (CH_4).**

I. Introduction

Considering the political and economic process in Latvia, a target to increase renewable energy production by promoting biogas collection of MSW landfills, wherewith reducing greenhouse gas emissions from landfills surface has been set. Landfills produce LFG as organic materials decompose under anaerobic conditions. The aim of the calculations was to draw attention to economically, ecologically and socially favorable solutions. The limits of possibilities and benefits for sustainable action have been found out during the analysis.

II. General Regulations

Currently in Latvia have ten municipal solid waste landfills, which are specially equipped for waste disposal in accordance with requirements of environmental protection laws and regulations.

A. Amount of produced waste

Annually 700 000 tons of municipal solid waste are produced in Latvia and about half of this amount is biodegradable municipal waste. 40% of the total generated waste is produced in the capital. If analyzing the amount of waste produced by resident, then compared with U.S., it is less then 3 times, about 230 *kg/a*. Various methods of modeling shows that figure could rise up to 300 *kg/a* by inhabitant until 2015. Some sources published their calculation data that 400 kg/a/i had been produced already before the economic crisis. As shown, a relatively high dispersion can be observed. Important factor is where people are living as in rural areas this figure will be lower. Unfortunately, the data are very approximate; as a result, there are many uncertainties on the calculations for long-term.

B. Composition of the waste and recycling

MSW typically contain plastic materials, food waste, textiles, paper and leather. Little information about composition of the waste in Latvia is found. Morphological analysis of the composition of the waste in landfill *Getlini Eko* (2007) determined that till 22% of the waste could be used for recycling (inert waste), 14% could be used for the thermal treatment (does not include biodegradable wastes) whereas organic materials for biodegradation and landfill gas production comprised 64% [1]. Waste composition and quantity are defined by different parameters, such as climate, frequency of collection, the community traditions, well-being, rural or urban origin and seasonality.

III. Objects

A study on the landfill gas collection and power generation facilities has been made on the basis of the largest Latvian landfill *Getlini Eko* data analysis. Waste composition plays a dominant role in the production of gas from landfill. The maximum potential depends on the quantity and content of organic wastes. Other important factors are: humidity, precipitation, nutrient content, bacterial content, temperature, oxygen content of the site, atmospheric pressure, waste age, pH, site- specific nature of the project and type of operating. [2]

A. Landfill gas quality

Methane (CH_4) is the main component of LFG with a global impact, as it is a greenhouse gas. LFG component content is variable and may vary within single landfill boundary. Accurate analyzes of specific landfill definable in specialized laboratories. The calorific value or energy content is normally determined by the percentage of methane present. Considering that the volume of methane varies from 30-70%, calorific value will be from 10.74 till 25.06 MJ/m^3. Of course, for gas combustion equipments are necessary to take into account other compounds in LFG such as sulfur, chlorine, which requires gas treatment.

B. Quantity of LFG and power generation

In recent years, at the *Getlini Eko* landfill from 300 000 to 400 000 tons of waste per yeashall be deposited. Gas flow currently provides 2000 – 2200 m3/h with an average methane content of 52-54%. There are several models for estimate the LFG amount in long term (*Scholl Canyon*, *US EPA*, etc.).

Prognosis of gas quantities for long term was modeling with *LandGem* model (USA), which under certain influencing factors (assuming CH_4=50%) gives right enough results. After the model predictions with the existing four engines it is possible to work with a constant power until 2020 year. By further year, methane productions will decrease. Calculations shown that there is a possibility to install an additional Organic Rankine Cycle equipment (0,4 *MWel*) that can produce annually plus 3200 *MWel.*

D. Methane emission from surface

There are many factors effects on surface methane emission rate, such as gas production rate, LFG migration properties throw the waste layers and through the top layer of landfill, LFG collection system, oxidation activity in the landfill cover and metrological conditions. Few methods used to measure emission rate, some of them are used to quantify the emission rate [3].

IV. Other recommendations

In recent years Latvian management improves, but in the immediate future it will not be possible to refuse from landfills. In the future one should look for other technology useful in Latvian landfills, such as the use of bioreactors.

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Cogeneration Power Plant Efficiency Improvement Using Absorption Chillers

Daniels Turlajs, Aivars Cers and Raitis Kaulakalns (*Riga Technical University, Faculty of Transport and Mechanical Engineering, Department of Heat and Power Engineering*)

Keywords **– absorption chillers, cogeneration power plant efficiency improvement, district cooling, lithium bromide**

I. Introduction

In the 21st century one of the most popular topics between important is energy efficiency, "green energy" and CO_2 emission reduction. Nowadays, when energy consumption is increasing every single second, it is very important to think about energy savings. Furthermore – most important is not only to think about usage of renewable energy resources, but also to think about efficient use of energy, which so far has been used ineffectively. Therefore district heat and power plant development in the EU are particularly encouraged as it provides combined electricity, heating and cooling energy production and reduces fuel consumption.

During the winter when demand for heating energy is high, the efficiency of the power plant also remains high. While during the summer period when, at the best case, is only the demand for domestic hot water or steam for industrial purposes, a large amount of energy is wasted, especially when it comes to Latvia where cold winters alternates with hot summers. As one of the solutions to improve the efficiency of a power plant during the summer is installation of absorption type chiller.

II. Absorption Chillers

Absorption-type chiller's working principles are based on organic Rankin cycle, with two circulating fluids - water is used as refrigerant and it changes state from liquid to gaseous, second - lithium bromide, as one out of the many is used as an absorbent. During the closed cycle it changes its concentration from low to intermediate than to high and than again turns back to low. Its best feature is the ability to convert low-potential heat into useful, worst – crystallization when concentration is high and corrosion of such materials as copper and steal. Absorption chillers consist of generator, evaporator, absorber and condenser. In order to improve efficiency double-effect chillers are used. COP for these kinds of absorption chillers can be achieved up to 1.6. Using this type high-power unit, it is possible to offer to the market a new product – the district cooling. It is very developed in the Baltic Sea region countries, with literally identical weather conditions. Climate in Latvia is similar to Finland (for example in Helsinki 10 absorption chillers are installed with total installed power capacity of 12MW) and Sweden (30 power plants with annual power production capacity of 700 GWh).

III. Optimization Theory and Methods

The aim of this research is to explore the absorption-type refrigeration unit operating principles and calculation methods, and applications in power plants, and to design the function in order to optimize chillers operation mode using Monte-Carlo method which is based on stochastic simulation (random number generation) modeling.

Optimization function is as showed below.

$$Lmax(C_{Q'} \cdot Q' + C_q \cdot q + C_N \cdot N - C_B \cdot B) = max(\$) \quad (1)$$

The aim of optimization is to increase power plant income and efficiency. Considering the fact that internal energy of revised steam or enthalpy of power generation steam turbines is about 50% of the total supplied to the heat cycle, expected results of a research can significantly increase profits and power plant's efficiency.

IV. Conclusion

District cooling is not only providing power plant efficiency improvement, but also it costs less for final consumer than local small and medium output refrigerators and when it comes to visual aspects – you don't have to put those ugly boxes (outside parts for compressor refrigerators) on the walls or roofs, making buildings look ugly.

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Water-Loop Heat Pump Systems: Latvian Experience

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Andrejs Semenako and Gita Actina (*Institute of Physical Energetics*)

***Keywords* – ventilation and air conditioning (HVAC), water loop heat pump system (WLHP), energy balance, energy economy**

I. Introduction

Today most modern buildings in the world widely use the systems of heating, ventilation and air conditioning (HVAC) in order to create and maintain a microclimate in the rooms corresponding to the required norms. One of the most update HVAC systems is the water loop heat pump (WLHP-system).

The engineering systems of the complex „Riga Plaza", including the systems of heating, conditioning and air preparation are divided into several independent parts each of which corresponds by its characteristics to a particular functional area of the complex. The source of the heat supply of the complex is a gas boiler house. The sources of cold are twelve chillers and twelve dry cooling towers installed in the utility rooms on the roof of the building as well as on a special site next to the building of the complex.

II. Method

As the basic method for the efficiency estimation of the systems of heating, ventilation, conditioning and air handling is a method of drawing up a balance of the efficiencies of the system equipment generating and consuming heat and cold. The microclimate quality insurance was evaluated in agreement with the standards adopted in the country. The estimated temperature of the heating system is based on perennial climatologically observation data about the outdoor temperatures in a particular region of the country. The terms for the estimation of the conditioning and air handling technology are based on the climatologically data about the repetition frequency of various combinations of the outdoor air entropy, temperature and relative humidity. The estimation methods of the energy consumed in the air handling equipment depend on the combinations of various ventilation and conditioning units and their operation schemes.

III. Results

The heat efficiency of the boiler house constitutes only 4950 kW, and it was limited by the level of emissions CO_2 into the surrounding environment in the centre of Riga. At the same time, in order to satisfy the needs of the heat-generating equipment of the complex, a heat capacity of 6783 kW is required, the share of the calorifiers of the central conditioners constituting 4936 kW (73%) but the share of the WLHP-system constituting 940 kW (14%). Consequently, the capacity of the boiler house makes only 73% of the maximum demand for the heat capacity of the heating equipment of the complex. If the areas of shops and the atrium are considered separately, the capacity of the calorifiers of the central conditioners (AHU) constitutes 64% but the capacity of the WLHP-system makes only 21.5%. Hence it follows that the WLHP-system plays a secondary role in the heating system of the complex since even in the same functional area where it is used it consumes not more than 21.5% of the heat envisaged for heating the area.

The maximum designed capacity of the cold supply system of the complex (the chillers and dry cooling tower) is 18016 kW, the overwhelming part of which (13740.6 kW or 76%) pertaining to the areas of shops and the atrium. A large part of the cold supply complex is ensured by an air handling system "chiller-fancoil" the share of which constitutes 8308.8 kW or 46% of the entire cold produced. 4200 kW go to the WLHP-system, which makes less than 25% of the cold produced in the complex, and, consequently, the WLHP-system plays a secondary role in systems of the cold supply complex. Its value increases for the areas of the shops and the atrium where the WLHP-system duplicates the system "chiller-fancoil" since it ensures approximately 30% of the cold supply of this functional area. At the same time, the system "chiller-fancoil" ensures more than 50% of the cold supply of this functional area. Thus the consumption of cold in the rooms of the complex exceeds the consumption of heat more than two times. Moreover, if the consumption of heat more often is effected by calorifiers of the central conditioners (AHU), the consumption of cold generally takes place by means of the air handling systems (70%) to which the systems "chiller-fancoil" and the WLHP pertain.

IV. Conclusions

At the present time the water loop heat pump (WLHP-system) is one of the most update systems of heating and air conditioning in the rooms. It can be used both – as end equipment for air handling in the systems of central conditioning, and as an energy-efficient substitute for such other air conditioning systems as the VRV (VRF) and the "chiller-fancoil".

In the building of a shopping and entertainment complex, discussed as an example of its use, air handling in the area of shops is executed according to the scheme "chillers-AHU-fancoil" to which the WLHP is added. The main function of the WLHP-system is the function of additional cooling of the rooms in the shops during the summer period. The system "chillers-AHU-fancoil" is controlled and operated in a centralised manner, while the WLHP-system is started and controlled by the end-users. Such a scheme is applied since it is necessary to ensure independent, individual temperature regulation simultaneously in a great number of shops and offices of the complex.

It is necessary to expand the application of the WHLP-system in the HVAC in order to raise energy efficiency. The local municipalities should arouse the interest of enterprises in conducting energy monitoring and optimisation of the HVAC and the WLHP operation to achieve energy economy.

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Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
The 1st Congress of World Engineers and Riga Polytechnical Institute / RTU Alumni

Micro-Cogeneration and Stirling Engine

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Keywords **– Decentralized Energy Systems, micro-CHP, Stirling Engine Configurations.**

I. Introduction

The development towards energy supply which has to be based more on energy efficiency and CO_2 reduction the decentralized energy systems will be wide used now and in the future. The article takes a close look at micro-CHP system based on the three different technologies known as Stirling Engine, Internal Combustion Engine and Fuel Cell. Although the emphasis is placed on Stirling Engine calculation and design problems of implementation of micro-CHP in Latvia are also considered.

II. Micro-combined heat and power

Micro-combined heat and power (micro-CHP) units utilize waste heat while simultaneously producing electric power for a residence or building. The EU Directive 2004/8/EC obliges member states to conduct analysis of the potential of high efficiency cogeneration in their country and to establish a support system to encourage cogeneration. Micro-CHP is defined by the Directive as being of less than 50 kW electrical power output or as generator with rated output of ≤16A per phase.

It is not practical to transport heat for long distances, due to heat loss from the pipes. Since electricity can be transported with less loss, it is more efficient to generate the electricity near heat consumers. In a decentralized energy system "micro-combined heat and power system" (micro-CHP) individual buildings power plants can be used.

Compared with a condensing boiler, an engine based micro-CHP unit could save up to 1.7 tons CO_2 annually for a typical family home, whereas an Fuel Cell could save more than 4 tons CO_2 [1].

III. Micro-CHP with a Stirling engine

The Stirling engine is a type of external combustion piston engine which uses a temperature difference to produce mechanical energy. The cycle is based on the behavior of a fixed volume of gas.

Recently in market become available number of Micro-CHP unit with a Stirling engine. For example the Viessmann Vitotwin 300-W generates 6 kW heat with an efficiency of 81% and 1 kW power with an efficiency of 15% simultaneously [2].

The constantly generated power of 1 kW covers the base load of the electricity demand of house and surplus energy can be sold to the public grid, but regulation for Micro-CHP should be developed in Latvia.

The gas inside the cylinder of a Stirling engine is not burned. In contrast to the internal combustion engine, the Stirling engine does not use an exhaust or an intake. All the Stirling engine requires to operate is a temperature difference

If a renewable external heat source like wood is used with the Stirling engine, it can be an source of CO_2 free energy.

IV. The Three Stirling Engine Configurations

There are known three standard configurations for Stirling engines: ‘alpha’, ‘beta’, and ‘gamma’.

Gamma engines are similar to beta engines, except that the power piston is “shifted” down. This can make it easier to construct the mechanical drive and this reason; the gamma configuration is often preferred choice for Stirling engine in micro-CHP

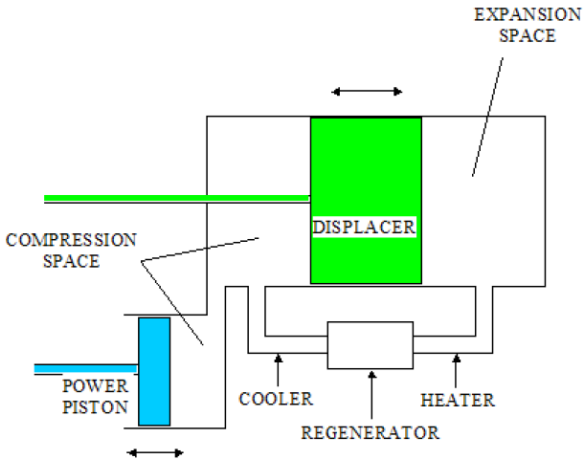

Fig.1 The Stirling Engine of Gamma –Type

IV. Design of Stirling engine

The authors carried out Alfa-type Stirling engine 3-D simulation in Solidworks and calculation based on theory described in [3]. As result of design authors developed demonstration 165 W output engine with following dimension 100x100x50 mm. The efficiency can be increased by the use of recuperators. Theoretical efficiency predicted as 33% high, but experimental not proved yet.

Comparison between various Stirling engines presented.

V. Conclusion

Stirling engines have low emissions and create low noise levels. These engines are also mechanically simple, and because there is no internal combustion, the maintenance requirements of Stirling engines are relatively low.

Anyway development of Sterling engine in Latvia in combination with biofuel application can result as innovation in green energy production.

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What is More Important – Energetics or Economics?

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Keywords **– energetics, economics, nuclear power plant, hydroelectric power plant, electricity prices.**

I. Introduction

During the previous times it has become popular to compare different ways and methods of energy production. It's creditably as any decision should be built on sensible evaluations, which confirms the necessity of analysis. Still, it is important to recognize that a comparison is possible between similar things, between categories with an equivalent level of likelihood, especially; if it corresponds to the current situation in the energy branch – the attempt to compare nuclear power and hydro energy in the Baltic Region and Latvia. Both energy sources have their own value and contribution on the electricity market, which means with their own good done for the clients.

II. The Technical and Economic Comparison of Both Projects

If it is necessary to compare the productivity of both projects, then the installed capacities, their working "fields" and the final amount of produced electricity have to be observed. The possible hydroelectric power plant (HEPP) will cover the peak loads (except flood periods) with the working time up to 2000 hours pro year, but the nuclear power plant (NPP) will cover the base load with 7500-8000 working hours pro year.

Visaginas NPP, in case the Latvian commercial company has 20% from the installed load of 1350 MW (respectively 270 MW), can produce 2-2,2 TWH/year electricity, which, how it was already mentioned, the electricity from the base load – produced when it is necessary and not when the nature does a favor, as it it would be with a HEPP on Daugava. New hydroelectric power plants on Daugava (in Daugavpils and Jēkabpils) could give about 0,35 TWh/year of electricity, which is 6-7 times less than 20% from the Visaginas NPP.

Investments that differentiate in double (NPP about 700 million lats and for two HEPP – 350 million lats) with the sevenfold difference in contribution determine the better possibility of payback for of the nuclear power plant (the fuel cost component is rather negligible in the total balance). New technologies, which increase the efficiency, performance, load, contribution of units and systems have limits set up by the laws of nature.

III. The Influence of Both Projects on the Baltic region and Latvia

The potential of the Visaginas nuclear power plant project can be observed as the entrance of an important load in the region, and the appearance of a new market participant increasing the concurrence that can lead to the drop of prices of electricity. Especially, if this new participant has a very low variable cost component as NPP's have. It is known that the entrance of a new efficient participant on the electricity market the price cannot increase, as in case a participant is unable to compete, he do not take part, leaves the market.

IV. CONCLUSIONS

As it was mentioned, the new hydroelectric power plant on Daugava and Visaginas nuclear power plant do not compete with each other and can be performed independently from each other.

New hydro building projects in Latvia can be fulfilled independently from the Visaginas project, they even correspond to other problems in the country, make them more interesting, because they are connected with the solutions of following problems – possible measures against floods on Daugava, building of railroad bridges over Daugava, the employment of the community, the development of the regions. For hydro building project realization EU founds and state, local governments finance should be used. The projects connected with Daugava should be completed with the active participation of local governments and inhabitants.

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The Co-firing of Wood Chips and Pellets with other Solid and Gaseous Fuels

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Keywords **– co-firing, carbon emissions reduction, gasification, waste wood, combustion optimization.**

I. Introduction

Biomass has a huge potential to replace fossil fuels and during the upcoming decades it will happen more and more often. The main way to use biomass energy is via combustion under loads from several kW up to hundreds MW. The aim is to do it with the highest possible efficiency and low level of exhaust. Still these parameters are worse in comparison with oil or gas fuelled units. A way to increase the efficiency is clearly seen and can be motivated with not enough conventional sources. Together with previously mentioned aspects the decrease of gaseous organic and non-organic carbon complexes has to be done till minimum values. To complete these tasks the physical and chemical parameters of the process have to be modeled. Generally, the combustion process consists of two steps: first stage, when solid fuel is gasified, second stage – the reaction is completed. It makes important:

1. To optimize the combustion efficiency by making better the aerodynamics of combustion chambers.
2. Combustion by low amounts of excess oxygen that is the source of high coefficients of performance.
3. The adding of gases, which formed during electrolyze of water to the secondary air to decrease the amount of carbon complexes in exhaust.

II. The Experiment

The work included the co-firing of wood, biomass and Brown gas. The aim was to create an environmental friendly, stable and fully controlled (especially, biomass) combustion of fuel. The complex of research included the dynamics of flame, heat and mass transfer processes, as well as local flame temperature and composition measurements on different stages of combustion process, evaluating the influence of combined combustion process on the flue gas composition.

The experimental unit (universal pellet-wood fuelled boiler GD-BIO 25 kW) was created for the research of combined combustion processes It included a wood biomass gasification unit with primary air feed (under stocker type burner), which was constructed of heat proven steel, where the fuel is fed in with a transporter like auger. The velocity of fuel feed could be changed and depended on the consumed heat power. To simplify the experiment the fuel consumption was about 100 g/min, which corresponds to the load of 25 kW. A burner to form a vortex flame and to supply the secondary air – HHO mixture to the region above wood biomass was installed.

The primary air supply initiates the combustion of the wood biomass, giving heat that starts the gasification process and forming of the gaseous combinations. Installing CFD as a result calculated conical (modified de Laval) nozzle for secondary air – HHO vortex flow initiation made it possible to get complete combustion mixing gaseous compounds with air. The velocity of primary and secondary air supply in the unit was a separately changeable value - from 300 to 1600 l/min. HHO feed velocity in the burner was also changeable from 15 to 30 l/min, but the relationship of air supply (λ) for initiating the stoichiometric combustion was controlled automatically on the input of the burner. All was done to ensure complete combustion and minimization of exhaust containing carbon. All parameters were regulated by a programmable automation module with 1-10 V on the output, which corresponds to 1-100% of relation between air and HHO. The experimental unit was equipped with all necessary sensors as in the prototype technological scheme.

III. The Results of the Experiment

The maximal coefficient of performance and the minimal amount of flue gases is possible in following case: the relationship of primary air is 1/0,8 (410/520 l/min) and λ value is 1,7-2,1 to minimize the CO amount. Periodical addition of 5% of HHO (26 l/min) to the secondary air can minimize CO_2 amount.

The new technology allows completing combust waste wood with low quality and big moisture saturation. Also it helps to reduce the hazardous emissions in the environment – particularly atmosphere.

Resulting the project the by load of 1,75 MW CO_2 emission factor for wood with moisture saturation of 55% is 0,388 t/MWh. The planned reduction of emissions in relation with fuel relative consumption is near to 40%.

During the project it was determined that by conventional circumstances the temperature in the combustion zone is about 1000°C, but during the experiments with the new technology the fact temperature measured was 1350°. With further research the optimization this temperature value might be achieved.

The offered technology makes possible to reduce CO_2 emissions up to 0,1552 kg CO_2/kWh.

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Transport

Road Transport

Determination of Engine Oil Change Interval by Results of Chemical Analyses

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***Keywords* – engine oil, engine wear, oil change interval, oil chemical analyses.**

I. Introduction

Motor oils are very important data carrier about general technical condition of the engine and its elements. Therefore the analysis of engine oil helps to carry out to the expert the express preliminary treatment of engine and information about engine oil condition. According to the results of oil condition, oil change interval can be determinated. Correct engine oil change interval helps to reduce costs connected with engine wear and transportation.

II. Object of research

25 buses, MAN and Neoplan models were chosen for this research from big transport fleet in Riga. All of them are used in regular long-distance routes. Buses were divided in different groups according to ecological class of engines and road conditions in the route.

III. Research methodology

Firstly information about engines used in buses was assembled.

According to technical demands of manufacturer of the buses oils must correspond to MAN standards 3275; 3277; 3477 and MB standards 228.3, 229.1 in dependence of ecological standards of engines. That is why 3 kinds of engine oil from one manufacturer were used.

Oil samples were taken according to intervals shown in table 1.

TABLE 1
Intervals of taking oil samples

Kind of oil	**International routes**		**Intercity routes**	
	1 probe	2 probe	1 probe	2 probe
	run, km			
Oil **A**	40000	60000	30000	45000
Oil **B**	70000	90000	40000	60000
Oil **C**	70000	100000	50000	75000

Probes were sent to laboratory and chemical analyses of engine oil were done, a detailed report was generated and revealed the true condition of the oil.

In the analysis the main attention was paid on the changes of properties of engine oil, degradation of additive compounds, also on various pollutants of engine oil and products of wear of the engine parts.

Measured parameters:

- The maintenance of products of wear (mg/kg) – Lead, Aluminium, Chromium, Iron, Copper, Tin, Nickel, Molybdenum;
- The maintenance of additive compounds (%) - Calcium, Magnesium, Zinc, Phosphorus, Boron, Sulphur;
- The maintenance of pollutants - Silicon, Sodium, water (%), insolubles, Ethylene Glycol
- Oil condition - oxidation, viscosity at 40 °C, viscosity at 100 °C, a viscosity index, fuel dilution (% mass).

According to the results of chemical analyses, conclusions about engine oil change intervals were done. Oil change intervals were compared with bus manufacturer's recommendations. In the same engine the oil condition depended on the routes, that is why recommendations to reduce engine oil change interval in intercity routes were given.

In addition chemical analyses helped to find technical problems, wear process and internal failures of the engines and its elements.

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Studies on the Effects of Oil Additives on Friction Surfaces

Armands Leitāns (*Riga Technical University*)

***Keywords* – Internal combustion engine, oil additive, sliding friction machine.**

I. Introduction

The world's automobile manufacturing industry each year has brought ecological requirements of automotive internal combustion engine of harmful exhaust emissions. This is also means to fight the friction energy loss of an internal combustion engine. The addition of a special anti-friction engine oil additive makes it possible to reduce frictional losses reducing fuel consumption and engine combustion-generated harmful emissions as well.

II. General Regulations

A. Approaches to reduce mechanical losses

Common approaches and guidelines to reduce mechanical losses in the engine can be divided into the following:
Engine construction, technological, operational.

The first approach assumes an impact on construction: changing the kinematic scheme to reduce the loads on the mechanism or the rate of movement of parts, modernization of the shape, size, and macro-and microprofile friction surface details.

The second principle is associated with the material and the parameters of the workpiece surface, taking into account the mutual influence of lubricant properties on the properties of the rubbing surfaces of parts.

Third approach involves management engine mode as a whole and its individual components in order to minimize losses of mechanical energy. In this context, there is a need for anti-friction oil additive effectiveness test.

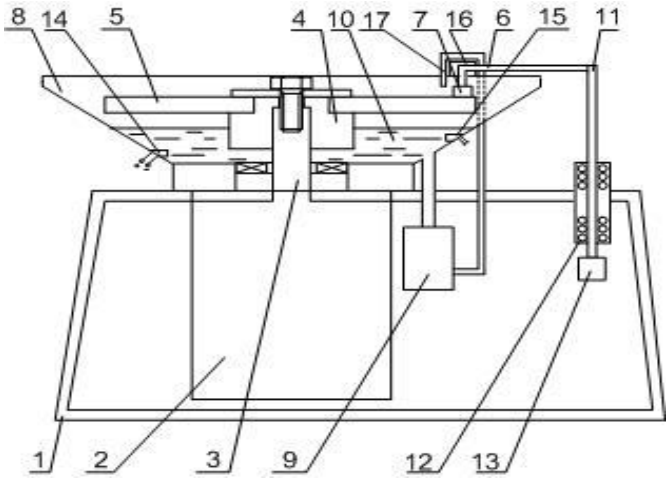
B. Anti-friction oil additive practice

For the simulation a machine which can simulate sliding friction pairs and approximated to working conditions in an internal combustion engine was built. The friction processes taking place in defined friction pairs were simulated. The materials lubricated with engine oil and engine oil with anti-friction additives were compared monitoring the differences.

When simulating the friction pair in the working conditions all the samples should be used accordance with materials that are used in internal combustion engines and ensure to process them accordingly. Appropriate working conditions such as contact pressure, sliding speed, oil temperature etc. should be provided.

Monitoring of following parameters: oil temperature, the friction elements of downforce and reciprocal temperature, the friction torque and rotating disk rotation will take place during the experiment.

III. Objects



Pic.1 Sliding friction test machine

A. Test machine construction

The main details of the test equipment are described below. The electric motor 2 is attached to facility housing 1 using screws. The axis (3) is placed on the motor below the shift (4) for supporting the rotary disc (5). At rotating disk 5 sample (7) is pressed against the test material with the pendulum (6), which is attached to the pendulum axis (11), and is supplied with oil. Oil is kept in the reservoir (8) and supplied with the help of pump (9) through a delivery tube (17). To insure the oil temperature there is a heating element (14) and the temperature sensor (15) Friction torque is measured on the dynamometer (16), which is forcing the pendulum 6.

IV. Conclusions

The above-described sliding friction machine can be used for testing oil and oil additives in various sliding friction pairs, providing equipment to measure the friction torque component variations of the friction process cycles, test the different oils and oil additive effects on the frictional torque changes.

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Transport

Railway Transport

Simulation of the Interaction of Railway Station and Harbour

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Keywords **– forming of a train, cargo subject, modeling, forming algorithm, standstill of a wagon.**

I. Introduction

In the period of market economics, customers choose the type of transportation at the lowest cost and with a certain quality of transportation: speed and timeliness of delivery, as well as convenience of documents. Because of the shortage of refining capacity of Free port, implementing transfer of goods from rail to sea, Latvian Railway is often forced to implement convention prohibitions on the export cargo handled in conjunction with the production trains for safekeeping forming a so-called "warehouses on wheels".

II. Identification of Processes of Multimodal Transportations as a Management Object

For the decision of task of optimal guidance of trains at transport junction is necessary to depict next tasks:

1. Forming of the system of parameters for optimal guidance of trains to harbor station;
2. Formalization of process of guidance of trains to harbor station;
3. Development of algorithm of search of optimal distribution of trains in accordance to train table;
4. Development of programmatic complex for trains' operations in direction „harbor station-harbor terminal-harbor station".

Formal presentation of task of optimization of guidance of trains to harbor station is done like task of the quadratic setting. The great number of criteria of optimizations is offered, by means of which it is possible to produce the account of conflicting aims of market of transport services for subjects participating in the processes of multimodal transportations.

Basic parameters are defined for optimal guidance of trains to harbor station:

1. Time of wagons location at the harbor station holding technological operations and waiting for supply to harbor terminals.
2. Loading of all harbor terminals.
3. Time of unloading of wagons during planned period.
4. Volume of processing of wagon flows during planned period.
5. Amount of „abandoned trains" at transport junction.

III. System of Imitation Modeling of Processes of Transport Junction: Development and Analysis

Development of simulation model of a transport junction is executed with next tasks:

1. Choice of modeling tool from alternatives;
2. Modeling of structure of transport junction;
3. Laws of distribution of entrance of train flows at transport junction;
4. Simulation models of elements' functioning;
5. Design of basic characteristics of incoming and out-going flows of objects of transport junction.

For the estimation of influence of management factor to the efficiency indexes of work of harbor station (wagon's turnaround time, loading and unloading), in process of experiment a hypothesis is considered about influence of next factors on wagon's turnaround time:

- strategy of guidance of train;
- amount of shunting locomotives, served harbor areas and terminals;
- duration of period, when harbor terminals cannot accept wagons for processing, including others reasons (weather terms, impossibility of realization of unloading).

TABLE I

Factors' Coding of Imitation Model of Harbor Station

Description of factor	- (current condition)	+ (improved condition)
Train guidance strategy	Without optimization method	With optimization method
Amount of shunters at harbor station	-	+
Rejection of harbor to accept goods (weather terms, absence of vessels)	-	+

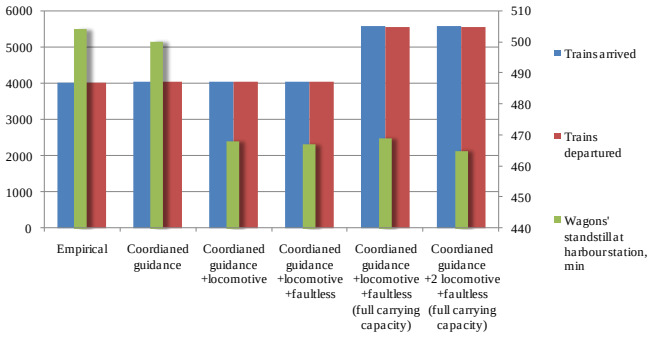

Fig. 1. Simulation results during one year

IV. Conclusions

System of parameters is formed for optimal guidance of trains to harbor station.

Simulation of processes is made by modeling tool with material flows and freight units from the entrance to the exit from the system.

Decrease of wagon standstill at the station is due to the change of technology without investing in infrastructure. It is experimentally set that coordinated guidance of trains, faultless functioning of transport junction and additional locomotive, and full usage of carrying capacity of line increasing traffic rate by 38 % from existing, wagon standstill will be 469 minutes, which is 35 minutes less than 504 minutes at existent technology.

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Optimal Secondary Suspension of Railway Carriages for Improved Passenger Comfort

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Keywords **– secondary suspension, track irregularities isolation, improvement of passenger comfort**

I. Introduction

This paper gives insight in the fundamental problems associated with dynamics of railway carriages secondary suspension's role in the comfort level and states the necessary objectives to be achieved for an optimal secondary suspension for improved comfort levels.

II. Comfort level

A research [1] showed, although the measured level of comfort was within the allowed, 94% of passengers stressed that vibrations and jerks are obstacles to use laptop in the train. The 35.30 minutes long average travelers' time spent on the laptop stresses that the comfort level must also be suitable for activities during the travel. This will make traveling by train being a justified choice.

To achieve this, besides fulfillment of railway carriage dynamical properties present requirements, it is also necessary to seek feasible ways of further reducing carriage vibrations. Existing comfort measurement methods show that the comfort level can be improved by lowering the level of carriage vibration accelerations. Also, more emphasis has to be done on the frequencies mostly qualified as uncomfortable by the passengers - generally in the range 4 - 8 Hz.

III. Approximations

We will focus on a simplified model of a passenger carriage consisting of two bogies with primary and secondary suspension, looking at the carriage only in the longitudinal plane (fig. 1), evaluating carriage vertical and pitch vibrations. Although roll vibrations are similarly described, we will omit these for clarity of the idea.

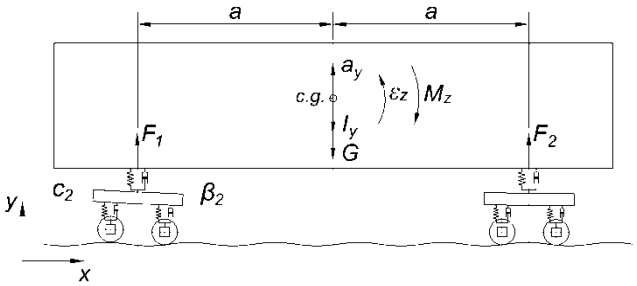

Fig. 1. Simplified dynamical model of a passenger carriage.

Our simplified model focuses on the car body, where passengers are located. Vibrations from running parts are transferred through elastic links and damping part. For evaluation of the carriage body, we will discuss only the links between bogie frames and carriage body.

IV. Dynamical equations

From force equilibrium equations we can derive expressions for both linear and angular acceleration:

$$a_y = \frac{c_2 \cdot (\xi_1 + \xi_2)}{m} + \frac{\beta_2 \cdot (\dot{\xi}_1 + \dot{\xi}_2)}{m} - g \quad (5)$$

$$\varepsilon_z = \frac{c_2 \cdot (\xi_2 - \xi_1) \cdot a + \beta_2 \cdot (\dot{\xi}_2 - \dot{\xi}_1) \cdot a}{J} \quad (6)$$

where:

c_2 - stiffness of the secondary suspension;

β_2 - damping coefficient of the secondary suspension;

ξ_1 , $\dot{\xi}_1$ - deflection of the links and the speed of the deformation (derivative of the deflection);

m - inertial mass of the carriage;

a - distance from the center of gravity to the point of the attachment of link;

J - moment of inertia of the carriage;

V. Analysis of the equations

Analyzing the equations (5) - (6) we may conclude that passive suspension systems were designed as a compromise between acceptable comfort level in terms of acceleration and reasonable amplitude and damping. Nowadays active devices have demonstrated serious improvement, but still don't solve the problem completely.

A research should be made in how to stabilize a body of the carriage which would be supported by secondary suspension having very low stiffness, stabilizing the body against impacts, which could induce large amplitude oscillations. Such a system would offer almost complete isolation of vibration transfer between bogies and carbody, and with a supplemental stabilization system, could offer substantial comfort level improvement. Lateral stabilizing systems are already being researched, and it would be only the last step to develop such a system also for vertical stability.

VI. Conclusions

The developing of active vertical suspension system could be done by lowering the secondary suspension stiffness rate and by providing another carriage body stabilization means against all disturbances except those, deriving from track and which would be almost completely isolated.

Improvement of the comfort level has a great potential for the attractiveness of the railway passenger transportation, at the same time giving economical benefit in terms of decreased track maintenance costs. This can be advantageous especially for lines, were passenger traffic due to slow speed is losing competition, but line maintenance expenditures cannot be justified to be increased.

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Railway Safety Control Systems – ERTMS, ALS and KLUB Compatibility Options

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Keywords **– ERTMS, ALS, KLUB, sorting hills.**

I. Introduction

In railway remote systems are important items for automatic and telemechanic objects.

Processing speed of the train determines railway bandwidth. Train motion reliability depends on the safety movements on station. This motion has features of train movement through the arrows, simultaneous movements and two different movements type (motion and maneuver) existence.

Reliability and performance criteria railway transports depends on automation level. At this moment on Latvian railway is rapid modernization of old control systems and modern microprocessor control systems substituting.

Developing new safety algorithms of remote automation control for maneuver stocks, its exploitation can significantly increase reliability and performance criteria on railway transport.

New inserted technologies and methods at this moment can't automate remote control for railway transport and solve a series of questions that becomes on it, because existing methods of automation control do not correspond to safety level that is on Latvian railway or can not be used with modern microprocessor control systems.

II. KLUB, ALS, MALS, GALS

At first is important to consider modern remote control systems for maneuver stocks that are used in Russia.

KLUB –a complex safety system for locomotives. It is established on traction and railway self-propelled rolling stock and functionally combines automatic locomotives signalization (ALS) and electronic locomotives speed control device.

ALS – an automatic locomotive signalization. Train automatic braking and automatic locomotives signalization – railway importing devices that are necessary to provide train motion safety. Use continuous automatic braking automatic locomotives signalization (ALSN) and interrupted (ALST) – only in paths with half-automatic blocking.

MALS - is a system of automatic signalization for maneuvering locomotives. It's intended for safe maneuver work on railway stations and motion prohibition for locomotives with speed that is over then permitted, also automatic stop before the prohibit signal or working place. This system can help to avoid wagons and locomotives collisions on stations and avoid accidents that can make service personal mistakes. MALS includes station on locomotives equipment.

GALS – is automatic hill signalization for locomotives. It provides working safety at hills paths for detaching stocks from locomotive that makes maneuvers. It makes easer locomotives control if is route or hills lights low visibility. System forms and sends information about motion speed regulation in different operation modes into the locomotive.

III. Digital radio communication in motion control systems

Information-control systems and systems that are directed to train safe motion development are not without radio communication use for different data transmission channels.

GSM-R system works on frequency 900 MHz that provides train radio channels and train motion intervals for regulation systems in high speed and high speed paths. It has centralized structure with communication equipment placement and motion control systems equipment in railway control level.

IV. ERTMS - THE *EUROPEAN RAIL TRAFFIC MANAGEMENT SYSTEM*

ERTMS/ETCS levels define ERTMS different use as train control systems, that is made as from communication line path-locomotive (1st level) till the continuous communication line between the train and central radio block (2nd level). 3rd level, is in conceptual phase, will increase ERTMS potential by inserting "fuzzy block-path" technology. At this moment ERTMS 2 level offer significant profit, 1 level leads to significant benefits for railways and observes high speed movements.

For example, Fig.1 shows images and show both the track layout and the information available to the dispatchers (produced by EBIScreen).

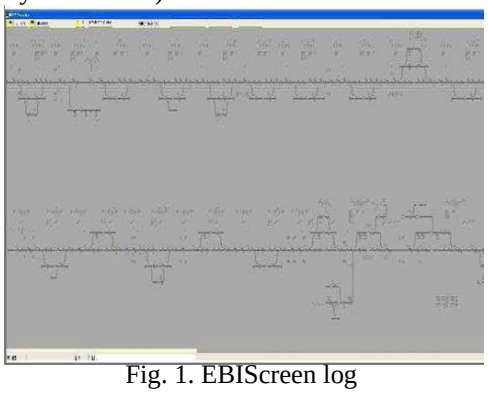

Fig. 1. EBIScreen log

V. Conclusions

Having considered different systems that are used for maneuver locomotives control on railway transport we suggest that for LDZ equipment is necessary to make modernization or substitution. At this point would be better to adopt systems that are used in Russia, even so Latvia is in European union it's necessary to follow European standards.

That's why is possibility to propose new system that will combine Russian system (MALS) and European system (ERTMS 2 level) and GSM-R system.

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Transport System Rail Transport in Riga

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Keywords **– intelligent transport system (ITS), efficient transport service, transport logistics.**

I. Introduction

Purpose of the message - to show a concrete example of Riga features of ITS as a mechanism for reliable and efficient transport service for the society and economy of the Riga agglomeration at the maximum possible preservation of the natural and artificial (architectural and urban heritage) environment.

II. General Figures

The relevance of ITS in Europe (improving the efficiency of transport logistics and the adequacy of market conditions and economic and political situation) will be presented. Russia (elimination of the lag in the development and innovation - in technology, infrastructure, fuels and technologies) and Latvia (the adequacy of the changing conditions of the transport market of the country and neighboring states) will be discussed.

The development strategy of ITS in Europe is determined from 3.28.11 White Paper (2020, 2030, 2050.). By the year 2020 the final upgrading of transport management system (ERTMS, ITS, RIS) and reducing congestion on the roads (a simple cargo and passengers by 4.2 billion hours a year, losing 87.2 billion dollars.) should be implemented. By years 2030-2050 the share of private vehicles should be reduced by 2 times and stop completely by 2050. The freight traffic should mostly be diverted to the use of water and air transport. The increase of railway transport should also be supported. The innovative development across the European intermodal network TEN-Tr; rail transport corridors should be promoted and its use increased by 2030. Creation of a European system of high-speed rail roads, providing direct high-speed connection to the sea ports and terminals, airports would mean also benefits for ecology since the use of jet fuel would be reduced to 40% of jet fuel with low carbon content and 40% oil-fired emissions on water transport. The economical benefits would include reduced payment for mileage and excess emissions, as well as the initiation of the private sector to invest in the development of transport.

III. Concept of the formation of ITS

The concept of the formation of ITS would mean several things for Latvia:

• Development of national strategy towards the development of ITS for all types of intermodal transport;

• Development and implementation of innovative solutions based on the integration of all aspects of the transport service to customers in a particular place at a specific time and specific infrastructure;

• The introduction of innovative technology and operation of transportation systems management (ITS). For the agglomeration of Riga: an organization of high-speed communications rail-type S-Bahn (city train), including the organization of high-speed trains non-stop city airport.

The physical content of ITS for Railway Transport in Riga: an object transport service levels, the degree of integration of ITS, the structure of the transport system, the requirements of customers to the system of transport services, transport services market. Structural and modular version of ITS in the transport service of Riga in the interests of consumers of transport services can be presented as a conceptual system macromodel of 8: 1 - the concept of comfort and design, 2 - Security in the transport, 3 - an intelligent system is lightweight railcar, 4 - logistics structure and processes, 5 - the concept and content maintenance of transportation facilities, 6 - the strategy of population mobility and flexibility of the adequacy of transport. 7 - intelligent transport management system, 8 - innovative transport systems.

IV. CONCLUSIONS

The main mission of ITS - Riga consists of:

• the justification of an integrated intermodal transport system in the basis

• the proposal for a new innovative forms of Latvia rail,

• the development of the territory of Latvia and the Riga agglomeration areas of international systems of European corridors TEN-T.

An innovative integrated rail transport in Riga includes:

• upgrade the existing main and suburban railways in Latvia and Riga agglomeration

• City-Bahn (S- Bahn) with diameters of pendulum,

• Fast communication through the city to the airport. "

Low-floor tram should be used as transport to railway stations and car parks - the main intercity transportation.

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Transport Logistics Airflows Thro "The City - The Airport"

Eleonora Shabarova (*PSTU, St. Petersburg*)

Keywords **– Logistics flows. Urban and intermodal transport.**

I. Introduction

Purpose of the message is to show specific examples of transport logistics capabilities to ensure reliable and efficient service passengers largest cities and agglomerations on the basis of an integrated rail system at the maximum possible preservation of the natural, built environment (architectural and urban planning, and inheritance).

II. General Figures

General features of the presentation:

- the relevance of air transport in urban and intermodal transport
- Transport logistics for passengers' door to door "- the possible alternatives
- Logistic tandem "railroad - the plane" or system "tracks - the air."
- The European experience of high-speed "aerotrain." (aerozug, aerocity,)
- Innovative and ongoing projects for the Sochi 2014 (Tuapse - Sochi - Adler - airport - Krasnaya Polyana) and Vladivostok -Summit 2012 (Airport-Vladivostok - Russian Island (commissioned July 16)

The population of metropolitan Greater Sochi by the year 2014 is estimated to be 420 thousand. To this the number of tourists which is additional 4.5 -5.0 million people/ year should be added on the area which is 3600kv.km. The length of the coast is 145 km and the radius of residential area is 50 km. It is expected that for the Olympics Sochi-2014 the number of mandatory participants will reach 86 thousand people. The maximum passenger load is estimated as 240 thousand people per day. One should also estimate that the number of visitors per day in the mountain area will be about 79 thousand and on the coast, in Imereti it will be around 42 thousand. The level of car ownership currently is 320 cars / 1,000 inhabitants. The passenger load for the Sochi air transport currently is 1.1 million passengers per year, with a capacity of 750 passengers / hour. During Sochi 2014 the statistics will probably go up till more than 2 million passengers / year meaning that a capacity of 3800 passengers / hour will have to be ensured. Refer to this table in the full paper version for other options.

III. Projects

Projects "with the sad fate of the century" for the agglomeration of Riga include Riga Airport (Skulte) and the airport Spilve. For the first time in Riga (and USSR), the idea of a direct rail link through the city - the airport "at the Riga airport was justified by the author in the project "Integrated transport scheme development for all modes of transportation in the metropolitan area of Riga for the period 1975 - 1990 he. "(LATGIPROGORSTROY)". The recommended system of the city S-Bahn, based on the modernization of the existing inner areas potentially provide all areas of the city of Riga a direct link to the airport. A sufficient number of stations in the area are almost walking. However there was no political will.

IV. CONCLUSIONS

4 relevant factors of the problem today:

1 - the development of air transport in Riga - more than 5 million passengers / year through the Airport Riga;

2 - the revival of Airport Spilve for intermodal, regional and local posts;

3 - Transformation of Airport Spilve: Appealing to a new point of attraction of its own and foreign tourists holding Holidays aircraft on the airfield, showing the air and land vehicles, visit the Museum of Aviation in the historic terminal building in tandem with the house in Zasulauks Zahnder and the history of Riga hangars for dirigibles in the Central Market;

4 - pure Bolderaya coast, with its protected area for migratory birds, with its unique fortifications fortress Daugavgrivas exceeding Peter and Paul Fortress in St. Petersburg, the historic lighthouse in Bolderaja, the first railway in Riga (1861g.) and the oldest in the yacht-club Latvia.

To implement the above items require environmentally friendly transport, comfortable, reliable, secure, with a large carrying capacity, which can be flexibly changed depending on the size of passenger traffic. This is the railroad.

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The Electromagnetic Compatibility in Railway Automatic Devices

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***Keywords* – track circuits, frequency modulations, power lines.**

I. Introduction

The track circuits are the main element in the system of interval regulation of the trains` traffic. The information about free sections of the railway lines and about the integrity of the railway track wires provides the interval regulation of trains` traffic. By track wires of track circuits, which at the same time is the floor channel of the automatic locomotive alarm, the information about traffic lights forward, is given to the locomotive.

The main feature of the railway automatic devices system is the use of railway lines, where the backdraft currents flow, as the lines for transmission the automatic locomotive alarm in the code combinations to the locomotive, as well as for the control of free railway line.

II. Electromagnetic Compatibility

The electromagnetic compatibility of these devices is provided, using the frequencies, which differ from the harmonics of the traction current. However, modern electric locomotives are a powerful source of the interference in a wide range of frequencies. Used high-voltage filters not always may to provide the reduction of the interference level.

The increased traction current of the asymmetry in the elements of track circuits and the automatic locomotive alarm, lead to the generation of direct currents, which could worsen the quality of the functioning of these elements, causing the disruptions in their operation and the overlapping of automatic lock signals in front of moving train. As a result the safety of train's traffic worse, the costs increased due to additional stoppages and delays of the train[1].

The main source of the interferences on the electrified sections of the AC current is the traction power frequency and its harmonics. For the operation of track circuit the receiver and the radio transmitter are used.

Depending on the type of track circuit, the different code combinations and forms of the electrical signal are used. For example, in tone track circuits of the third generation the amplitude-modulated signal is used, as well as the alternation of the different carrier frequencies (420,480,580,720,780 Hz) and the frequency modulations (8,12 Hz).

The intervals of code combinations may be filled by pulse or harmonic interferences. The impulse interferences usually are the result of abrupt changes in the traction current in the rails and the locomotive, as well as the result of the magnetization of the rails. The main source of the impulse interferences is the electric draft of the locomotive equipment.

The absolute value of the traction currents difference has not to exceed 15 A [2,3,4]. The difference between the traction currents in the track wires is directly proportional to the value of the longitudinal asymmetry and transversal asymmetry of the electric resistance of the railway line and the value of the traction current. The transversal asymmetry appeared, if railway wires have the different resistance to the ground. The transversal asymmetry always presents in places, where the railway wires are connected to the grounding circuits of the contact network [5].

The purpose of the modeling is to research the changes of the asymmetry coefficient of AC traction current under the coils of the automatic locomotive alarm, when the train moves on various railway track circuits. To implement such tests experimentally during operation is quite difficult; therefore, we propose to use software simulation in Matlab environment, as well as to check the values in the Electronics Workbench.

The input resistances of railway wires are the main parameters of the distribution of the traction current under the coils of the automatic locomotive alarm. During this simulation the scheme of the back-draft railway network replacing was used within the non-regular lines [4], which were supplemented by the leveling choke-transformers. This model is characterized by the following sections:

- for the stages of non-joint track circuits, when grounding of the traction substation is connected to the midpoint of the Drossel - Transformer, which is established on the border of stage to the station;
- for the stages of track circuits of automatic lock code and for track circuits of the station, when grounding of the traction substation is connected to the midpoint of the Drossel - Transformer, which is established on the output - point of the track circuit.

In such sections the reversal traction currents in the rails have a maximal values [6]. The intensity of automatic locomotive alarm failures and track circuits malfunctions in such sections are the highest.

or example, the input resistance of the track wires can be calculated by the formula (1):

$$Z_{BX1} = Z'_{14} + \cfrac{1}{\cfrac{1}{Z^{\bullet}_{14}} + \cfrac{1}{Z'_{15} + \cfrac{1}{\cfrac{1}{Z^{\bullet}_{15}} + \cfrac{1}{Z'_{16} + \cfrac{1}{\cfrac{1}{Z^{\bullet}_{16}} + \cfrac{1}{Z_{ДР12} + Z_{ДТ}}}}}}} \quad (1);$$

To know the values of the input resistance of the track wires of various lengths, we can calculate the distribution of back-draft traction current under the coils of the automatic locomotive alarm by the formulas (2):

$$I_{T1} = I_T \times \frac{Z_{BX2}}{Z_{BX1} + Z_{BX2}} \quad (2);$$

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Test Point for the Battery under Load

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Keywords **– battery testing with load, internal resistance of battery, estimation of internal resistance, accuracy of estimation.**

I. Introduction

Use of batteries by rather commonly used approach of uninterrupted operation guarantee for power supplies. The correct choice of technology defines battery life and preservation of guarantees of the manufacturer.

The condition of battery is defined by the personnel after measurements of internal resistance. Accurate of estimation of the internal resistance affects the future decision about the state of the battery. Therefore, for highest accuracy of measurements is important to know the affecting factors.

Article examines the impact of duality battery mode on the internal resistance of battery.

II. Duality of Battery Mode

The mode of battery is determined by conditions, so if the battery spends energy, it is a load mode, or if the battery loses energy, it is a source mode.

The hypothetical dependence of the internal resistance of battery from mode is presented in figure 1.

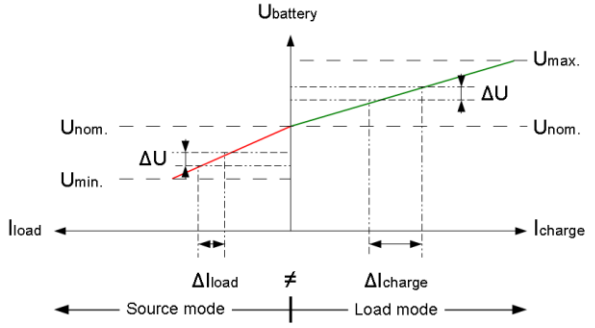


Fig. 1. Internal resistance hypothetical dependence from mode

A. Practical results of measurements

For internal resistance of battery estimation HIOKI HiTESTER 3550[1] is used to. Measurement results are more details considered in table I in full version.

B. Estimated dependence

The dependence of the internal resistance of battery from mode estimated after table I results analyzing is presented in figure 2.

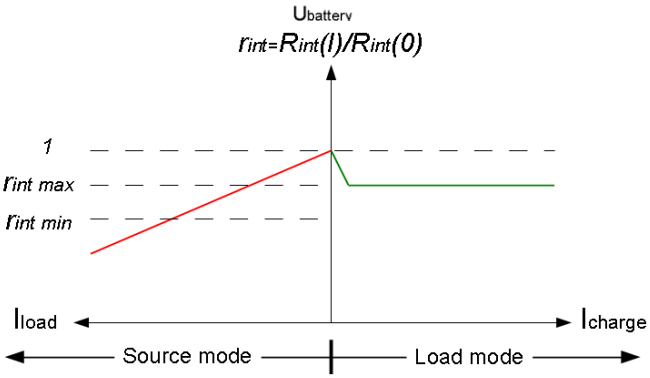
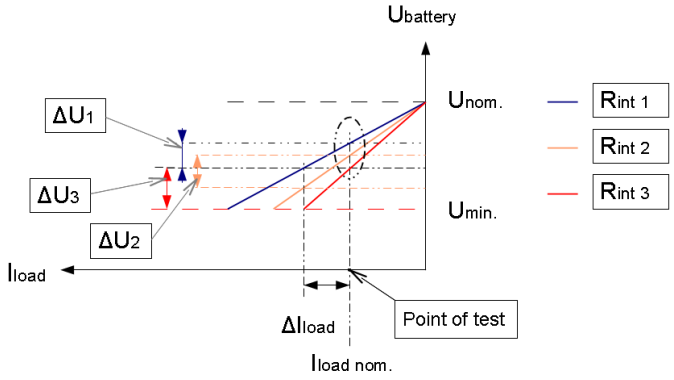


Fig. 2. Internal resistance practical dependence from mode

III. Battery Test Point

Using the method of tracking generator load with simultaneous assessment of the internal resistance of the formula (1) propose to use the point of testing for a specific



type of battery (figure 3).

Fig. 3.Point of battery testing for highest accuracy

A. Battery testing condition

Test conditions, or the establishment of a test point, shall be considered satisfied if the provision of conditions (1).

$$\begin{cases} I_{load} = (0.1 \div 0.15) * C * st.^{-1} \\ U_{battery} \geq U_{battery\,nom.} \\ t_{load} \geq T_{load\,min.} \end{cases}$$

Test conditions are more details considered in full version.

IV. Conclusion

Given the duality of the battery, as a consequence is dependence of the internal resistance from mode, and rejection of influence of variable component in current of load to increase the accuracy of measurements.

Using the tracking generator of loading eliminates the effect of variables components in load current and simultaneous result point of testing for the battery.

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The Freight Transportation Evaluation in Local Traffic of Latvia

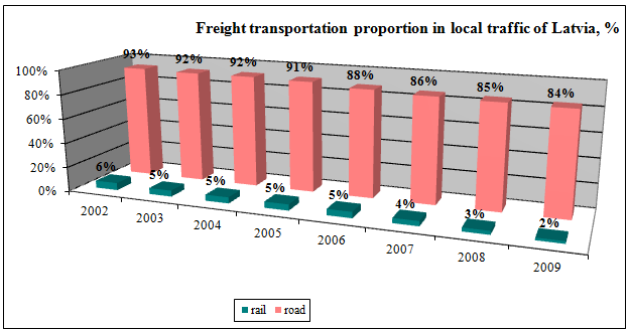
Mareks Mezitis (*Riga Technical University*), Eva Skrebutene (*Riga Technical University*)

Keywords – Railway, Road, Freight Transportation.

I. Introduction

Historically, Latvia has been one of the main transit points for both north-south and east-west trade flows. The transit sector is one of the strongest industrial sectors in Latvia.

The freight transportation system of local traffic in Latvia includes two mode of transport: railway and road. The part of rail freight transportation in the local traffic is negligible, but the road freight transportation is superiority. Figure shows the freight transportation proportion in local traffic of Latvia between 2002 and 2009 years.



I think that despite the fact that transit is a priority direction, but do not forget about the internal traffic. Also [1] item 1.8. says: "1.8 Although the Roadmap relies on combining modes of transport (one aspect of co-modality), it also proposes specific modal shift objectives for road freight transport (i.e. 30 % of road freight over 300 km to shift to other modes such as rail or waterborne transport by 2030 and more than 50 % by 2050). " So this is baseline to promote researches to rail freight transportation increase into local traffic of Latvia.

It's important research both modes of transports in the local traffic of Latvia and make recommendations and scientific explanation how can advance rail freight traffic.

II. Freight Transportation Evaluation Model

Both modes of transports are evaluated with the economical model that is described in [2].

The economical evaluation model of all existing operating work indicators are characterized by expenses differentiation and cost determination. Each operating indicator evaluation applies certain measures, which links the changeable cost set.

The greatest impact to actual cost of the freight traffic provides the following quality indicators of the rolling stock:

- Wagon load - about 33% of the total cost change by growing or decreasing of load;
- Mass of the train - 20-25% cost associated with this indicator as inversely proportional relationship, for example, in the largest mass of the train, the less the cost;
- Section speed - affects 8-10% of total costs.

If costs are looked at depending on traffic movement volumes, then grow proportion of those indicators costs.

In the [2] has been produced by the mathematical transformation of cost per the 1wagon-kilometer, 1 train-kilometer and 1 train-hour savings special weight rates. These rates are modified derivatives values of the cost of a wagon-load, train mass and section speed. Thus, analyzing the costs by given scheme, only one variable (indicator) has changed.

Although the saving special weight rates are constant values whereas they are functions of other indicators, so as:

- The rate of the wagon load impact analysis is the function of the section speed and the mass of train;
- The rate of mass of the train impact analysis is function of section speed;
- The rate of the section speed impact analysis is the function of the wagon-load and the mass of train.

III. Summary of Researches

Experiments have shown that:

1) Use the road to long-range and large volume of freight transport very inefficient because it:

a. reduce automobile circulation, meaning that the car meets low transport activities;

b. increased energy consumption, so that air pollution;

c. increase the human resources work, which negatively affects the transport cost.

2) Use of rail transport for short distances and a small amount of freight transport are inefficient because:

a. irrational use of rolling stock, because train indicators will be considered in the overall vehicle energy resources, human consumption of resources;

b. more idle time under the storage, clearance operations are not reflected in the indicators characterizing the movement, but also affect the time of delivery to the customer;

c. freight carried by rail over longer distances is more economical than short distances, which may explain the high proportion of expenditure that is not directly dependent on the transport distance and thus raise the cost of small distances. They are the cost of opening and closing operations, including feeding wagon loading and unloading locations, maintenance, cargo operations, etc. Compared with other modes of transport, rail less impact on the environment, the lower the energy intensity of transport and higher degree of safety.

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Surfacing of Frog Core

Dijs Sergejevs[1], Sergejs Mihailovs[2], Pavels Gavrilovs[3] [1-3]*(Riga Technical University)*

Keywords: **surfacing, electrode, frame rail, rail wing.**

Every year a great number of cores and rail wings with vertical and lateral wears are detected on Latvian Railway. These damaged cores and rail wings disturb smoothness of train movement, create danger for safe railway traffic and necessitate slowing down speed in the case of evolution of wears which consequently leads to higher purchase costs for replacement of faulty switch elements with new once. The value of wear ΔN is usually estimated on layer thickness Δh, volume ΔV or mass of material ΔM taken away from a friction area. The most popular characteristic of the wear process is I, which represents the ratio of the wear ΔN to the distance ΔS or to the volume of work ΔA where the wear process occurred 1:

$$I = \Delta N / \Delta S \,,\; I = \Delta N / \Delta A \quad (1)$$

The process of wear is evaluated in terms of non-dimensional quantity of the linear wear rate I_h which is the first derivative of the thickness Δh of the damaged layer with respect to the friction distance ΔSa performed 1:

$$I_h = \Delta h / \Delta S \quad (2)$$

The process of wear comprises three stages: surfaces interaction, change of surface layer and surface failure. It is known that the rate of wear for the same bodies may increase or decrease tens or even hundreds times at apparently insignificant fluctuations of environment parameters, e.g. humidity or temperature elevation.

On Latvian Railway, on the basis of innovative technology, repair of damaged cores and rail wings is carried out without their removal from switches.

To surfacing are subject frogs, in which vertical wear of cores and rail wings reached 3 mm. Previous to frog surfacing, it is necessary to determine what material it is made from. Dimensions of the frog profile and supposed surfacing area are determined using frog templates. The results of measurement are marked on the rail base. The core and the wearable part of a rail wing are made of high-manganese steel with the manganese content of 12-14% and are surfaced without preliminary heating. Since properties of high-manganese steel degrade at temperatures from +200°C to 700°C and there is a risk of crack formation in surfacing area, no frog heating above +200°C can be allowed by no means.

The above cores surfacing should be as far as possible carried out at low ambient temperatures. Thus a risk to overheat high-manganese steel would be less. Damaged material is removed from core and wearable parts of rail wings by grinding. The total area of surfacing should be grinded evenly as far as possible. After "colored testing" a drying of high-manganese steel is carried out by warming-up to +50 – +60°C using propane torch reducing thus a possibility of pockets formation during welding. Surfacing should be carried out using electrode OK 86.28 4.0 – 5.0 mm of diameter by short welds till 100 mm of length which gives a minimum heat to a core. Each surfaced weld should be forged using hammer of 500 g of weight in order to avoid shrinkage cracking.

A core temperature should be tested during surfacing using a digital thermometer. In the case when the temperature is close to +200°C, the work should be suspended to cool down a core to +130 - +140°C. The determined sequence of making the welds should be observed during surfacing. The initial and final weld craters should be superimposed on the frame welds which are non-active materials and are totally removed by grinding after the surfacing has been completed. In the rest of cases the initial and final weld craters should be carefully grinded before proceeding with the next welds superimposing.

The repair of a switch core is shown in Fig. 1. A rail wing should be surfaced using the same principle.

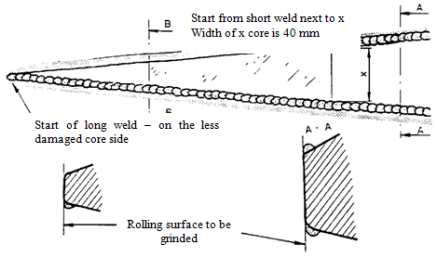

Fig.1. Frame welds surfacing

On the beginning and finishing three welds are surfaced on frame welds transverse to the point. Outside weld surface to be grinded at an angle of 45 °. Then welds of 100 mm of length are surfaced parallel to any of working side of the core ending on the transversal welds. Thus the surfacing of the longitudinal welds along the working side of the core continues. Don't forget to control the working temperature of the core during the repair. When the fore-part of the point is completed, the surfacing with transversal welds is proceeded, starting and finishing on the frame welds. The same principle is used to proceed with surfacing to the necessary height of the surfaced area. Immediately on completion of the surfacing, a rolling surface should be grinded to an approximate level and profile. A surfaced material is left for fine grinding.

When the core cools down to +30 - +40°C, a final polishing is carried out to the designed profile. The grinding is carried out using a grinder type "ROBEL" for switches as well as polishing tools. The heating of the core at grinding should not be above +70oC in order to avoid a temperature strain which may lead to its incorrect geometry. The control measurements are taken using templates. As it was proved by experience, on the completion of each 30 cm sector surfacing, the rail can be grinded without a necessity to be cooled down. The ultrasonic testing of the frame rail in the place of repair is carried out in the course of 1 – 7 days after the surfacing has been completed, drowning up a corresponding statement. For the time of surfacing in the field conditions the switch should be closed for train operation.

CONCLUSIONS

1. The quality of surfaced layer on the average meets the requirements, does not disturb a smoothness of train movement and does not create danger for the safe traffic provided the technology of switch cores surfacing has been strictly observed;
2. According to the calculations, frog core surfacing economically is more advantageous than its replacement with a new one;
3. The supervisions of frog cores surfacing on Latvian Railway confirm its effectiveness with respect to the increment of the intervals between maintenances of switches, which provides for lower purchase costs required to replace faulty switch elements with new once.

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Transport

Aeronautics and Transport Systems

Assessment of Aircraft Crew Skills Development Dynamics by Means of a Separate Exercise Results

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Key words **– learning curve, flight evaluation, progress evaluation.**

I. INTRODUCTION

It is recognized that the skills of the operator performance due to interactive learning and exercises develop by large exponentially from the initial level until required level with the negative degree coefficient.

The skills development dynamics of a particular aircraft crew are influenced by many factors and the possible precise identification of this correlation creates a chance to optimize and individualize the learning process.

In order to obtain skills dynamics parameters several consecutive measurements of the successful exercise fulfillment are necessary. These measurements are not possible to acquire reliably by means of a one summary exercise assessment since this is usually formed by small differentiation 4-5 grading system (from 2 to 5 with possible "between" mark 3 minus or 2.5) and deals with absolute security level not with the progress of the skills development.

II. ASSESSMENT METHODS

For the more precise identification of the aircraft crew skills dynamics the following methods are proposed:

- For the exercise progress assessment partial evaluation should be used:
  - About the keeping of the flight parameters within defined diapasons;
  - About the operations with the systems (turning on, turning off);
  - About the decision making in each exercise step;
- The emphasis should be put on the more important flight steps (uniting similar ones) and in each step the parameters should be classified by their importance into 3 groups:
  - 1. group – the aim of the step is to reach the value of the parameter (emphasis – 4);
  - 2. group- the parameter directly influences the parameters of the 1.group (emphasis – 2);
  - 3. group – the parameter is evaluated but it is not included in 1. group or 2.group (emphasis – 1).
- In accordance with the grading linguistic meaning:
  - Partial mark "**5**" means – "the aim is fully realized" – therefore successes level for following particular parameter, operation or decision is 100%.
  - Partial mark "**2**" – the aim is not achieved - success 0%.
  - Partial mark "**3**" – 'average', 'good enough' – success ≈ 50%
  - Partial mark „**4**" – 'good', 'above average', 'normally' - success ≈ 80%
  - Partial mark "**2.5**" – 'below average , but not complete failure' - success ≈ 25-30%
- The impact of the marks on progress assessment can be quite precisely described by the approximation (1), (fig. 1), that shows approximately 1.5 times larger impact of the negative marks;

$$Progr(Mark) = 142.1 - 42.1 \cdot 1.5^{(5-Mark)} \quad (1)$$

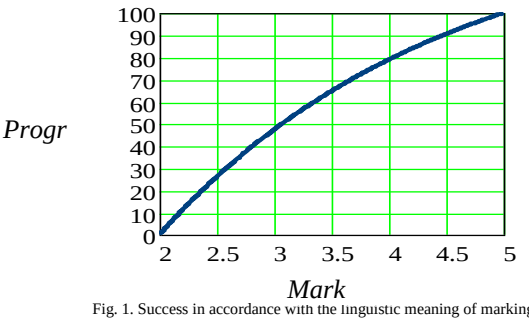

Fig. 1. Success in accordance with the linguistic meaning of marking

- The assessment of the exercise results progress should be calculated by summing up partial assessments and by taking note of their emphasis and 1.5 times larger impact of the negative marks (2):

$$Mark_k = \frac{\sum_{i=1}^{n} (Mark_i \cdot 1.5^{(5-Mark_i)} \cdot MCount_i)}{\sum_{i=1}^{n} (1.5^{(5-Mark_i)} \cdot MCount_i)} \quad (2)$$

where:

$Mark_i$ – particular partial mark ;

n – number of the different grades, marks;

$MCount_i$ – number of marks of the particular $Mark_i$ grade.

- In accordance with (2) the resulting mark of the piloting in each step is acquired, then the resulting mark of the piloting for the whole exercise (n - number of steps), and then of the discreet operations and the decision making (uniting all partial marks) and finally of the whole exercise in total;
- Learning curve are generated by formula (3):

$$Progr(flight) = 100 - (100 - Progr_0)e^{-Ac \cdot flight} \quad (3)$$

where:

$Progr_0$ – initial level of the progress (learning);

Ac – learning speed constant (individual for the crew);

$flight$ – serial number of the exercise (usually flight in circle).

The parameters Ac and $Progr_0$ are obtained by processing the exercise results marks using Gauss method.

III. CONCLUSION

It is advised to form the final assessment about learning steps not only from the assessment obtained in the final control exercise, but also to take into the consideration the marks of the previous exercises. It is proposed to use a linear assessment of the previous exercises impact correlation and to take into account from 1 up to 7 previous exercises.

E-guided Vessel – Introduction to Collision Avoidance System

Darja Andrejeva (*Institute of Aeronautics, RTU*)

Keywords **– vessel collision avoidance, traffic systems, automatization.**

I. Introduction

Statistical data and accident rate at sea allow determine and understand the human role in today's shipping, its interactions with electronic navigational aids and process automation in general. The majority of accidents are caused by human error and the right approach to automation could help to reduce the number of accidents.

II. Economic aspect

The number of crew members has been reduced as a result of cost cutting due to the prevailing economic situation, together with the fact that fewer people have wanted to work on a board ship over the last years. The inevitable results are that safety levels decrease and the amount of work load increases for deck officers. For example, the large container ships with 8,000 TEU capacity may have a crew of 15-17 people. A few years ago when the world economy was not hit by the global crisis, the same ship were served by 22-25 people. One vessel crew cost reduction can reach up to $ 250,000 per year [1], which is really an impressive figure, considering that an average of one sailor costs $ 30,000 per year [2]. Despite this Drewry Shipping Consultants' studies predict that in 2013 the ship's officers and ratings shortage will reach 7% of the total number of seafarers, it is 32,153 and 46,881 person respectively [3].

III. Collision Avoidance Systems

As an already working analogue of such a system one could name the following:

Traffic Alert and Collision Avoidance System (TCAS) – mandatory on all large transport aircraft (on more than 25,000 aircraft worldwide) and has been in operation for more than a decade, prevented several catastrophic accidents.

Vehicle Collision Avoidance System (VCAS) – uses millimetre-wave radar to detect vehicles and obstacles on the road ahead and to help to reduce the severity of collisions, along with newly developed stereo camera to detect pedestrians and support evasion manoeuvres by the driver, retracts the seatbelts and warns the driver when it determines a high possibility of a collision.

Railway collision avoidance system (RCAS) – calculates own position and movement vector and broadcasts this information as well as additional data like vehicle dimensions to all other trains in the area. The system can take into account different danger sources, like advancing trains or road vehicles or obstacles, and classify them according to a specific scale.

Whale anti-collision systems (WCAS) – represents a chain of buoys with sensors and other equipment that analyses sounds, locate each particular whale in 3D. There is also communication system buoy – shore installed both ways in such a way that all vessels in the vicinity of whales receive relevant information.

IV. The ways of introduction ACAS on board

Considering the opportunity of such system introduction on board of the merchant vessel, several moments should be taken into account – it should be simple enough and safe at the same time. It could be introduced as an additional computer on the bridge (or as a part in the Integrated Bridge System) with the corresponding software which would receive input data process into a warning message and possible situation decision. Automatic Collision Avoidance System (ACAS) leads to the idea of equipping the ship with 3G system (the latest Dynamic Positioning ships are equipped with 2G – GPS and GLONASS satellite receivers, which provide the highest vessel positioning accuracy.

There also raises a question, whether ACAS should be introduced on all the vessels, the same as TCAS or RCAS, where there is an information exchange between retransmitter of two vehicles or it could work the same as VCAS independently to avoid the collision situation. No doubts that the second option has an advantage, it also makes possible for the ship owner to implement such system step by step on all the vessels. The first option – like single requirements that could concern ships of certain tonnage and navigation area would be too complicated and time consuming process.

Considering the ships manoeuvre as an action which has to be done timely, in certain point and to the certain course according to the collision regulations and bearing in mind all the manoeuvring characteristics at the same time fully automatic system would have more opportunities in this situation. However it is impossible to exclude absolutely the human from ship operating chain for now.

Besides the initial information the main attention should be paid to the way of data processing, i.e. to the software of the ACAS. Here as well different options are possible: using fuzzy sets, catastrophe theory, expert systems, neural networks, hypothesis-based reasoning system etc. None of these methods can be employed singly to solve the problem. A new way needs to be introduced that would combine probably a mix of several different methods.

V. Conclusions

Besides the human factor reduction, ACAS provides safety at sea, as an aid to vessel traffic service VTS to control the traffic in restricted waters. More and more tasks have been taken over by electronic systems – it is likely that ACAS is going to be one of the most effective ways to overcome its occurrence. Although such a system is not used on merchant vessels now, it could be implemented in the near future.

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Underwater Survey Future Perspectives

Kristine Carjova, Vladislavs Zavtkevichs, Ilze Stelpa, Darja Andrejeva (*Institute of Aeronautics, RTU*)

***Keywords* – underwater survey, ship's hull corrosion, fouling.**

I. Introduction

Survey of ship's hull underwater part is necessary to provide safe exploitation of ship, to notice hull defects in advance and to give opportunity to plan work, which should be done to underwater part to maintain it in good condition. The process and necessity of this survey is set out in international regulations.

When operating in the water, ship is continuously exposed to both corrosion and fouling, which have a significant impact on fuel consumption costs and ship's safety. Normal procedures for survey of ship's underwater part were dry dock or using divers. But these methods are neither economical nor safe. Survey in dry-dock means considerable cost to ship owner, but survey in water, which is done by divers is not the safest way and not the most economical either.

II. Legislation of surveys of ship's underwater part

Survey of ship's bottom is survey of ship's underwater part, including underwater elements, to ensure that they are in satisfactory condition and ensure operation of ship.

IMO resolution A.997 (25), which replaced previous resolution A948 (23) in 2007 determines procedures for ship's hull surveys. Taking into account international legislation, there must be carried out at least two surveys of ship's bottom outer part in every five year period.. Period between every two surveys cannot exceed 36 months. This resolution combines requirements about ship's hull surveys of number of conventions, for example, SOLAS-74, MARPOL-73/78 and other laws and regulations. Ship's underwater part survey should include survey of details and places mentioned below:[1]

- ship's hull, including bottom and forepeak,
- keel, stern, frames in the region of rudder, rudder,
- rudder bearing gap measurements,
- propeller, propeller shaft cushion inspection,
- inspection of kingston boxes, lattices.

Classification societies are using possibility, which is made by IMO harmonized survey system (A.997) for several ship types, i.e., to carry out ship's underwater part's inspection in dry dock with time interval of 7.5 years instead of previous 5 years. This innovation is a benefit for ship owners, which now will be able to save money on dry-dock survey. Of course, it will not release the ship from surveys at all, but will provide it with opportunity to carry out the survey in floating condition, and it also does not mean, that ship safety will be in danger.

III. Problems of underwater part of ship's hull

Corrosion causes not only damage to ship's hull, but also to other parts of underwater constructions, for example, propeller, rudder. In the areas, which are subject to corrosion, metal becomes thinner, reduces its resistance, density of constructions and all the ship's hull as whole.

The intensity of corrosion increases metal's abrasion, resulting in probable cracks in metal, which gradually spread to the depth of metal, doe to which there could develop damages in ship's hull and underwater constructions, which leads a negative impact on ship's safety. There is loss of metal due to damages caused by corrosion. To remove them, it is necessary to invest economical and human recourses.

Fig. 1.Ships hull corrosion [2]

IV. Conclusions

Corrosion (see fig.1) and fouling of ship's hull have a serious affect on safety and costs of shipping. Due to that there is necessity to do the surveys of ship's hull underwater part. The survey can be carried out by dry-docking, using divers or using unmanned underwater vehicle.

The certification process for ships is combined in IMO resolution A.997 (25). Classification societies, taking into account technological development, offer better survey regulations. The survey in dry-dock must be carried out in interval of 7.5 years instead of previous 5 years.

Latest trend in inspection process of ship's hull underwater part is unmanned underwater vehicle. Most of the work usually carried out during dry-docking can now be done in water. Using underwater vehicle can significantly facilitate work of divers. It will not only be safer (because of no people in water), but also cheaper. The cost of divers is approximately twice as much as costs of using underwater vehicle. However, currently, due to the disadvantages of such vehicle, the complete survey of ship's hull underwater part is not possible by completely replacing divers with underwater vehicle.

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Composition and Structure of Micro Arc Oxidation Coatings

Aleksandrs Urbahs, Vladimirs Zujevs, Konstantins Savkovs (*Institute of Aeronautics, RTU*)

Keywords **– oxidation of micro arc, anodic oxidation, coatings, vacuum technologies.**

I. Introduction

Micro arc oxidation (MAO) is comparatively new way of surface modification and strengthening of metal materials mainly. Beginning of this method can be seen from traditional anodizing and this is electrochemical process. Using micro arc oxidation allows obtaining polyfunctional ceramic materials (Fig.2.) with unique qualities: wear resistance, corrosion strengths, electric insulation and decorative overlays.

II. Experimental Micro Arc Oxidation equipment

Experiments were conducted on the equipment constructed in such way that it was possible to make micro arc oxidation on surfaces with different overlay made by ion plasma method with thickness 5 micrometers and more.

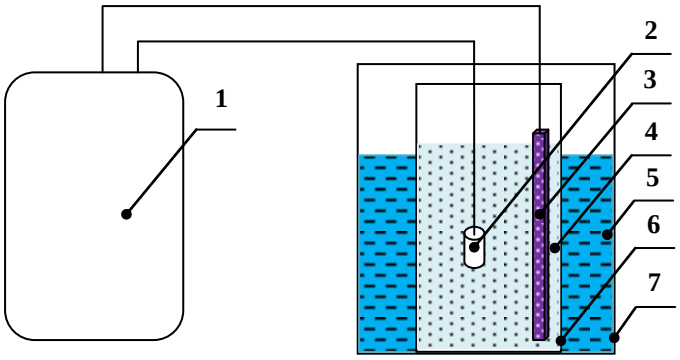

Fig. 1. Arrangements for micro arc oxidation:

1 – power source; 2 – anode; 3 – electrode cathode; 4 – alkaline solution; 5 – cooling solution; 6 – inner reservoir; 7 – outside reservoir

This equipment is constructed in the way that allows to conduct micro arc oxidation process over details with thin overlay. Source of power selected – direct current. Using this type of power allows minimize risks of uncontrolled MAO transition to the phase of electro arc which could damage overlay.

III. Composition and structure of micro arc oxidation coatings

Main phases of MAO:
1. Passivity;
2. Anodizing;
3. Glowing discharge (shining);
4. Sparkling;
5. Intensive micro arc sparkling;
6. Arc discharge.

Structure of overlay depends on the nature of material to work with and technological parameters of process:

- Electrolyte;
- Regime;
- Duration of treatment.

Main factors of micro arc oxidation process are composition of electrolytes, support material, regime and duration of treatment. It significantly affects content, structure and qualities of surfaces overlaid. Electrolytes used in micro arc oxidation can be divided in two groups. First group contains electrolytes not containing elements which are able to form indissoluble oxides, for example solution of sulphuric acid or alkali. Overlays made with such electrolytes penetrate into metal surface thanks to oxidation according to reactions:

2Al + 6OH-aq - 6e ® 2Al(OH)3 ® Al2O3 + 3H2O; Al - 3e + K+aq + 4OH-aq ® 2H2O + KAlO2,

where KAlO2 is inside overlay in the shape b-Al2O3 [1].

Structure of overlay during this process can contain several layers, each of it influenced by electrolytes and Technologies used.

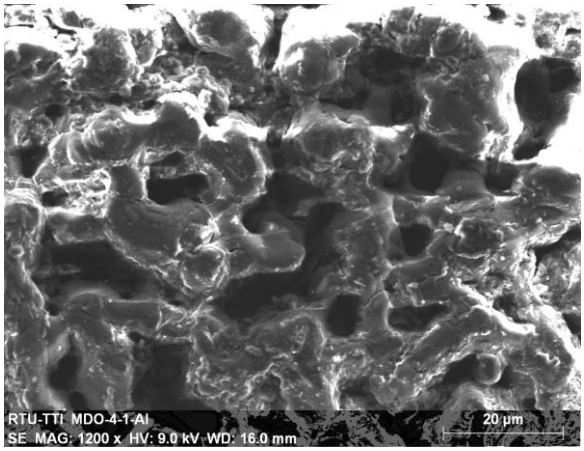

Fig. 2. Microstructure of dielectric overlay on aluminium

Technology of micro arc oxidation is used to process various metals and alloys (Al, Mg, Ti, Ta, Nb, Zr, Be etc.). It is used for metals which oxide membrane is formed in electro chemical way and have monopolar d.c. link in the system metal – oxide – electrolyte.

IV. Conclusions

Micro arc oxidation is promising process which depends on various circumstances and regularities. Defining interconnections between treated material, parameters and conditions of process will improve exploitation qualities of overlays and will enlarge spheres of application.

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Ship Main Engine Bearings Vibration Analysis

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***Keywords* – ship main engine, vibrations, bearings.**

I. Introduction

Damages to the crankshaft main bearings and pins account for the most engine damages. Through bearing temperature monitoring in real time the damages listed hereafter can be quickly detected while the engine is running:

- Excessive wear of the bearing shells;
- Bearing misalignment;
- Detective lubrication.

During engine running operational personal can only trace temperature dynamic for some engine sensitive points (see Fig.1).

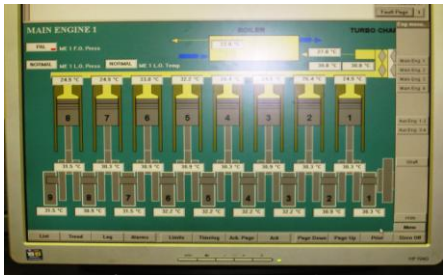

Fig. 1 Passenger ferry "Julia" one of 4 main engines bearing temperature indication screen

II. The Main Engine Bearing Behavior

Usually main bearing failures were in middle of engine. The bearing was a steel backed thin wall lead bronze with a tin lead overlay, tin lead gone, lead bronze held and crankshaft just needed a polish (see fig. 2). Class Inspection Society had no program for main bearings opening before 25 000 hours. All main bearings during 25 000 hours must be removed for inspection and if not satisfactory, to be changed. The thrust usually is at the aft coupling face. As it was mentioned above we usually see a lot of failures most in the middle of an engine.

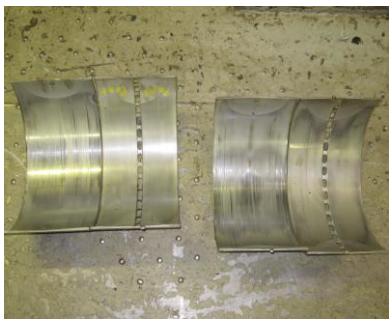

Fig. 2 SEMT PIELSTIC PC2-5 L bearing shells

If the engine is misaligned, there will be a lot more force on the drive end main bearing and that will become more worn than the rest, the overhanging mass of the flywheel can also cause more wear in the lower bearing supporting it. The "bend" in the shaft caused by the weight of the flywheel or misalignment can also cause excess wear on the opposite face of the next bearing.

If the chocking or supporting structure for the engine has failed causing excessive crankshaft deflections, the deflections may also indicate which bearings are likely to become damaged. The vibration measurement for a ship's main engine (SME) set with base system - an anchor bolt system could be conducted. The engine unit of an SME to be measured .The SME set is installed on a ship hull foundation with anchor bolts (anchor bolt system) (See fig. 3).

Fig. 3 Scheme of ship's hull underwater part survey [DetNorskeVeritas, 2010]

The engines are mounted on an elastic suspension system so that engine vibrations are minimum transmitted to the hull. This study evaluates the assessment of a coil spring-viscous damper system for the vibration and isolation of an SME from ship hull by measuring its operational vibration and ship hull responses. The vibration performance of a coil spring-viscous damper system could be evaluated by the vibration measurements for l SME set with existing base system - an anchor bolt system .The performance of the coil spring-viscous damper system could be evaluated by tests with a scaled model of a base isolated on a ship hull frame. The effects of SME base isolation on the fragility curve and core damage frequency in ship plant could also be investigated through a case study.

The SME set of ship in research Unit 4 is mounted on a rubber plate system in order to prevent a transfer of an operational vibration from the SME body to the ship hull. A rubber plates consists of 18 rubber elements and has a vertical stiffness of 35.6 N/mm and a horizontal stiffness of 24.9 N/mm, as shown in fig. 3. A viscous damper has a damping coefficient of 2.5 kN/m in both the vertical and horizontal directions.

III. Conclusions

The resultant vibrations could be measured by using 8 PCB Piezotronics model 393B12 accelerometers whose locations is proposed in engine bedplate, during both non-operating and normal operating conditions of the engine for comparison. For the anchor bolt system, 6 accelerometers (P1-P6) could be installed on the surface of the SME steel foundation separated from the floor frame by a gap, one could be installed on the engine, and one accelerometer could be installed on the floor slab, as shown in fig. 3.

The accelerations measured from the SME with the anchor bolt system normal operating conditions of the engine must be shown in Tables. For the SME with the anchor bolt system, the average accelerations measured on the hull foundation must not exceed 0.166 m/s2 or 84.0 dB under normal operating conditions. A larger acceleration measurement during engine operation indicates growing problem with engine bearings and it give time to plan engine maintenance.

Diesel Engine Faults Structure and Analysis of Possible Diagnostics

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Keywords **–diesel engine, common rail injection, acoustic emission.**

I. Introduction

This review paper gives an insight in the problems associated with faults of new generation of diesel engines equipped with common rail injection systems and the possibilities to test the condition of system with non-invasive methods.

II. Consequences of improper working process

Today it is very important to keep engine emissions as low as possible in diesel engines. Diesel exhaust is a carcinogen and is placed by International Agency for Research on Cancer (IARC) in group 1 carcinogens. It causes lung cancer and is associated with bladder cancer. Among these pollutants, fine particle pollution it is perhaps the most important cause of diesel's deleterious health effects. Faults in fuel injectors makes not only low engine efficiency, but also high and sometimes even unacceptable level of unburned hydrocarbons caused by poor air fuel ratios. In addition, injector faults increase noise and vibration which may cause damage to engine components. Therefore, the detection injector faults at their early stage and maintain combustion performance is one of key tasks in controlling pollutant emission as an engine ages and not just its early life performance.

III. The aim of research

A European emission standard defines the acceptable limits for exhaust emissions of new vehicles sold in European Union member states.

Diesel engine designers and manufacturers use different types of fuel injection systems most common are mechanical so-called conventional and new generation of injection systems – common rail injection system. To reach EURO5 and further demands for emissions the most appropriate system is common rail. As any mechanical system common rail system's items still have technical problems due to material quality what they are made of, fuel quality and contamination of it. The problem with system item can be found out making vehicle ECU self diagnosis. But it only shows if the item is in working condition or not however it does not show the actual working condition. The "weakest points" in the system are injectors, pressure relief valves and common rail pumps. To find faulty injector there are some tests to be done "on engine", but it can show only already broken injector or pump. To identify the condition it is necessary to dismantle the engine and make visual testing of item or put on testing equipment. These aspects are making vehicle out of service. This all abovementioned shows the loss of profit if it is used as commercial item.

Predictive or so called not-invasive maintenance can make the elimination of trouble or to "catch" the start of deterioration process on a certain time. So the owner can calculate is it necessary to prepare spare items or to run the engine, thus reducing the maintenance and repair costs. Finding faulty injector makes reducing emissions from unburned fuel and it saves exhaust system from built up of carbon.

In predictive maintenance there are used different systems to obtain signals from mechanism. The most common and conventional is obtaining and analyzing audible signal or vibro-acoustic. However some signals can interfere with signals from other mechanisms.

By making analysis of articles and materials it has been found that acoustic emission method is good method to eliminate the problem with fuel injectors. The results from joint angular and frequency analysis has shown that AE can clearly monitor the changes in the combustion process due to its high signal to noise ratio in the high frequency range from

10kHz to 45kHz where other vibro-acoustic sources have little influence [1].

IV. Conclusions

Many researches have carried out for engine fuel injection diagnosis based on airborne acoustics and structural borne vibration. Because of complexity of vibro-acoustic sources in a diesel engine, it is difficult to obtain detailed information regarding to fuel injection for reliable fault diagnosis. In contrast, acoustic emission (AE) from engines usually may be a more effective approach to detecting injection related faults because it is measured in high frequencies such as 100kHz above and hence has the good localization performance. AE measurement on the cylinder head is a non-intrusive method and has been successfully implemented for monitoring diesel engines. Various signal processing techniques of the AE signals are used to extract features sensitive to faults. These investigations have shown that the AE signals have a very high signal-to-noise ratio and the faults of interest can be extracted with certain effort in signal processing.

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Applications of Electromagnetic Conveying System in Powder Metallurgy Industry

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***Keywords* – electromagnetic conveying, ferromagnetic powder, powder metallurgy, dispensing.**

I. Introduction

Over the last few years, in Riga Technical University a new approach for conveying of ferromagnetic powder materials has been developed. In the Laboratory of powder materials of Riga Technical University an experimental low-voltage electromagnetic conveying system EMC-05 has been developed [1]. The process is based on interaction between ferromagnetic materials and impulse electromagnetic field. The designed equipment has been used for development of laboratory testing of different powder materials, as well as for process parameters optimization.

II. Principle of Conveying and Experimental Equipment

Process of powder conveying can be expressed as a displacement of the determined centre of mass under the influence of pulse pressure (Figure 1).

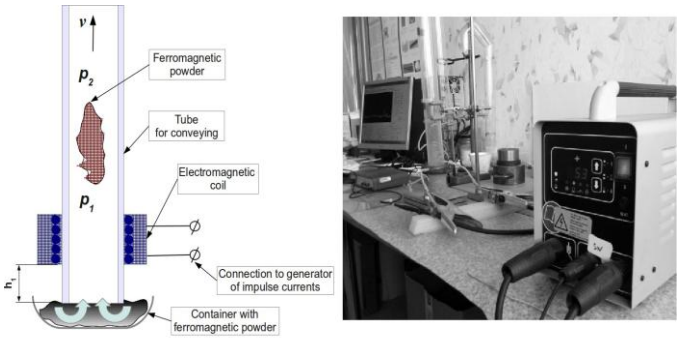

Figure 1. Experimental electromagnetic conveying system EMC-05 (Laboratory of powder materials, RTU).

Main parameters of experimental conveying system are shown in Table 1.

TABLE I
Main parameters of RTU EMC-05 laboratory-scale electromagnetic conveyor

Parameter	Value
Capacitance of generator of impulse currents, μF (F)	66000 (0.066)
Max discharge energy, J	1600
Impulse duration, ms	1.0-5.0
External diameter of conveying tract, mm	50
Length of conveying tract, mm	2000

III. Experimental Part: Conveying, Dispensing, Mixing.

Using an experimental conveying system EMC-05, a variety of possible applications have been investigated (Figure 2.).

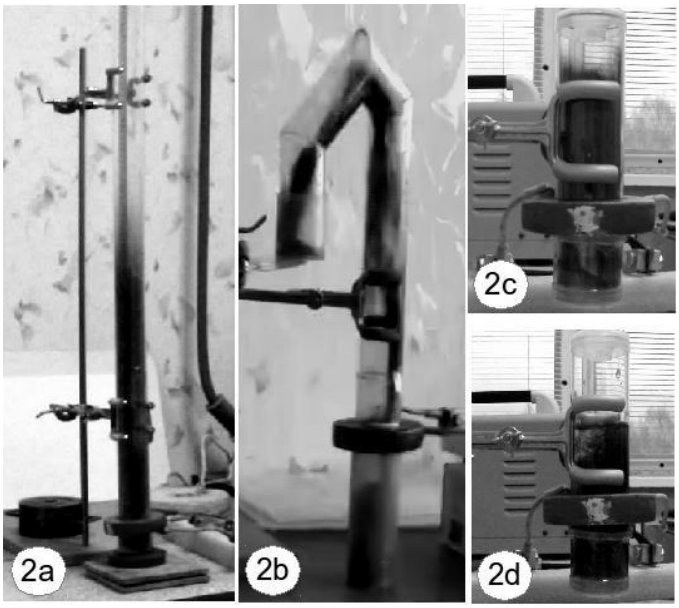

Figure 2. Conveying of ferromagnetic powders in vertical pipe (Fig. 2a), dispensing system for ferromagnetic powders (Fig. 2b), mixing of ferromagnetic powders in the air (Fig. 2c) and aqueous (Fig. 2d) environments.

IV. Possible Applications of Technology

- Powder metallurgy manufacturing plants.
- Manufacturing of powder metal components.
- Chemical plants, where mixing or dosing are needed.
- Feeding systems for production of ferrous fiber.

V. Conclusions

A developed experimental conveying system can be used as a prototype for further pilot equipment design.

A perspective industrial application of electromagnetic conveyors is a vertical transportation device for ferromagnetic powder materials [2].

VI. Acknowledgements

ESF
EIROPAS SOCIĀLAIS FONDS
EIROPAS SAVIENĪBA

This work has been supported by the European Social Fund within the project "Support for the implementation of doctoral studies at Riga Technical University".

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Development of Unmanned Air Vehicle features for ice monitoring in Baltic Sea

Aleksandrs Urbahs, Ilmārs Lešinskis, Vladimirs Petrovs (*Riga Technical University)*, Jānis Bērziņš, Aleksandrs Pavlovičs (*Latvian Maritime Academy)*

Keywords **– ice at sea, Unmanned Aerial Vehicle, Gulf of Riga, Maritime traffic**

I. Introduction

This paper describes an innovative approach, where the capability and potential of using the micro class Unmanned Aerial Vehicle (UAVs) for ice conditions recognizance has been already probed practically. The particular experiment has been conducted with the means of UAV, manufactured in Technical University of Riga and equipped with the electromotor, thus considerably minimizing the ecological impact, compared with these UAVs equipped with combustion propulsion. There are seemingly many ways and methods of acquiring the data and information about ice conditions at sea and coastal zone, however, in areas with the dynamic process of ice shifts and movements, there is necessity to have a real picture ‘’in-situ”. Precise ice cover information can be of vital importance for ships at sea, especially when such situation has being aggravated. The outcome of experiment is practical proof, that micro-class UAV can be effectively implemented, thou with minor limitations, for local ice conditions reconnaissance and surveillance at sea.

II. Global warming and ice navigation

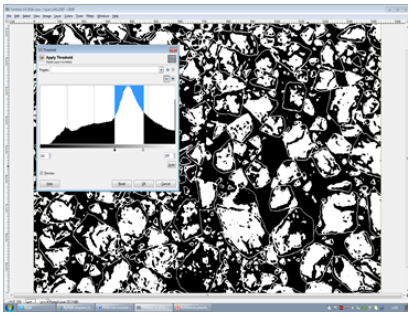
The notorious process of Global Warming does not affect much practical ice navigation not only in the Polar Regions, but also in the Baltic Sea. Operators and actors of maritime industry should arrange safe and absolutely reliable maritime traffic in heavy ice conditions, so, the leveraged and layered data and information about ice covers at sea become of extreme importance. The data on ice conditions at sea can be in form of assumed forecast or/and factually collected, real data. Nowadays such blocks of information on ice cover at sea can be originated from different sources: ships on sites, coastal surveillance and weather stations, satellites, and aircraft [1].

III. Capabilities of unmanned aviation

Due to modern rapid developments of UAVs worldwide, there is innovative opportunity to deploy them for needs of ice surveillance and reconnaissance. Direct UAV surveillance and visualization of ice conditions at sea provides the real-time capture of ice situation. Use of UAVs for these purposes massively decreases associated risks and functional expenses. Key consumer of this information is a ship in marine area, which has to use optimal and best passage, once the ice field is expected to be penetrated.

The basic methods of UAV deployment as the means of ice conditions surveillance are as follows: Perspective surveillance; detailed surveillance; pre-planned aerial photo surveying. The methods are being implemented depending on missions, particular situation and location where the UAV is being launched from.

In the process of flight and collecting of visual photo and video data on and ice-openings are being surveyed, with the aim to clarify their sizing and dimensions. Additionally, the more detailed data on ice thickness, ultimate ‘’breed of ice’’ and other related ones are being acquired. The thickness of ice packs could be estimated and assumed by mutual comparison of visual and video data, when dedicated data library is being dynamically created and updated, in order to extract provisional ice-thickness from visual images.



Example of GIMP software histogram: manually selected most clear from ice areas on image from UAV (white color areas) with the designation of threshold

IV. Recommendations for navigation in ice

All data from particular UAV flight are being processed by specific software GIMP [2], which is suitable for a variety of image manipulation tasks, including photo retouching, image composition, and image analysis. GIMP has many capabilities. It can be used as a simple paint program, an expert quality photo retouching program, an online batch processing system, a mass production image renderer, an image format converter, etc. Every visual color image can be processed and quantified by special GIMP featured capabilities of ‘’layering’’, ‘’thresholds’’ and ‘’dynamic masking”. The task of processing images from UAV particular flight is to calculate the visual mutual correlations by colors, contrast and brightness of images, in order to create and support Data Base for given flight circumstances.

V. Conclusions

UAVs, particularly micro-class aircraft, are coast effective, convenient and safe tool for the shipping route planning in complex situation of ice. UAVs might be used from ships of relatively small size. There are great opportunities to use digital technology to process image of ice field. A big scientific, practical and economical potential is in use of UAVs for maritime security.

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Use of Sea Territories' on the Western Coast of Latvia

Madara Nagaine (*Latvian Maritime Academy*)

***Keywords* – wind energy, maritime spatial planning.**

I. Introduction

Wind energy due to the widespread availability of its resource is one of the most perspective of the renewable energy types, the wind which can be used to produce power in an environment friendly way. The most suitable placement of wind turbines is in sea or on the coasts. "BatlSeaPlan" is the maritime spatial planning pilot project of Baltic coast of Courland that intends a construction of offshore wind farms on the West coast of Latvia, but due to insufficient political support this territory is not utilized and the development of wind energy in Latvia is hindered.

II. Usage of wind energy in Latvia

The strongest winds in Latvia (at 10m height) are along the coast of Courland and in the vicinity of Ainazi (6 m/s average), but in the rest of the territory the speed of wind is less than 5 m/s. The required speed of wind for a wind generator to operate is at least 5 m/s, which means that the coast of Courland has enough wind resources to be suitable for construction of wind generators [1].

Maritime spatial planning (MSP) will contribute to the growth of wind energy industry in Latvia, because it is one of the tools recommended by the EU, which will help carry out an integrated maritime policy, including the implementation of maritime planning in the whole EU, and one of the main planning tasks in Latvia is to find the best suitable sites for offshore wind farms according to Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources the renewable energy industry of the countries of the EU.

In compliance with law of 28 October 2010 "Marine Environment Protection and Management Law" [2] maritime spatial planning (MSP) is a long-term process for development planning aimed at protection of marine environment, rational use of the sea and integrated management, as well as balancing the social welfare and economic development with the environmental protection requirements. The main goal of MSP is a marine spatial zoning plan that identifies and manages existing and potential interests of maritime spaces and its coasts in a manner that best meets the priorities and objectives set by the participants. Project "Development of Maritime spatial planning in the Baltic Sea" (BaltSeaPlan) is implemented from 2009 till 2012 in order to support the process of developing, introducing and implementing MSP in the Baltic Sea. There are seven countries: Germany, Poland, Denmark, Sweden, Estonia, Lithuania and Latvia. In Latvia BaltSeaPlan is implemented on the Western coast of Latvia in the Latvian territorial waters and exclusive economic zone from Nida till Ovisrags (total water area is about 20 000 km2). Wind farms are planned in eight areas:

1. 12 nautical miles (nm) from Uzava in the reserved area;
2. 12 nm from Jurkalne in the priority area;
3. 12 nm from Pavilosta in the reserved area;
4. 12 nm from Pavilosta and Ziemupe in the priority area;
5. About 10 nm from Liepaja in the reserved area together with security and monitoring of the coast and 12 nm from Liepaja in the reserved area;
6. About 8,5 nm from Bernati in the reserved area together with security and monitoring of the coast;
7. 12 nm from Bernati in the priority area;
8. And 12 nm from Pape in the reserved area.

47-80 wind turbines are planned in the Western coast of Latvia. The total budget is about 500 – 600 million euro for wind park construction in the Western coast of Latvia [3]. The project is funded by the EU Baltic Sea Region Programme and part-financed by the European Union (European Regional Development Fund). The total power of wind parks is estimated about 200 MW, generating 590-910 thousands MW electricity per year.

Table 1.
Share of electricity generated from Renewable Energy Resource in Latvian gross electricity consumption

20	05	06	07	08	09	10
Share of electricity generated from RES[1]	**48,4**	**37,7**	**36,4**	**41,2**	**49,2**	**48,5**
Large hydro power plants	46,3	35,9	34,3	39,0	46,9	45,9
Small hydro power plants	0,9	0,5	0,9	0,9	0,9	1,0
Combined heat and power plants using RES	0,6	0,6	0,5	0,5	0,6	0,8
Wind power plants	0,7	0,6	0,7	0,8	0,7	0,7

III. Conclusions

If compared to other countries of the EU, the amount of wind energy obtainable in Latvia is smaller; however the Courland coast of the Baltic Sea is suitable for obtaining of wind energy. The Maritime Spatial Planning Project "The introduction of maritime spatial planning in Baltic Sea" (BaltSeaPlan) intends the construction of wind farms on the western coast of Courland and is considered one of the promoters of wind energy industry development in Latvia, but insufficient political support, including un-coordination of political matters, absence of favorable legislative framework and other conflicting industries, delay the development of wind energy industry of Latvia.

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Micro-class Unmanned Aerial Vehicle Design Solutions

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Vladimirs Bulanovs (*Institute of Aeronautics*)

Keywords **– Unmanned Aerial Systems, Micro-Class unmanned aerial vehicles, operations, UAS manufacture.**

I. Introduction

Design, manufacture and operation of micro-class unmanned aerial system (UAS) has to take into account several specific requirements, including condition of "flexible" manufacturing technology, reliable and safe exploitation, ecological safety etc.

II. Basic Requirements to UAS Design

The principal task of this research was a creation of an UAV construction corresponding to the following principal requirements [1]:

- possibility of implementing environment monitoring;
- implementation of the functions of strategic and nature conservation objects protection;
- possibility of determining the exact location of the target;
- possibility of detection and mapping of seats of fire and contaminated environmental zones;
- implementation of patrolling functions to solve the tasks of national armed forces and police;
- implementation of meteorological research, etc.

In addition, in the process of designing, a number of specific requirements are also taken into account, including:

- performance (the UAS ability to take-off and land in the conditions of no-runaway available, the simplicity of maintenance and repair, etc.);
- ecological safety requirements (non-contaminated environment, minimum noise level, etc.);
- effective steerability requirements (possibility of controlling the UAS both in manual and automatic mode using modern navigation systems and communication devices).

III. Design and Construction specifics of UAS

Designed UAV is made according to classical scheme with electric type dragging propeller. Original construction of UAV is equipped with special capsules for working load (fig.1).

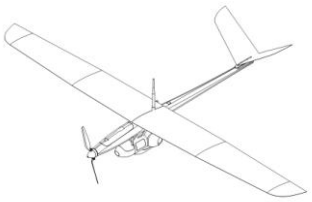

Fig. 1 Principle design of UAS.

In UAS construction different innovative materials are used – combination of polystyrene, tar-based composite and ultra light balsa-based materials.

Main UAS load-carrying construction is made from special extra strong carbon tubular members. Centre-section has partly working binding, which allows increasing durability and hardness of UAS construction and decreasing weight of primary load carrying members. UAS can execute environment monitoring, with high accuracy spot location of different objects and targets, map seats of fire and environmental pollution zones.

IV. Specifics of UAS manufacturing

Modeling of main elements, as well as UAV construction generally has been performed using CAD technologies, specifically SolidWorks program.

Details and nodes are modeled taking into account manufacturability of UAV assembly. Objectives of lining up are fulfilled with a high precision level, optimal setup of UAV main elements and nodes composition are chosen. Possibility of computer modeling allowed creating optimal constructions of main elements and vehicle construction as such, given aerodynamic characteristics, as well as durability and weight.

In UAV details manufacture modern methods and technologies were applied, e.g.:

- milling cut at 3D milling-machine,
- sticking together details from composite materials according to beforehand prepared matrices;
- detail shaping from different expandable polystyrenes;
- hot shaping from plastic sheets,
- detail manufacture at 3-D Printer (see fig.2).

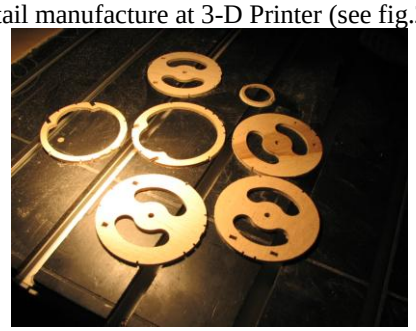

Fig.2 Example of UAS parts production on 3D milling-machine

V. Conclusions

UAV are designed considering possibilities to manufacture majority of its details on 3D milling-machine and *Computer-aided manufacturing* (*CAM*) technologies. This allowed not only optimizing manufacture process of details and nodes, but also increasing its constructability in further mass-production. Technological processes of different UAV details manufacture are designed taking into account specifics of details geometry, used materials, machinery equipment characteristics and production capacity.

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Analysis of Geometry of Rough Surface - Actual Area of Contact

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Keywords **– rheological properties, contact interaction of parts.**

I. INTRODUCTION

When determining the characteristics of the frictional interaction of rough surfaces and the area of their contact altitudinal and longitudinal properties of the irregularities, the radius of curvature of protrusions and depressions, the laws of their distribution and regulation are used.

Another most significant aspect of the contacting of the surfaces is the molecular mechanics of contact. The surface energy of solids is so great that it causes the active interaction of the solid with components of gases, liquids and parts of solids, forms adsorption and chemisorption layer on the surfaces, adhesion force to resist motion, setting, deformation, heat and other processes.

II. GEOMETRY OF ROUGH SURFACE

In a random arrangement of the asperities on the surfaces of contacting solids, actual area of contact which is known by the geometry of contacting surfaces limits bringing closer these contact surfaces under the influence of external load. Fig. 1 shows the main characteristics of the standard geometry of the rough surfaces: roughness with a maximum profile height of R_{max}, the maximum corrugation height Rw_{max} and macrodeviation from horizontal base plane with height characteristic δ .

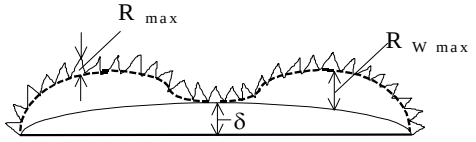

Fig.1 Main characteristics of the rough surface geometry

Well-known theoretical approaches to calculate the actual contact area [1] do not take into account the effect of time of loading and temperature of the contacting surfaces of solids. However, all materials to a greater or lesser extent have the viscoelasticity and viscoplasticity, i.e. elastic and plastic deformation does not affect immediately after loading, but progress after some time.

III. RHEOLOGIC PROPERTIES OF CONTACT

The rate of increase of deformation increases with raise of temperature. Such behavior of materials, leading to a change in the actual contact area depending on the temperature and time, is described by means of rheological models. Rheology - a set of deformation study methods for studying the deformation and flow of media having a viscosity and plasticity.

Assessment of contact deformations, considering the microgeometry of the surfaces and the heterogeneity of the mechanical properties of surface layers, surface films, and the stress distribution in the surface layers is necessary for the calculation of nodes with minimal friction and high wear resistance. During the capillary adhesion condensation of water vapors leads to the formation of thin liquid films on solid surfaces.

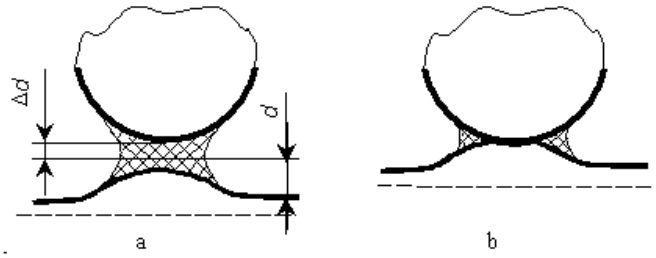

Fig. 2 The scheme of the convergence of the contacting surfaces
a – initial position; b – end position and deformation of the protrusion.

Contact characteristics in the presence of a liquid film depends on the shape of the stamp, the bilateral attraction of two molecular roughness, the energy dissipation in the loop "converging-removal" roughness (see fig. 2).

IV. CONCLUSIONS

An important place in the knowledge of the contact process belongs to the interaction between the surfaces, gases and moisture. The size of the gas molecules is equal to 10^{-9} …10^{-8} m, the average density is equal to $3{\sim}10^{-19}$ mol/cm^3, the velocity $U \approx 4{\cdot}10^4$ cm/sec., indicating a significant kinetic energy of gas particles interaction with surfaces.

In conclusion, one more important process from the scientific and practical point of view should be noted - the electrochemical interaction of surfaces separated by a layer of grease (which creates the conditions of the electric condenser). According to the laws of electrochemical kinetics the anode is dissolved and the dissolved metal ions are deposited on the cathode.

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Analysis of Northern Sea Route Role in Merchant Shipping

Ilze Stelpa (*Institute of Aeronautics, RTU*)

Keywords **– Ice melting, transoceanic voyages, financial benefits, advantages, disadvantages, shippers, ship-owners, seafarers, cargo flow, Baltic seafarer competitiveness.**

I. Introduction

Article analyzes possibility to use *Northern Sea Route* as a viable means to shorten long transoceanic voyages in the Northern Hemisphere due to ice melting, its advantages, disadvantages and accessibility.

II. Advantages in *NSR* use

With every year the Northern Polar waters are becoming more accessible to shipping due to the reduction of Arctic ice. Polar waters' availability, as well as polar global resources (gas, oil, and iron ore) stimulates a significant growth of shipping cargoes, including transoceanic. Shipping in the Arctic Ocean trade takes two main shipping routes - the Northwest Passage along the Canadian coast and the Northern Sea Route (*NSR*) (*Северно морской путь*) along the Russian coast. *NSR* that stretches from Murmansk to Bering Strait can reduce distance between European and Chinese Northern ports by 10 – 30%. The most beneficiaries are European ports, E Asia ports North of Hong Kong and North America ports N from Portland. These regions include 10 of the biggest world ports.

From all vessels' costs – capital costs (~40% of all costs), voyage costs (~35%), and operating costs (~ 25%) – the most significant savings due to shorter distance and subsequently fuel reduction can be made on voyage costs. Vessel's operating costs have been reduced every day by sailing along *NSR* rather than through the Suez Canal.

Savings can also be made on Suez Canal fees. A significant advantage of *NSR* is the absence of the pirates which currently plague major shipping routes.

Plans by the Russian Federation are: to improve *NSR* infrastructure and increase national export include the building of four new ice breakers and a 12 hydro graphic ships, the improvement of the transmission performance of *NAVAREA* XX and XXI regions, the establishment of a *GLONASS/GPS* shore station, and a *NSR* chart bank establishment [1].

III. Disadvantages in *NSR* use

The main disincentive for more *NSR* transoceanic voyages is the small number of powerful ice breakers and their current use as passenger vessels for tourism to the Arctic. The variable ice breaker fee, which ranges from 3 to 73 USD per ton, is the major costs in transiting the *NSR*.

Other unfavorable factors for the development of the route are the large investments required for the operation of permanent vessels in *NSR*, the current inaccessibility of the *NSR* to non – Russian federation companies.

NSR infrastructure – low capacity *NSR* ports, unreliable navigational charts, poor rescue options, long demurrages and bureaucratic obstacles – needs to be developed.

IV. *NSR* Freight and export freight characteristics

From year 2000 there has been a growth in freight transportation in *NSR*. In period between years 2005 – 2007 cargo traffic has exceeded 2 million tons. In year 2011 freight volume was around 15 million tons, in year 2020 – it is estimated that even 65-70 million tons will be carried in the *NSR*. Nowadays traffic mainly constitutes vessels plying from Varandey terminal, opened in 2005, Dudinka port and the White Sea ports to Europe.

The annual commercial potential of *NSR* in period 2015 – 2020 [2] will consist of:

- 25 – 30 million tons of crude oil export from the Kara Sea Timans - Pechory area, as well as from the Oba and Jenisey oil fields direction to the Europe;
- 15 – 20 million tons of liquefied gas exports from the Harasavey Terminal - completed in 2013 – in the Yamal peninsula;
- 1 – 3 million tons of gas condensate exports from the Oba and Jenisey fields;
- 1 – 2 million tons of fertilizer export;
- 1 – 2 million tons of timber cargo exports.

V. Baltic States (Latvian, Lithuanian, Estonian) seafarers' competitiveness for working in NSR

Baltic seafarers' competitiveness for working in *NSR* is currently assessed to be average. Baltic seafarers' strengths are Russian and English language skills, as well as the similarities of mentality and culture. Baltic seafarers' relatively short contracts – an average of 3 – 4 months – represent no special advantage over other nation's seafarers. Co – operation with the Russian Federation ship company *Sovkomflot*, which mainly plies in *NSR*, may be considered as one of the key opportunities for the Baltic States seafarers.

Latvian Republic's 3 maritime training centres *Interorient*, *LAPA* and *NOVIKONTAS*, as well as numerous Russian Federation maritime training centers' have created a training course *Ice navigation/Ship's handling in Ice covered waters* which faces significant increase of the demand [1]. There is also great demand for officers with ice condition experience.

VI. Conclusions

The European Union, China, Japan, S Korea, Canada and the U.S., which would be the greatest beneficiaries, should support the Russian Federation in *NSR* development including the construction of ice breakers, *NAVAREA* district infrastructure creation, enhancement of navigational charts, etc. – in order to effectively use *NSR* in international supply chains.

In order to nominate Baltic sailors as a significant source of officers in Arctic waters, training of seafarers must be carried out. To be competitive, Baltic seafarers have to be a step ahead and courses or lectures in *Ice navigation/Ship's handling in Ice covered waters* must be included the Baltic Marine education programs. It is preferable to use the Norwegian ship classification society *DNV* standard for preparing ice officers.

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Efficiency of Energy Efficient Ship: Use of Spinnaker

Ilze Stelpa (*Institute of Aeronautics, RTU*), Gunārs Šteinerts (*Latvian Maritime Academy*)

Keywords **– wind power, spinnaker, fuel reduction, trading routes**

I. Introduction

This paper analyses effectiveness of wind power and spinnaker use in order to reduce significantly fuel consumption, CO2, NOx emissions.

II. Spinnaker principles

In order to reduce significantly CO2, NOx emissions, as well as gain independence from dwindling oil resources, the maritime industry is searching for various alternative energy uses.

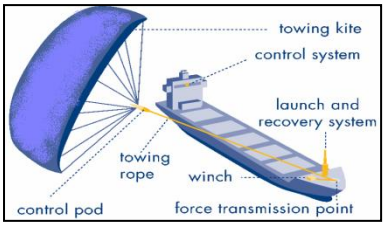

Fig.1 Spinnaker components [1]

As one of the solution is spinnaker or kite sail (See Fig.1), which is much more flexible in maintenance, because it can be easily added to an existing ship or moved from one vessel to another. When towing rope rises above 213 m, where the surface friction does not affect the operation of spinnaker, it's use is very effective. Previous test results indicate that fuel savings can be of between 10-20%.

III. Advantage of spinnaker

Advantage of commercial spinnaker is that it can be used up to 500 to wind at the wind velocity 12-74km / h (7-40 knots) or 3 - 8 points on the Beaufort scale. Besides it can be used by almost all wind directions relative to ships course – even 50 degrees and 310 degrees upwind. At altitude exceeding 200m, winds are stronger and last longer than on the land, as on sea surface friction has negligible impact to the operation of the wind – so called stable wind gradient.

Although spinnaker can be used only 3 nautical miles off obstacles and outside Traffic separation schemes, there are no other restrictions and regulations that concern spinnaker. The most effective use of spinnaker is in the main shipping routes, in both directions from Europe to North America, North America to East Asia, because of the highest potential for wind energy.

As calculations [2] have proved the most effective spinnakers nowadays are 160m^2 and 320m^2 size spinnakers and the most efficient use of them is on the multipurpose heavy lifts or general cargo vessels with maximum length up to 130 m and main propulsion output up to 3800kW. With such parameters vessels can save ~20% of fuel.

IV. Spinnaker system components

The spinnaker system components (See Fig.1) can be divided into 3 large groups:

1. Double wall spinnaker as paraglider with high strength and weatherproof towing line;
2. Launch and recovery system including dynamically operating winch, force transmission point, rope stowage box. Complete spinnaker launch and recovery can take up to 20 minutes;
3. Automatic control system including control pod on towing line, on board computer, autopilot programme, programmable logic controller for launch and recovery system.

As a minimum the following sensors must be installed on the ship for spinnakers: GPS, wind direction gauge, anemometer, rudder position, course. The ship's sensors must comply with the NMEA standard, because data are transmitted via RS 232 or RS 422.

V. Amortization period for existing spinnakers

Tractive force of spinnaker can be calculated as:

$$Fa = c * \frac{P}{2} * v^2 * A$$

where:

c – lift coefficient of the towing kite;
p – density of the air;
v – airflow velocity of the kite;
A – surface area of the kite.

Consequently it means that not only spinnaker size is important but trading area with prevailing winds – small multipurpose heavy lift feeder operating in North Atlantic trading route can cut amortization time twice in comparison with the same size and type vessel. Differences in fuel prices affect amortization time, as well. Amortization time for existing spinnakers (calculated in 2009) is not less than 2.1 year in favourable wind route up to 5 years.

As one of disadvantages can be mentioned extra crew training that is not included in amortization costs.

VI. Conclusions

Growth of spinnaker use on merchant vessels is relatively slow, mainly because of long amortization and industry been waiting for final results of first maintained spinnakers, rigged in 2007. However since 2007, when first spinnaker was installed on cargo ship, this technology has been recovered in another breath. In 2012 in the world's fleet less than 10 vessels are equipped with spinnaker still indicating that use of spinnaker can be much wider. Calculations show that the currently widely available 2 size spinnakers with size 160m^2, 320 m^2 can be fitted on ~ 60 000 world merchant vessels reducing CO2 emissions by 150 million tonnes every year and saving million of fuel tonnes, as well.

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Development Prospect of Cargo Terminal Mangali

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***Keywords – railway transportation, cargo terminal, examination of carriages, automation*.**

I. Introduction

There is slight increase of various kinds of transported cargos in Latvia railway transportation. When comparing transported cargo volumes of LDZ Cargo in last six years, then it is clearly seen that the greatest transported cargo volume was in year 2011, when it reached 59 385 thousand tons.

II. Mangali Cargo Terminal

The amount of the Mangali terminal cargos is increasing steadily, however the more rapid development is constantly delayed by the outdated infrastructure in the area of the Mangali cargo terminal. As there is not enough quantity of cargo gateways, the total carrying capacity of terminal is decreased highly.

In order to insure more effective work of the Mangali cargo terminal, few more cargo inbound and outbound gateways in terminal are needed, which would ensure higher carrying capacity and increased the time in which a carriage is handled. As the terminal works according to certain forming plan, then it is necessary to ensure the execution of it.

Fig. 1. Ezera street Railway move in Mangalu cargo terminal

Mangalu cargo terminal is crossed by the Ezera street move, that limits the general terminal action substantial, because it is not possible 24 hours in the day-time to use a move, additional work and time are necessary also the that adjusting of this railway. Park of the his transversal "B" 6a., 7., 8., 9., 10.a. roads and tricks into a road, which joins to 6.a.travel with 70.pointer.

III. Possible Decisions

It is impossible to provide cargo delivery from cargo terminals to Freeport enterprises in Riga in time, when moves "Ezera Street" and "Tilta Street" are closed. Work stops in these terminals, when these moves are open for inhabitants of Riga.

LDz hopes, that also Riga City Council will search a decision for this problem, constructing a crossing of two levels free motor transport and pedestrians motion in this district, then the populations of Riga will not suffer and also so important railway transportations. [1]

Very important is automation of cargo flows in Mangalu cargo terminal. Examination and verification of all carriages works in is the terminal of the Mangalu loads executed hand, using human resources, that prolongs treatment of compositions of all carriages time substantial. A 1 hour is given instantly released examination of load carriages, but automatizing a carriage stand reviews, is possible to diminish this time to the minimum, which gives substantial changes in all in a terminal action.

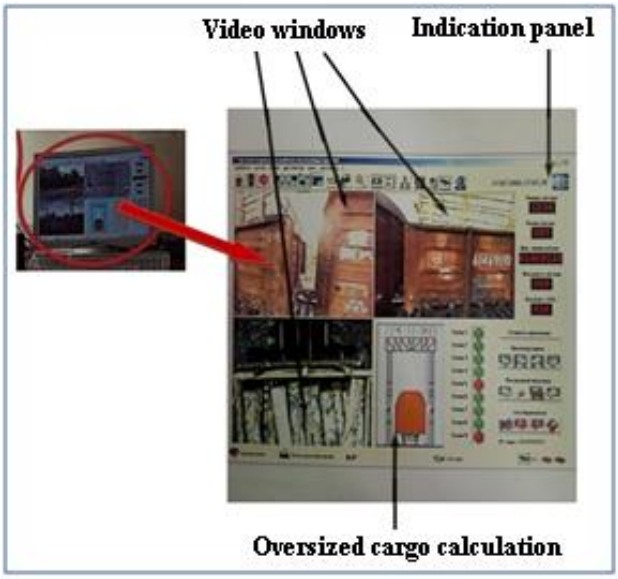

Fig. 2. Automation of wagon inspection work

Special equipment (operated with certain program) are used.

IV. Conclusion

Once the optimal plan of development of cargo terminal is created, it will be possible to gain following benefits- to increase the total carrying capacity of the terminal and to decrease the amount of human work, while the time in which each carriage is handled increases. In both cases the considerable accuses are obtained.

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Nanostructured Multicomponent Coatings "KJONBOMU" for Restoration and Protection of Machine Friction Parts

Margarita Urbaha (*Institute of Aeronautics, RTU*), Konstantins Savkovs (*Institute of Aeronautics, RTU*), Jeļena Urbaha (*Institute of Aeronautics, RTU*), Gints Rijkuris *(Institute of Aeronautics, RTU)*, Viktors Kozyukov *(Institute of Aeronautics, RTU)*

Keywords **–ion-plasma coatings, friction parts, restoration and protection**

I. Introduction

This paper deals with a development of a new ion-plasma technology for obtaining nanostructured wear-resistant composite coatings (multilayer, multicomponent) by the combined method for restoration and protection of machine part surfaces in the process of manufacturing and repair.

II. Basic research results

Development of new effective technologies of worn surface restoration of precision friction pair parts is a topical issue [1].

The authors offer the restoration technology of precision pair parts - valves, plungers and injectors of vehicle fuel pumps.

Experimental samples, i.e. steel plates (100x30x1.5 mm) and a precision pair (PP) of hydro fuel plunger, which is a part of high-pressure pump of a diesel engine, were used as an object of research. The precision pair consisted of an internal element called plunger and an external element called sleeve (Fig. 1.).

a) b)

Fig. 1. Precision pair (a) of hydro fuel plunger, which is a part of high-pressure pump of a diesel engine, and plunger (b)

The technology stipulates the creation of a special restoring wear-resistant coating "KJONBOMU" on the basis of Ti – Al – N deposited by ion-plasma sputtering. In the process of sputtering Ti was used as the first evaporator, Al – as the second evaporator, also Al – as a magnetron cathode material [2].

Distribution of the main elements forming the coating are presented in Fig.2.

This method has considerable advantages – absence of part distortion, some allowances for further machining and possibility of regulating coating properties over a wide range by changing sputtering modes.

Besides, the above-mentioned method ensures higher coating quality – considerably higher micro hardness and adhesion as well as lesser surface roughness.

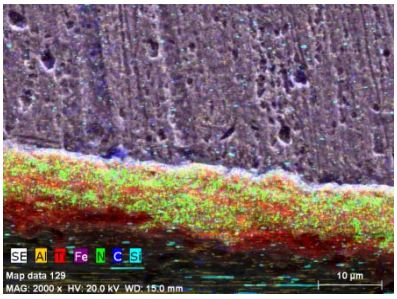

Fig. 2. Main elements of wearproof coating "KJONBOMU"

Except the restoration of trim dimensions, the composite coating possesses improved performance characteristics at the expense of increased hardness, wear-resistance, oxidation and hold resistance, corrosion resistance and decrease of friction coefficient.

The obtained coatings "KJONBOMU" are peculiar because of their enhanced wear resistance, low coefficient of friction, and good adhesion with basic material [3].

III. Conclusions

Authors developed a new high-performance ion-plasma technology for obtaining a nanostructured wear-resistant composite coating by the combined method (KJONBOMU – condensation and ion bombardment + magnetron sputtering). The combined technology makes it possible

- to create nanostructured coatings,
- ensure high microhardness and wear-resistance of a coating, its adhesion and thickness uniformity on a large area;
- to variate the composition of a coating in a wide range within a single technological cycle;
- to obtain high smoothness of coating surface (the influence of "drop phase" and the parameters of coating roughness decrease considerably) and more uniform coatings from the point of view of composition;
- as well as to ensure the ecological cleanliness of production cycle [1].

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Examination of Ion-plasma Coatings Surface Layer by Means of X-Ray Diffraction

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Konstantins Savkovs (*Institute of Aeronautics, RTU*)

***Keywords* – X-Ray diffraction analysis, ion-plasma sprayed coatings, diffractometer.**

I. Introduction

This paper deals with a more profound analysis of physical-chemical processes occurring in ion-plasma sprayed coatings requires the investigation of coating phase structure - X-ray diffraction analysis.

II. Basic research results

Ion-plasma deposition of coatings has been developed at the modernized vacuum installation NNV6, 6-I. [1]. During the experimental studies two plasma sources have been used - an electric arc vaporizer (Ti) and magnetron (Al) [2].

One of the informative methods of examining crystal objects, including nanostructured materials, is an X-ray diffraction analysis based on the use of X-ray diffraction in the crystal lattice of coating material. [4]. Layer-by-layer investigation of objects is carried out with the help of "sliding ray" method. The method is based on decreasing penetration depth into the near-surface of a sample layer along with the decrease of x-ray sliding angle. This phenomenon is described in the Bragg law.

In the graphical interpretation of X-ray diffraction analysis (a diffractogram of investigated material), it is possible to observe X-ray reflections or peaks (diffractogram lines) of different intensity that appear sequentially, along with the change of X-ray sliding angle. Coordinates and height of such peaks characterize the basic properties of crystal lattice in the coating being investigated:

- crystal phases contained in a sample are determined (phase identification) from the angular position of diffractogram peaks and from their correlation by intensity by using special databases of X-ray lines;
- a quantitative analysis of crystal phases is carried out with account of peak height (intensity), which means that the concentration of each crystal phase in a sample is determined.
- the preferred crystallographic orientation of growth in the coating is determined from the correlation of intensity of X-ray lines in each peak, depending on the technological parameters of sputtering process;
- the total content of amorphous phases is determined from the intensity of non-linear background.

Diffractogram peaks have different width, depending on the size of crystalline particles, and can shift due to material microstresses. Regularities of width change and peak shift are used in analytical practice:

- the average size of crystalline particles in a certain phase is characterized by the width of peaks which increases as the size of crystalline particles diminishes;
- the increase of peak width also occurs as a result of a change in the interplanar spacing of crystal lattices caused by microstresses due to deformation during the cooling of coatings.

A diffractogram is obtained by using diffractometers. A schematic diagram of the diffractometer is shown in Figure 1.

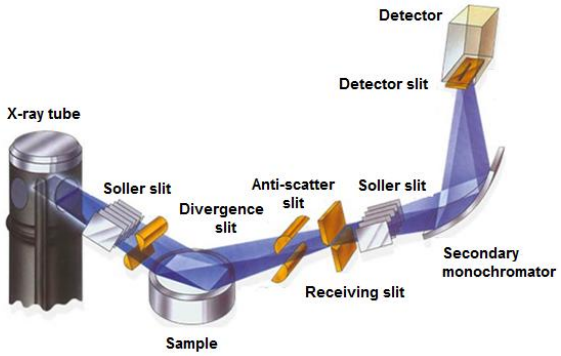

Fig. 1. Schematic diagram of diffractometer

A schematic diagram of most diffractometers includes a high-voltage electric source of X-rays with certain wavelength depending on X-ray source anode material. An electron beam generated by the source moves through the system of diaphragm slits and filters before and after it is reflected from the surface of investigated material. After its diffraction on the surface, X-radiation gets to the detector and is converted to an electric signal that enters the recording and analysis system.

III. Conclusions

Using the opportunities provided by the X-ray diffraction analysis as well as modern computer software and databases, it is possible to receive quite complete information about the process of sputtering and its basic characteristics that make it possible to forecast and optimize properties when developing new coatings. [3, 5].

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Perspectives of Ship's Hull Diagnostics Using Acoustic Emission Method

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Keywords **– acoustic emission, ship hull strength, cracks in ship structures.**

I. Introduction

Present paper shows most important reasons for acoustic emission (AE) method implementation in shipping industry, particularly in ship hull and crankshaft cracks detection. If we are speaking about large container carriers, than before 20 years it was vessel with appr.4000 TEU and length appr.250m, before 10 years- appr.6000 TEU and length appr.300m, today- more than 14 000 TEU and appr.400m. It is clear than such constructions are affected by different loads. And constructions strength not always is calculated correct. [1]

II. Types of ship's stress

All ships live circle her hull and other structures are under different forces influence .as: wave generated, cargo generated (loading and discharge), accidental loads from contact with floating object, pier, seabed etc.

In general stresses in ships we can divide:

a) Longitudinal stresses
b) Torsion
c) Transverse
d) Local (mostly ship bow)
e) Collapsing stresses (due to cargo weight on ship bottom- that force tends to draw ship sides together. If ship is in dry dock- effect is opposite).

III. Common and distinctive in ship types

Simplistic we can accept ship hull as beam which is subjected by complex of loads.

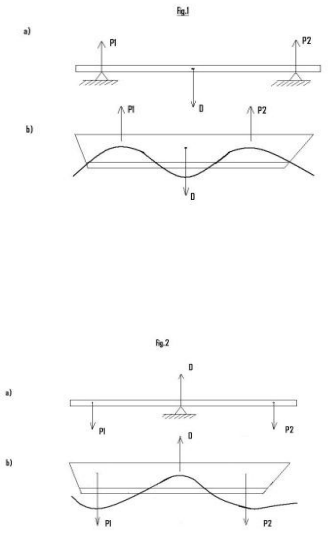

Fig. 1. Simplified waves effect to the ship hull

Depending on ship type also stresses influence to ship structures are different. Bulk cargo carriers- ocean going vessels are mostly 50 000- 300 000 dwt (Handysize- Panamax- Capesize) with large hatchways and machinery space aft. Such design significantly effect bending moments as during cargo operations in port as in open sea. Correct cargo operations are essential for these vessels. The IACS (International Association of Classification Societies) research shows than 10% overload could increase bending moment up to 40%. In modern port facilities 10% overload could be reached in 5- 7 minutes. It is necessary to take in to account high corrosion risk for bulk carriers as some cargo has aggressive effect to the metal constructions

Container carriers- usually are single deck vessel with large hatch openings. Machinery space for smaller vessels is aft, larger- about ¼ from aft. Ocean going ships today carry 4000-14000 TEU. Such design produces mostly longitudinal and torsional stress (from unsymmetrical loading) as well ship structures twisting in a seaway

IV. Acoustic emission method implementation

Today ultrasonic is well known in shipping industry but mostly in concerns ship hull and construction thickness measurements. AE method implementation for ship hull stress limit definition is little studied. In a last half year there was several cases where AE method was able to help reveal cracks in their early stages, in this way to protect owners not only from large financial losses but also from indirect losses

. In the laboratory status it is easy to apply AE method for crack detection in beam at a very early stage- fixing sensors on the beam. It is also possible detect AE limit when material collapse. The same principle is proposed to use for cracks detection in the ship hull and structures

V. Conclusions

There were first steps made last spring in this field. AE sensors was fixed on Riga Port Authorities tug "Sfinksa" main engine (Caterpillar, Ne=,2 x 1500 kW, n= 1600 n^{-1}). The goal was to fix AE waves from main engine crankshaft. Due to high revolutions and small engine dimensions with existing hardware the first attempt was unsuccessful. In spite of this negotiations with some shipping companies and engines manufacturers concerning this matter are in progress.

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Non-destructive Monitoring Methods for an Oil Pipeline

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***Keywords* – acoustic emission, oil pipeline monitoring.**

I. Introduction

The aim of the research is to design an acoustic emission (AE) monitoring system for an oil pipeline. To achieve this aim, a number of work tasks were identified: to carry out the analysis of other non-destructive monitoring methods and reveal their advantages or disadvantages from the point of view of developing an oil pipeline monitoring system; to investigate the method of AE testing, the required tooling equipment and methodology as well as to reveal the advantages and disadvantages of this method from the point of view of developing an oil pipeline monitoring system by making a comparison with other non-destructive monitoring methods; as a result, to develop an effective oil pipeline monitoring system.

II. Monitoring of the Condition of an Underground Oil Pipeline Using the Acoustic Emission Method

A test was carried out to monitor the technical state of oil products pipelines using the AE method. The AE method was chosen due to a large number of essential advantages for the monitoring of oil pipelines. The AE method makes it possible to detect fluid (gas) leakage through cracks and holes, and record the mechanical deterioration of existing faults (the consequences of critical deterioration of such faults are shown in Fig. 1). The method is characterized by high susceptibility and, when compared to other non-destructive monitoring methods, has fewer restrictions related to the features and structure of construction material. The AE method can also be characterized by integrity that provides monitoring of the whole object with a comparatively small number of sensors which help to detect not only faults or leakages, but also their position coordinates. This method also allows to classify faults by the degree of danger and by detected and identified AE sources. It helps to make an objective evaluation of the technical condition of tested objects.

Fig. 1. Leakage from an underground oil pipeline

III. 4.5. Acoustic Emission Methodology

Portable dual channel device PAC Pocket AE-2 (USA) with an internal amplification of 0, 14, 40, which allows recording the parameters of AE signal within the frequency range from 1 kHz to 1 MHz, was used as AE equipment (presented in Fig. 4.2.). There are several AE systems intended for the monitoring of oil pipelines. Therefore, there is an opportunity to choose the best and most effective monitoring system for each individual oil pipeline system. This work deals with the development of a wireless acoustic emission monitoring system for the above described 4.2 km long oil pipeline section.

AE sensors were placed at the distance of 50-80 m from one another. AE signal taken in by the sensors was amplified with the help of preamplifiers built in the sensors, after which the signal passed through an AE cable to the wireless transmitter placed above ground. The transmitter sequentially passed the received AE signals to a nearby transmitter until the signals had travelled along the whole oil pipeline section and been taken in by a receiver connected to the AE equipment via USB. AE equipment registering these signals was connected to alert and status equipment which was in its turn connected to an internal computer network and the Internet (in the form of software visible to users who have a computer with Internet access). Every time one of the AE sources caused some amount of emission with a certain level of alert, the system operated in the alert mode and displayed alert messages visible to all users. Such a system ensures effective and continuous monitoring of oil pipelines. The system in general is schematically represented in Fig. 2.

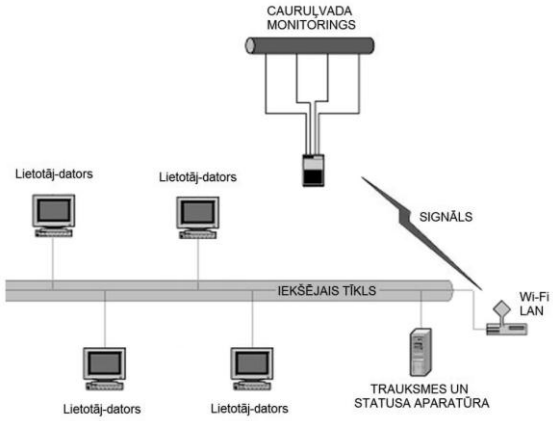

Fig. 2. Leakage from an underground oil pipeline

IV. Conclusions

Although other non-destructive monitoring methods offer many different types of testing for machine parts, they are not suitable for the creation of an oil pipeline monitoring system. It is mainly related to the fact that these methods require direct access the surface of an object or at least the area near the surface.

In comparison to other methods, this method has fewer restrictions related to the features and structure of construction material, it has high susceptibility (which is good for detecting small leakages) and it is passive. However, the most important point is that this method is characterized by integrity which ensures the monitoring of the whole object with a comparatively small number of sensors and provides for the possibility of continuous oil pipeline monitoring.

Design and Manufacture Analysis of Underwater Remotely Operated Vehicle Hull

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***Keywords* – underwater vehicle, parameters, construction, hull forms**

I. Introduction

In the beginning of new century with rise in variety of new high strength materials and modern radio equipment underwater vehicles have new expanded space for development. Underwater vehicles take us closer to still unknown Ocean, develops research for oil and gas industry, help in underwater cable laying operation etc.

II. Design stage plan

When modeling underwater vehicle there are many aspects to take into account: type of underwater vehicle, displacement, and main dimensions. After main characteristics are selected, details are précised. It is important to know all precautions to exploit vehicle safe and reliable. In comparison with ship it is difficult to provide damage stability for underwater vehicle even if small amount of water have entered hull. The paper deals with different forms of underwater vehicle and its characteristics and flow simulations during developing vehicle model. Parameters of underwater vehicle are: depth, basic equipment, autonomy, speed, special characteristics and equipment (see fig.1).

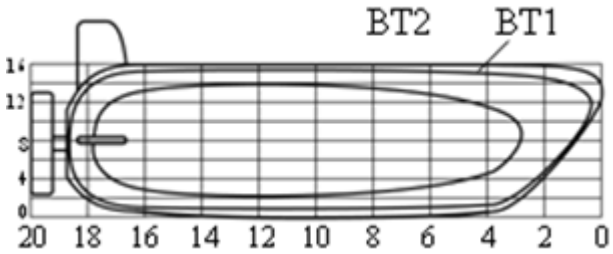

Fig. 1. Underwater Remotely operated vehicle (body plan)

III. Underwater vehicle tasks

Common research mission of underwater vehicle is to find better ways of observing and reporting on the interior of the ocean, its seafloors and coastal boundaries. A variety of sensors can be affixed in order to measure to measure the concentration of various compounds, the absorption or reflection of light. Research mission can not be separate nowadays from commercial mission.

Commercial mission of underwater vehicle mainly is performance of various missions in oil and gas industry. Surveys and inspection supporting offshore oil and gas facilities emplacement are intended to map all features that may impact the proposed structures. One of the common commercial applications is inspecting of pier underwater part and ship underwater hull (see fig.2). The next generation of these underwater vehicles was developed for purpose survey and intervention missions. The second commercial mission is ships underwater hull survey, port security, inspection of underwater pier constructions. These underwater vehicles should satisfy the following requirements: low cost, shallow water applications depth up to 20 meters, small weight and dimensions. Instead of sending diving teams to photograph the hull of a ship, survey inspector could release an underwater vehicle into water and will obtain a complete filming of ship underwater hull [1].

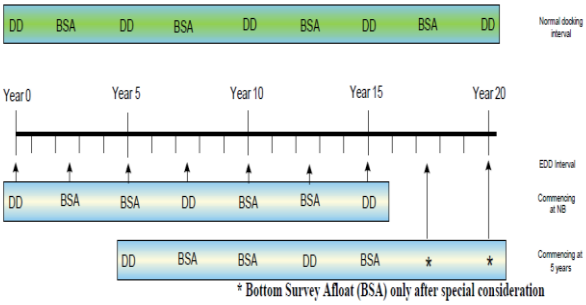

Fig. 2. Scheme of ship's hull underwater part survey [DetNorskeVeritas,2010]

IV. Underwater vehicle materials

The most reliable materials used in underwater vehicle building are steel, titan, aluminum and alloys, different composite materials and fiberglass. In construction can be used metals as cast ones and deformed ones (pressed materials, packed materials, etc). One of the most important characteristics when designing underwater vehicle is environmental hydrostatic impact during maintenance. There are many factors that influences floatation of this vehicle such as static, dynamic and fatigue stability, material, technology, construction concessions, etc

V. Conclusions

Authors have found three main difficulties which can arise during designing of underwater vehicle:

- Paneling and construction of underwater will be damaged in case of loosing floatation;
- Asymmetrical protuberances occur and lead to loss of overall floatation in case of loosing paneling in between two frames (for cylindrical underwater vehicle);
- Loss of stability – when axiametrical pockets in wave shape take place in between frames as a result of material tension.

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International Symposium on Biomedical Engineering and Medical Physics

Disposable Electrochemical Sensors for Biomolecular Recognitions

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***Keywords* – electrochemical biosensor, DNA, protein.**

I. Introduction

Many important technological advances have been progressed for the development of sensors to monitor nucleic acid, or protein interactions, and also the recognition events of biomolecules in solution and at the solid substrates. The growth of highly developed biosensors could affect significantly the areas of genomics, diagnostics, drug discovery and environmental monitoring [1-3].

The nanoscale sensors based on nanoparticles, nanowires, nanorods, nanotubes and other nanomaterials have recently received considerable attention [2, 3]. Herein, different nanomaterials combined with electrochemical sensor technology developed for biomolecular recognitions bring some important advantages; such as, more sensitivity and selectivity, and it also can eliminate advanced surface modification by resulting in a greatly simplified protocol.

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Novel Concepts of "Niche-Relief" and "Niche-Voltage" for Stem Cells as a Base of Bone and Hematopoietic Tissues Biomimetic Engineering

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Keywords **– calcium phosphate coatings, artificial microterritories, cell culture, mice, electron work function.**

I. Introduction

Currently, a lot of publications, mainly as hypotheses, were dedicated to niches for hemopoietic stem cells (HSC). Multipotent mesenchymal stromal cells (MMSC) are treated as important cell component of HSC niches [1].

At the same time, the circumstance that discussion of existence of niches determining fate of MMSC themselves just appears in literature sets at gaze [2]. Pilot experimental data about existence and dimensions of niches for osteogenic differentiation of MMSC, their close dependence on quantitative variables of bone mineral substance relief were recently obtained by us [3].

In this connection, investigation of the relief features effects of model mineral matrix on structural-functional conditions of human MMSC and remodeling of bone/bone marrow system in mice was of great interest.

II. Specimens preparation

A. Materials

Pure titanium specimens (diameter 12 mm, thickness 1 mm) with bilateral calcium phosphate (CP) coatings were used as artificial substrate for MMSC cultivation. Coatings were applied on titanium by means of micro-arc oxidation method in 10 % phosphoric acid solution containing suspension of nano-sized (20 – 40 nm) synthetic HAP particles.

Morphology of CP coatings was estimated by Quanta 200 ESEM FEG scanning electronic microscope (SEM). Roughness of CP coatings was evaluated by means of Talysurf 5-120 measuring system (Taylor-Hobson, UK). Ra (μm) index was determined.

Alterations of electron work function (φ) and voltage distribution over the specimens' surface were carried out as described earlier.

B. Cell Techniques

Culture of human prenatal stromal lung cells ("Stem cells bank" Co Ltd., Tomsk) as MMSC source was studied on pure titanium discs with CP coating in 4 days after implants addition into culture medium.

Computer morphometry was applied for detection of quantity levels of cellular alkaline phosphatase (ALP) activity. Concentrations of calcium and inorganic phosphorus, ALP activities in supernatants were estimated according to standard colorimetric method. Osteocalcin (OC) levels were measured in cell supernatants by "sandwich" ELISA.

Technique of subcutaneous heterotopic osteogenesis in mice from column of syngeneic bone marrow, preliminary applied on CP surfaces was carried out as early described.

Statistical analysis was made by means of variation statistics methods with the use of Mann-Whitney U-test.

III. Results

Implants with rough CP coatings have structural-functional sites (micro-regions) named "niches-relief" which are necessary for in vitro maturation and differentiation of HLPSC into secreting osteoblasts. ALP stained cells (osteoblast' marker) populated sockets of artificial surface. The ratio of area of ALP stained cell to artificial surface area occupied with stained cell was calculated. S_{ALP}/Sniche index has been established to correlate with CP roughness index Ra. Obviously, artificial "niches" for induction of MMSC osteogenic differentiation are a structural-functional concept.

These data allowed us to propose "niche-relief" conception for osteogenic differentiation and maturation of MMSC.

Maximal remodeling of mouse bone/bone marrow system in 45-day subcutaneous heterotopic test in vivo is also noted under optimal parameter (average index of cellular ALP area to artificial micro-region area is about 43 %) of osteogenic niche in vitro.

Probable physical mechanism of osteogenic niche functioning has been determined.

Our scientific team designed the device for electrostatic potential measurement of low-charged surfaces by means of M. Eguchi method developed. Work area of elevating electrode is 20 square millimeters. CP electrets demonstrated negative charge of surface electrostatic voltage with an average range of 45 mV.

A direct electrostatic interaction is considered as predictor of cells adhesion to implants. For all this, osteogenic cells have been known to migrate to cathode in electrostatic field. So, it can promote stem cell seeding and spreading.

Logarithmic interconnection of irregularities of CP coatings nanorelief and voltage estimated from the electron work function measurements was established. Increasing electron work function (φ) and negative charge amplitude in the sockets (artificial "niches") of CP coatings nanorelief were observed. It can promote stem cell osteogenic differentiation.

"Niche-voltage" concept for biomimetic engineering of bone and bone marrow tissues was proposed.

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Combinations of TL/OSL Single Dosimeters for Mixed High/Low Ionization Density Radiation Fields

Leonid Oster (*Sami Shamoon College of Engineering*), Soniya Druzhyna, Izhak Orion and Yigal Horowitz.

***Keywords* – Thermoluminescence, optically stimulated luminescence, LiF:Mg,Ti, neutron and alpha irradiation, discrimination dosimetry.**

I. Introduction

Accurate/near-total discrimination between high ionization density (HID) radiation (neutrons and heavy charged particles) and low ionization density (LID) radiation (gamma rays and betas) remains a very crucial/important frontier of ionizing radiation dosimetry. This derives from the very high radiobiological effectiveness (RBE) of HID compared to LID radiation. This requirement is therefore especially important in reactor generated radiation fields, space and air-craft radiation fields, many categories of oncological/clinical applications, accelerator applications and many others. It deserves emphasis that there are no existing practical/small-size/ passive or active dosemeters which have adequate discrimination capability.

The TLDs used in practical dosimetry have high sensitivity, reproducibility, environmental stability, low fading, etc. They are very convenient for measurement of dose, but the application of these dosimeters in real fields of non-monochromatic radiation is problematic. This arises because the response/efficiency of the TLDs depends significantly on the energy of the radiation, leading to possible errors of hundreds of per-cent in the determination of the dose components in the mixed radiation field.

The disadvantages and difficulties inherent to the various types of discrimination mixed-field passive and active dosimeters have been reviewed recently in [1,2].

We have previously demonstrated that the increased response of optically stimulated luminescence (OSL) compared to TL following HID alpha irradiation is naturally explained via the identification of OSL with the "two-hit" F_2 or F_3^+ center, whereas the major component of composite TL glow peak 5 is believed to arise from a "one-hit" complex defect. The preferential population of the F_2 centers (OSL emission band as a function of dose) at high dose by uniformly ionizing beta irradiation arises naturally from the cumulative probability of multiple ionization in a small volume related to the capture cross section of the multiple-hit F_2 trapping centers. This result is of fundamental interest since supralinear behaviour can be predicted for "2-hit" centers by kinetic/statistical models.The association of 2-hit centers with OSL suggested that near-total discrimination between HID radiation and LID radiation using combined OSL and TL measurements may have significant potential in mixed-field radiation dosimetry [3]. In this paper we discuss and compare the potential application of combined OSL/TL, the use of TLD-600 and TLD-700, which can, in principle, serve as ionization density discriminators.

III. Results and Discussion

The signal from the dosimeter is given by

$$S_{TL} = a \cdot D_n + b \cdot D_\gamma = S_{nTL} + S_{\gamma TL} \quad (1)$$

$$S_{OSL} = c \cdot D_n + d \cdot D_\gamma = S_{nOSL} + S_{\gamma OSL} \quad (2)$$

where S_{TL} and S_{OSL} are the signal intensities in appropriate units, and D_n and D_γ are the values of the dose deposited in the detector by the neutron (alpha) and gamma ray components of the radiation field respectively.

Because **Error! Objects cannot be created from editing field codes.** is a measure of the accuracy of the measurement of γ dose via TL and **Error! Objects cannot be created from editing field codes.** is a measure of the neutron dose via OSL we can establish the figure of merit (FOM) as:

$$FOM = \left(\frac{c}{d}\right) \times \left(\frac{b}{a}\right) \quad (3)$$

Beta and alpha particle irradiations were carried out with $^{90}Sr/^{90}Y$ and ^{241}Am sources (4.7 MeV) respectively and neutron irradiations were carried out at the PTB (Germany) (E_n = 5 MeV) and RARAF (Columbia University, USA) (E_n = 6 MeV) accelerator facilities. The highest values of FOM observed for the various techniques were ~30 for neutron/gamma discrimination and ~110 for alpha/gamma discrimination using OSL/TL - peak 5 measurements in TLD-700.

IV. Conclusions

The results reported herein demonstrate the potential application of of combined OSL/TL measurements in neutron (alpha)-gamma discrimination dosimetry. The OSL/TL dual readout of LiF:Mg,Ti as an ionization density discriminator avoids some of the difficulties [1,2] inherent to the various types of discrimination mixed-field passive dosimeters, and in addition has several advantages.

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Mission and social impact of the Multidisciplinary School of Engineering in Biomedicine

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Keywords **– biomedical engineering, BME education, multidisciplinary learning, education quality, learning organization.**

I. Organizational principles of MSIB

The Multidisciplinary School of Engineering in Biomedicine (MSIB) is an independent department of the AGH University of Science and Technology (AGH-UST) and has been in operation since the academic year 2005-2006 [1]. Although MSIB has been formed on the basis of the staff formally employed by five faculties, it is treated as a separate part of the AGH-UST and has its own students. Formally, MSIB's structure is similar to that of other faculties..

II. Management of human flow

One of the most important advantages of the School is the prerogative to create and implement the independent information policy. This tool can be used not only for administrative purposes, but can help in creating a public understanding of "biomedical engineering" and support the social mission of the School which extends far beyond the standard understanding of higher education [2].

Within the mission of MSIB four main directions were identified as targets of information policy:

- candidates, being the input of institutional human flow,
- employers, being the output of institutional human flow,
- students, being recipients of knowledge, skills and social competences as well as partners within a common corporate culture [3],
- society, being indirectly concerned by the outcome of biomedical engineering and requiring information as tax payers.

Thanks to the corporate culture in MSIB, the understanding of information policy by students is demonstrated by their help in college communication meetings, university open days or science festivals. In the same spirit, we encouraged students to join academic professors in a project of editing an introductory review book to biomedical engineering.

Since no specific college subject is directly related to the study, we analyzed feasibility conditions of high school competition in bioengineering. The country-wide competition is targeted to undergraduates and aimed at supporting the interest for the biomedical engineering, spreading the idea of bioengineering as a profession and university faculty as well as identification and recruitment of the most talented and oriented individuals to the university.

In MSIB we extended the understanding of "educational offer" and "educational product" by the way typical to other commercial offers and products. We presented the offer of MSIB, concerning the education of professionals for technical support of medicine in the faculty of biomedical engineering during the International Trade Fair of Medical Equipment and Instruments SALMED 2012 held in Poznań.

III. Impact to the social competences

Identifying of profession-specific needs for social competences and setting educational standards also belong to the extended mission of MSIB. Besides other particularities, striving for the technical excellence and ethical background belong to key competences of bioengineer. Consequently, a particular presumption of excellence is distinguishing the biomedical engineer among other engineers. Moreover, since the technology is currently fast enlarging the ability and efficiency of medicine, it also bears a particular responsibility for unfortunate medical acts.

Due to the fact of cooperating of professors from different departments of AGH-UST and medical doctors, the multidisciplinary education is and inherent feature of MSIB. As the university may be considered as an archetype of future workplace, this idea is consequently propagated to the expected educational competences.

IV. Impact to the local society

Health promotional events targeted at general public attract people of any age thanks to interesting equipment demonstrated in its everyday use. The public take the opportunity to familiarize with technology supporting health care, to learn about purpose and backgrounds of particular devices and therefore weaken all unpleasant connotations with disease. Future biomedical engineers get involved in broad education and benefit from the chance to develop their communication skills.

As shown by statistical surveys, biomedical engineering students belong to the most involved in voluntary actions organized for disabled or elderly people. Institutional sup-port of their activity in hospitals, hospices or homeless refu-gees also belongs to MSIB mission in the society. Performing such duties, students acquire competences impossible to learn in pure academic conditions.

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Defects of Field Structures

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***Keywords* – field structure, modelling, stress, defects, cracks**

I. Introduction

The field structures (FS) around the living biosystems are known from ancient times. People detected such fields by hands and the different devices (the metallic frame, the ticker and others). Now the method Bioelectrography, the Adaptometry and others are used. It's known that the state of the organism depends often from the state of the FS. However the FS can have the different defects. It's necessary to define its. In this report the different defects of the FS are discussed from the point of view of the mechanics of the solid bodies using the methods of the photoelasticity.

The concept of the strength, the hardness was known to people from ancient times. English anthropologist R.H. Dart (1925) supposed that the first culture was the culture the osteo- odonto- ceratic culture, as the bones and the teeth was the first instruments for the agriculture and the defence. The first ideas about the biomechanics were suggested by Aristotel (384-322 years BC). In 1638 year Galileo Galilée (1564-1643) tried to base the connection of the bone form with the applied efforts. In 1866 year the prof. doctor G.H. Meyer from Zurich and prof. Culmann from Zurich Polytechnic School showed on the example of the hip bone that the texture of the bone tissue corresponds to the mechanical laws. In particular the paths of the trabeculars of the sponge tissue coincide with the lines of the maximum stresses.

II. The stress state of the biosysyem

The natural constructions have the complicated structure with the time changing of the physical –mechanical properties α_k of the tissues and different mechanical, physical and chemical actions β_k of the environment. The parameters α_k are interrelations i.e. every parameters of α_k is the function of the all others internal parameters, the environment parameters β_j of and time t

$$\alpha_k = f(\alpha_1, \alpha_2, ..., \alpha_{k-1}, \beta_j, t).$$

All parameters α_k have the value limitations for the normal functioning of the living system. For the solving such problems the system analysis is used, all factors which influence on the state and the functioning of the biosystem are revealed. The general view of the equation system of the solid body mechanics including the changing of all factors and the anisotropic of the tissue structure is very complicated. For the studying of the functioning of the biosystem, for the revealing of the zones with the fracture defects the different methods of the physical and the mathematical simulation are applied. For the investigation of the stress state for the rigid tissues of the elements of the living constructions under the mathematical simulation Lame's problem is used [1].

III. Applications of the Lame's problem to the FS

If the outer pressure acts on the biosystem, then the system brings the influence to the environment i.e. some physical field appears around the biosystem. In the polarized light this field will be as the interference fringes in the polymer matrix around the glass sphere inclusion (fig 1.1) and detected by the method GRV (fig. 1.2) [2].

The degree of this acting on the value and the radius is certainly small in comparison with the dimension of the Universe – 4-5 radius of the body, but when the living systems occur among closely spaced groups the value of this acting will be perceptibly.

Fig.1.1. The interference fringes in the model with glass inclusion

Fig.1.2. The field around the finger (GRV method)

IV. The modelling of the defects in the FS

In the report the different state of the system depending from the mechanical properties FS, its dimensions, the acting and the boundary conditions are analyzed. The redistribution of the stress state is discussed. For several systems the stress state will be changed (fig. 2.1).

Fig.2.1.The model with 4 inclusions

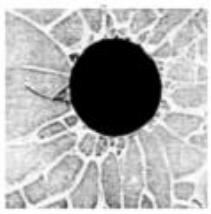

Fig. 2.2. The cracks in the matrix around the inclusion (Theocaris P.S., 1973)

Under the growth, under the function of the living system the different defects may be appearing similar to the defects of the composite models (fig.2.2). These cracks limit the information perception, new stress state and the reconstruction around the cells will be. Some departure from the norm of the behavior and the contracting a disease may be appearing. The suggested models are the base for the biomechanical interpretation of the fear and depressing state. It's necessary to project the medical apparatus for the detecting of the different FS's defects.

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System Pattern of Consciousness Functioning

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***Keywords*— Consciousness, senses, continuum, semantic field, rudiments of aptitude.**

All evolving World, perceived by us, we would consider as set of working programs. Programs are characterized by discrete and continual semantic components. It sets senses of the program. All possible senses are initially packed and placed in a continuum.

Differentiation of senses will be set not by division, but as procedure of scaling specify on all field. Scaling procedure consists in assignment to different sites of a semantic field of a certain extent. Occurrence as a result of scaling of system of preferences, selectivity in an estimation of various sites of a field, creates preconditions unpacking of senses and program generation.

The semantic continuum is an Entity, and it scaling unpacking – multiple. Therefore, the semantic continuum becomes involved to being and, thus, is shown in plurality of the World as semantic field. The main thing is it, that an Entity becomes plural not through crushing, but through set by function of a measure scaling.

The consciousness of the person acts in the World as a set of programs carriers of senses. Senses are initially set in the potential, not shown form and concrete unpacking of senses is represented free possibility for the person.

Let's expand the description of a basis of Entity of the World, postulating, that in its sources there is a semantic field and rudiments of aptitude (see fig. 1). Aptitude is a natural ability to exist and a natural ability to do something. When we learn the rudiments of something, we learn the most essential things about it.

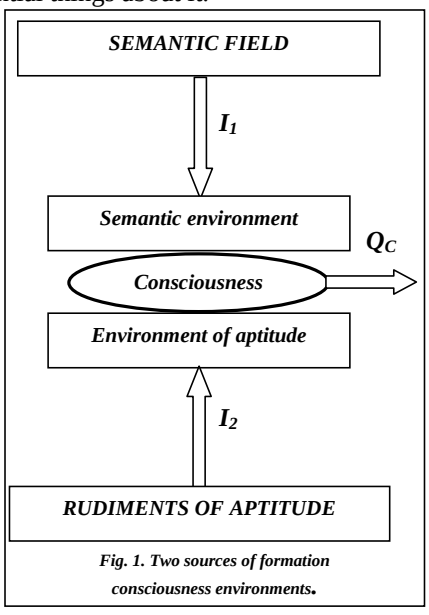

Fig. 1. Two sources of formation consciousness environments.

The actual personal consciousness in phenomenal life of the person, not only occupies certain position in hierarchical system of revealing senses, but also co-exists to quite certain concrete environment of aptitude.

Aptitude is an internal fundamental principle of any life and all processes accompanying it. In evolution of aptitude, consciousness of the person moves not in the peripheral nature of the Reality and aspires not to explanation of system and the World mechanism as its diverse hierarchical detection, but gravitates directly to essence of life in itself.

The environment of aptitude is defined in the native nature as essential dynamic and permanent harmonious conjugation of unity to multiplicity. In aptitude, specific tonalities of its underlying define the effective nature of concrete consciousness living in it, its position in hierarchy of a plastic susceptibility and, according to it, singularity this environment of aptitude.

Distinction of the World and chaining consciousnesses of individuals to the certain qualitative hierarchical status, is overcome by dynamic process of a life — perceptions and realizations of intuitive revelations pan-united rudiments of aptitude and a semantic field. The nature of intuition is essentially dynamical, and it reveals in mutual relations of realities of various hierarchical orders.

Between intuitions of a semantic field and rudiments of aptitude (I_1 and I_2) there is rather essential difference. In the semantic environment the hierarchical structure and all system of steps of the organization of senses ascending on the qualitative status is a phenomenal reality, in the environment of aptitude similar conformity is the hierarchy of a plastic susceptibility set for any concrete consciousness only transcendental.

The plastic intuition is intuition of a life in itself. It reveals not ascending chain of concrete action of cognition, but incorporation in underlying of all observable processes.

Aptitude in itself is rudiments of the unconscious. The aptitude *coexistence* of consciousness with rudiments becomes objectified and actual only at its disclosing as product of the semantic field defining evolutionary activity of consciousness under the hierarchical law. Only in this process, primordial aptitude receives the true place in the perspective of the World.

Semantic work of consciousness (Q_C) on creation of new programs is determined by product of quantity of a current semantic charge on quantity of the semantic status of consciousness, which is defined by the susceptibility environment of aptitude reached by consciousness. Process of work on finding of new senses is intuitive and based on regulating role of intuitions (I_1 and I_2) in consciousness functioning.

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Future Number of ESRD Patients' Projection Using Markov Chain Monte Carlo Model

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D. Goumenos (*University of Patras*) and N. Pallikarakis (*University of Patras*)

Keywords **– End-Stage Renal Disease, Markov Chain Monte Carlo Model, projection, Renal Replacement Therapy.**

I. Introduction

End-Stage Renal Disease (ESRD) is a chronic condition requiring one of the available forms of dialysis or renal transplantation, otherwise the patient dies. These types of treatments are known by their high cost for healthcare authorities. Prediction of the future patients' number and decision making tool for the better resources allocation and cost-effectiveness analysis is of special importance for any healthcare system.

II. Materials and Methods

We have previously reported a Markov Chain Monte Carlo model for predicting the number of ESRD patients [1]. The model was tested for Greece; however the approach is generic and can be applied to other countries. In the current study the model was applied to predict future number of ESRD patients in Austria. The Markov chain includes three mutually exclusive treatment states: hemodialysis, peritoneal dialysis, renal transplantation and a death state. The model comprises Monte Carlo sampling techniques applied on probability distributions of the constructed Markov Chain. The Monte Carlo algorithm embedded to Markov Chain for the simulation of the treatment changes and initial assignment of incident patients is described in detail elsewhere [1]. Age-specific data (<45, 45-65, >65 age groups) on incident and prevalent ESRD patients' numbers for Austria, available from European Renal Association - European Dialysis and Transplant Association reports for the period 1998-2009, were used for the implementation of the model [2].

An iterative technique was used in defining the transition probabilities of the Markov Chain. The limits were set in order to find the optimal age-specific transition matrices obtained from the internationally published literature. The incident patients' number was modeled for each age group separately. For the age groups <45 and 45-65 the incidence was represented by a linear regression. For the age group >65, the patients' number was projected by a logarithmic regression model. The model was successfully validated based on data for the period 2007-2009. The real prevalent patients' number was compared to the projected number and the error was expressed in percentage.

III. Results

Number of prevalent ESRD patients' was predicted to reach 9830 by 2020. The total prevalent patients' number increase is expected to be approximately 20% in 2020 compared to 2009. The mean annual increase in total number of prevalent patients is predicted to be about 2.8%. The results of the prevalence projection by therapy are presented in figure 1, while figure 2 depicts the expected prevalence increase by age group.

During the validation, the error in absolute percentage between real and modeled number of patients on the different treatment modalities, three age groups and total number of patients with ESRD was calculated. Calculated discrepancies were in the range from 0.9 to 5.1%, except the error for the year 2009 for the peritoneal dialysis. The latter error results in underestimation of the projected patients' number compared to the real by 12.6%, though the error for the year 2007 and 2008 were 1.1% and 1.3%, respectively. This high deviation of projected data for 2009 may be explained by the sudden increase in the peritoneal dialysis patients in 2009.

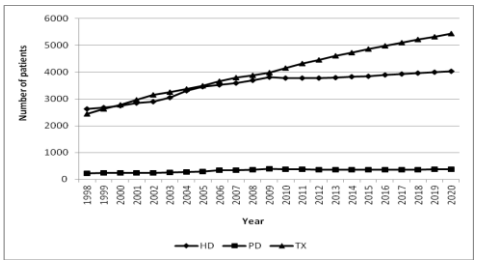

Fig. 1 ESRD patients' prevalence projection by therapy.

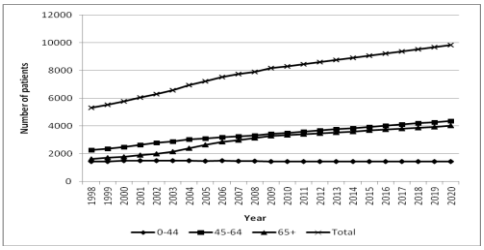

Fig. 2 ESRD patients' prevalence projection by age group.

IV. Conclusion

The generic model implemented for Greece successfully predicted a continuous increase of the Austria patients with ESRD disease during the period 2009-2020. Continuous increase of prevalent ESRD patients' is explained by improved survival rates [3]. Predicting future ESRD patients' number has a positive impact in decision making for better resource allocation of the available treatments.

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Dependence of the Natural Population Increase in Latvia on the Effects of the Anomalous Gravity Field

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Keywords **– anomalous gravitational field, intensity, natural population increase.**

I. INTRODUCTION

The Article summarizes results of the 20-year studies carried out by the authors in 10 regions and parishes of the country as well as countrywide. We considered response of the natural population increase (Ni) in large areas (regions, parishes, countrywide), to effects of the anomalous gravity field (AGF) of different intensity. The average demographics of the population in regions and parishes for 10 years or more beginning from 1980 and average intensities of AGP in the areas where this population lived have been analysed.

II. PARTICULAR FEATURES OF THE GRAVITY FIELD IN LATVIA

AGF in Latvia is created by different-density rock masses, which lie in the crystalline basement as well as in the deeper crust and mantle layers; therefore the spatial distribution of the anomalies as well as overall picture of the gravitational field depends on the pattern of the geological bodies' distribution. Areas composed of dense gneisses and amphibolites of the main composition as well as (in local areas) of iron ores are characterized by positive anomalies, but areas of less dense granites and felsic gneisses - by negative anomalies. [1] Figure 1 shows a map of AGF in Latvia.

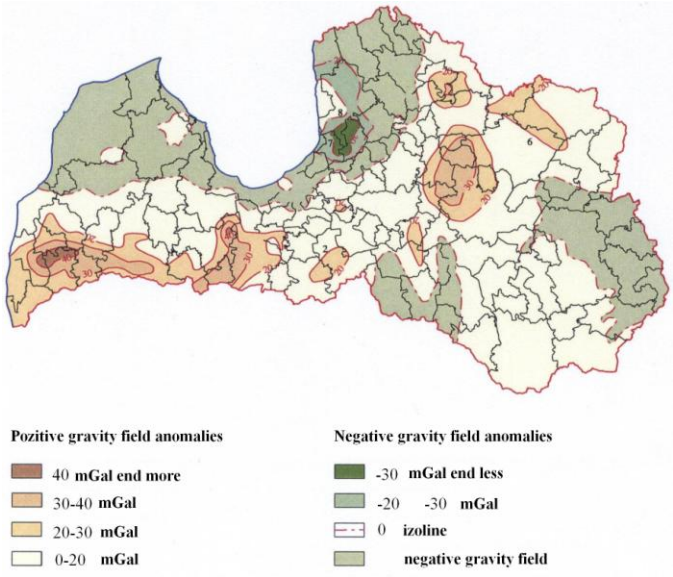

Fig. 1. Map of gravity anomalies in Latvia

III. RESPONSE OF ORGANISMS TO AGF EFFECTS

The First International Conference devoted to response of living organisms to effects of the gravitational field of different intensity was held on December 23-25, 1974, in Moscow. There were read 42 reports on gravitational biology. The reports emphasized great importance of gravity for the organisms. [2]

Space research showed that decrease in AGF intensity has a negative impact to functioning and reproduction of organisms.

Thanks to space researches, the question of gravity's influence on organisms has received the wide development. The gained information was important not only for space flights, but for solving earthly problems too, in particular, for proper placement of settlements within the gravitational field, in spatial planning projects.

IV. CORRELATION ANALYSIS OF N_I OF THE POPULATION AND AGF OF DIFFERENT INTENSITIES

XX-XXI centuries are characterized by a rapid decline in Ni of the population. The same trend is observed in Latvia too, and this hinders development of the country and has a negative impact to all spheres of the life. Save the population is the priority task in all countries, particularly in Latvia.

In 2010, RTU TURAP completed the work on the topic on "Influence of geophysical factors on demographic processes and spatial organization of human living environment", which analyses dependence of Latvian population's N_I values on AGF intensity in the country. [3] The analysis showed that there is a direct correlation (k = 0.25) between these values. The higher is intensity of AGF, the higher is N_I of the population is of the population.

Today, in Latvia, there is not population reproduction in areas with negative AGF intensity. Population declines rapidly. Due to this fact, it seems expedient to take AGF intensity into account in spatial planning projects and direct new developments to territories with positive AGF values.

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Fundamentals of Radiobiology

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Keywords **- ionizing radiation, radiation exposure, dose- response relationships, radiation biology, radiotherapy.**

I. INTRODUCTION

In the last few years we have observed among our Biomedical Engineering students a growing interest in application of ionizing radiation in therapy. Then we proposed to students of 5th year (9th semester) - the Level II degree- an elective course about the fundamentals of radiobiology. The aim of this work is to present the program of the course realized at the Multidisciplinary School of Engineering in Biomedicine in AGH University of Science and Technology [1] since academic year 2010/2011.

II. ORGANIZATION OF THE COURSE

The course entitled "Fundamentals of Radiobiology" is realized in 60 hours consisting of 30 hours of lectures and 30 hours of practical classes..

The syllabus of lectures includes following topics: types of ionizing radiation, interaction with matter (charged particles, photons), energy deposition, quantities and units in radiation protection, detection of ionizing radiation (gas-filled detectors, scintillation detectors, semiconductor detectors, films, thermoluminescent detectors) and spectrometry, biological effects of radiation, mechanism of radiation damage to cells, timescale of radiation effects (physical, chemical and biological phases), linear energy transfer and relative biological effectiveness, effects of radiation on humans (deterministic, stochastic, hereditary), external and internal radiation exposure, dose-response relationships, 5R of radiotherapy, theoretical models (target theory, two component TC, linear quadratic LQ, lethal potentially lethal LPL), radiosensitity of tumors, external beam radiotherapy, brachytherapy, pathogenesis of normal tissue (side effects).

III. PRACTICAL CLASSES

The practical classes of the course take place in the Student Radiometry Laboratory and Liquid Scintillation Spectrometry laboratory [3]. During the first meeting a group (10-12 people) of students is divided into 5-6 teams, which perform the exercises by themselves, but under supervision of the assistant professor. Before starting the experimental work students are instructed in regulations at the laboratory. Special attention is paid to the safety during the work with radioisotope sources. Exercises they have to do are chosen so that they would be relevant to field of student's line of studies. Single exercise lasts about 3 hours. Therefore students perform exercises from various branches of nuclear physics using a diversity of equipment. Most of the detectors, electronics and software in the lab is new, purchased in 2011. The exercises topics prepared for the Biomedical Engineering students are:

Gamma rays detection using Geiger-Mueller counter (with elements of statistics): students use a classical spectrometry track in order to register gamma radiation from ^{137}Cs and beta particles emitted by ^{40}K. They also have to test Gauss and Poisson

Gamma rays measurement with HPGe detector: the aim of this exercise is to calibrate the apparatus, identify an unknown radioisotope and perform a natural radioactivity measurement of the ash using modern Canberra HPGe detector, Canberra electronics and Gennie 2000 software.

Gamma rays measurement using NaI(Tl) scintillation counter: this type of the radiation detector is widely used in many applications. The stand is very compact and consists of a lead shield, 3-inch Canberra detector with osprey electronics and a laptop. The subject of the exercise is the same as with the HPGe detector. Students can compare HPGe and scintillation detectors.

Measurement of beta-particle scattering: using Canberra scintillation detector, osprey electronics and Gennie 2000 software students can observe the interaction between charged particles and various materials, which differ in atomic number of the elements.

The phenomenon of coincidence resulting from positron annihilation: this is the basis of PET tomography. Due to the longer time of decay in the lab ^{22}Na source is used. The students determine time of coincidence and measure the angle distribution of the 511 keV photons using Canberra equipment, Polish Tukan analyser and Tukan software.

Measurement of hydrogen contents in various materials using neutron techniques: Pu-Be neutron isotopic source is situated in a polyethylene block. The emitted neutrons are slowed-down in it, pass the Cd shield (thermal neutrons absorber) and interact with a sample. The number of the thermal neutrons, created in the interactions with the sample and registered by BF_3 proportional counters is a measure of the hydrogen contents in it. only a simple spectroscopy track is used in this exercise.

LSC spectrometry: Laboratory exercise for groups of 2-4 students enables practical contact with the specific radiation measurement technique that is frequently used in numerous applications for activities from natural environmental levels to levels of tracer experiments. Students participate in entire measurement process of beta or alpha radiation from liquid or solid samples, starting with preparation procedure of scintillation cocktail, then computer controlled measurement in Tri-Carb Canbarra Packard spectrometers and completing by numeric calculations and interpretation of the results.

IV. SUMMARY

The practical experience in nuclear physics gained by students in this course is appreciated by them.

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Medical Diagnostics with Ionizing Radiation

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***Keywords* – X-ray diagnostics, nuclear medicine, QA (Quality Assurance), radiation protection of patients and staff.**

I. Introduction

The use of ionizing radiation in medical diagnosis requires compliance with the principle of ALARA (As Low As Reasonable Achievable), as well as with the Council Directive 97/43/Euratom [1]. The AGH University of Science and Technology was first in Poland to enroll students in Biomedical Engineering (BME) in academic year 2006/2007[2-3]. To teach BME students a Multidisciplinary School of Engineering in Biomedicine was founded. Prof. Piotr Augustyniak has been nominated its head. The education program of BME follows the expectations from industry, health care and science. The aim of this paper was to present the course entitled "Medical diagnostics with ionizing radiation" prepared for students of 4th year (7th semester) in Biomedical Engineering - the Level I degree. The program of the course consists of lectures and practical classes to acquaint students with the Quality Assurance System in X-ray diagnostics and nuclear medicine.

II. Organization of the Teaching Program

The teaching program of the course "Medical diagnostics with ionizing radiation" is realized in 30 hours: 20 hours of lectures and 10 hours of practical classes.

The syllabus of lectures includes following topics: types of ionizing radiation used in medical applications, interactions processes of photons (X-rays and gamma rays) and charged particles with matter and tissue, biological radiation effects, fundamentals of radiation attenuation, deposition of radiation energy, doses (absorbed, equivalent, effective) and exposure, dose limit, lethal dose, linear energy transfer. Physical basis of X-ray imaging: X-ray tube, X-ray spectrum, attenuation characteristic of tissues, image receptors (fluorescent screens, film-enhancement screen, CR, DR), image quality (contrast, resolution), factors affecting the quality of X-ray imaging (kVp, mAs, time of exposure), conventional radiology, mammography, DEXA (Dual Energy X-ray Absorptiometry), Computed Tomography, Hounsfield scale, $CTDI_{vol}$(Computed Tomography Dose Index) and DLP (Dose Length Product), current EU and national regulations for radiation protection of patients and staff (Diagnostic Reference Levels in X-ray diagnostic, Quality Assurance, Quality Control). Physical basis of nuclear medicine: radiopharmaceuticals, principles of imaging (gamma camera), image quality (contrast, resolution), factors affecting the quality of image, SPECT (Single Photon Emission Tomography), PET (Positron Emission Tomography), MIRD (Medical Internal Radiation Dose), current EU and national regulations for radiation protection of patients and staff (Diagnostic Reference Levels in Nuclear Medicine, Quality Assurance and Quality Control in Nuclear Medicine), Equipment for radiation measurement and doses in diagnostic radiology and in nuclear medicine.

The practical classes is realized by measurements in accredited laboratory in the Institute of Nuclear Physics Polish Academy of Science, Laboratory of Individual and Environmental Dosimetry (LADIS), for diagnostic radiology and by Department of Nuclear Medicine in the Military Clinical Hospital, for nuclear medicine.

The system of QA for radiation protection in medical applications of ionizing radiation consists of acceptance tests, basic tests and specialized tests, in accordance with current national regulations. The program of practical classes includes only specialized tests for diagnostic radiology and nuclear medicine.

In the LADIS Laboratory students are familiarized with the tests carried out for X-ray machines used in conventional radiology, fluoroscopy and angiography, mammography, computed tomography and dentistry.

The program of practical classes in nuclear medicine includes radioprotection of staff and patient with radiopharmaceuticals, quality standards for radionuclide calibration and accuracy of administered doses (i.e. injected), Quality Assurance and Quality Control of gamma camera and computer, Quality Assurance of scintillation probe for measurement of iodine uptake.

III. Summary

The knowledge and practical experience gained by students in this course can be useful in their future work.

IV. References

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Approach to the Silicon Sensor with Pre-threshold Electron Emission Readout to Detect Exhaled Breath Gases

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Keywords **– exhaled breath gas, silicon gas detector, electron emission.**

I. Introduction

Preliminary diagnosis of human diseases such as cancer and diabetes is possible via the detection of violate organic compounds (VOCs) contained in exhaled breath gases. A pre-threshold electron emission yield from a solid emitter depends on the gas molecules adhered to the emitter, if the electron work function is influenced.

Since detecting techniques typically consist of a VOCs detector and equipment to amplify and record signal, there are two ways to enhance sensitivity: improving the detector and advance quality of the equipment.

The latter is boosted because of signal processing algorithms and circuitry decisions improvement. However, to get a better detector, the derivation of the signal (S) supplied by the detector on the VOCs concentration (C) is the most important option. The function S(C) could be written as:

$$S(C) = S(C_0) + (C - C_0)\frac{dS}{dC} + (C - C_0)^2 \frac{d^2S}{dC^2} + \cdots \quad (1)$$

C_0 – value of C at that vicinity that S is derived.

The accuracy of S(C) is high when the nonlinear elements of the formula are kept. This can be achieved when the highly indexed derivations provide significant impact even when the difference (C-C_0) is small. Such the conditions are available if the VOCs detector demonstrates nonlinear, preferably parabolic, dependence S on C. The pre-threshold emission of electrons gives such a property.

Photoelectron emission (PE) current density (I) generally obeys the equation:

$$I = A(h\nu - \varphi)^m \quad (2)$$

A – coefficient of proportionality, $h\nu$ – energy of the photon that excites the electron [eV], m –coefficient that deals with transitions between the initial and final states of the electron, m>1[4], φ – electron work function.

If the emitter attaches electrically active molecules, the value of φ depends on their concentration. At the first approach:

$$\varphi(C) = \varphi(C = 0) + \Delta\varphi(C), \quad (3)$$

$\Delta\varphi\ (C)$– the increment of φ resulting from C,

$$\Delta\varphi(C) = \frac{\Delta\sigma(c)l}{2\varepsilon\varepsilon_0}, \quad (4)$$

$\Delta\sigma$ - surface charge density increment, influenced by C, l – emitting electron main free path within the emitter, ε - electrical permittivity of the matter that the electron escapes from, ε_0- electrical permittivity of vacuum.

Because of the above, I is a parabolic (m>1) function of C and I fits in (1). However to get the Δφ response on C, the value of ε should not be large.

The alteration of φ can also give a contribution to the weak thermoelectron emission (TE). Its electron current density I_T obeys Richardson - Dushman formula:

$$I_T(C) = B \cdot T^2 \cdot \exp\left(\frac{-\varphi(C)}{kT}\right) \quad (5)$$

B – coefficient, k - Boltzmann constant, T – temperature K.

To prove this theory, the crystalline silicon (Si) specimens having n- and p- type conductivity were selected for the experiments (Table 1). This in addition to the above was motivated because:

- the PE of Si is provided due to indirect photoinduced electron transitions, m = 2.5 [1].
- the value of ε is small, ε = 11.9 [2].

TABLE 1 ELECTRICAL RESISTANCE OF THE SI SPECIMENS

Type	Electrical resistance, Ω·cm
p-Si, doped with Boron (SHB)	0.0005 1
n-Si, doped with Phosphorus (SEP)	0.0014 5

The gases of benzene (dipole moment D=0 D [3]) and isopentane (dipole moment D=0.29 D) were selected as examples that are typical of lung cancer patients.

As the visual result using PE and TE, the differences of the measured emission currents densities before and after exposure were measured for the different Si types with benzene and isopentane gases.

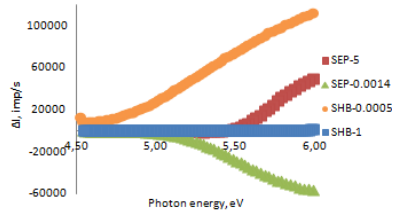

Fig. 1 ΔI of PE in bezene, exposure time 30 min.

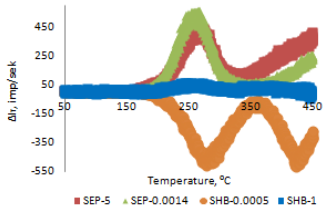

Fig. 3 ΔI_T of TE in benzene, exposure time 30 min.

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Development of Thermal Simulator of Human to Thermophysical Research of Medical Supplies and Thermal Surgical Equipment

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Keywords – T**hermal simulator of human, Thermal surgical equipment (TSE), Medical Products (MP), Thermo physical properties (TFP).**

I. Introduction

Today in Ukraine the development of medical devices are limited to some hygienic tests like hygroscopicity, capillarity, etc., in accordance with the relevant regulations. Other hygienic testing program tests are not provided.

The corresponding situation is caused by lack of data on the functional relationship between the hygienic parameters to be determined by known methods, and the measurements of professional performance in specific microclimatic conditions, and rates of heat exchange between the product and the human body.

The current system has several shortcomings:

- Hardware method for determination of the TFP today do not fully correlate with the heat exchange system in man-environment influence at MP, SC, TSE;
- Quite a long time study and significant financial costs.

Given the above, solving problems of studying TFP by manufacturing thermal simulator of human is important.

II. Investigation of thermal product features

Thermal conductivity of textile fabrics is associated with the transfer of energy of thermal motion of microparticles from the more heated parts of the body to a less heated, leading to temperature equalization.

In order to determine the optimum material for the production of a particular medical product it is necessary to study their TFP.

The heat transfer in the system "man - environment" and thermal characteristics of the MP, SC and TSE have been studied previously. This should determine the necessary characteristics for its material, which corresponds to the product intended purpose and scope of its efficient use. By optimizing the design and operating parameters of equipment for remote control of tissue temperature is conducting research on thermal simulator of human the problem could be addressed.

Purpose of the study was the development of thermal simulator of human for studying the basic thermo physical properties of the MP, SC and TSE.

The principle of carrying out the TFP assessment methodology experiments carried out was a semi natural laboratory research for layout samples. The choice of this technique was connected with its relatively high accuracy (compared to other similar methods), the presence of a large number of experimental data on samples with different layout TFP and the ability to use these data to predict performance in specific microclimatic conditions. [1]

It was established that material properties that are investigated depended on the microclimate in the environment. [2] In this context the test rig included micro-camera, in fact thermal simulator, a set of measuring devices and regulating devices.

Thermal simulator of human is a calorimetric chamber with built-in heating element that allows simulating the specific heat of man at rest and maintaining a thermal balance with the environment. Microclimatic camera provides automatic maintenance of air temperature and relative humidity and the possibility of regulating the speed of air movement and intensity of thermal radiation.

The main advantages of thermal simulator are:

- Ability to study heat transfer rights to use the clothes with desired properties and environment using various materials;
- Low cost research and ability to use automated procedures, materials research climate change etc.

III. Conclusion

Through the above research and testing set up terms of reference for the development and subsequent production of thermal simulator of human was performed. This device allows improving the choice of materials used in the manufacture of medical devices by extending the range of characteristics obtained after appropriate testing. In addition, the using of thermal simulator of human one can reduce the cost of testing in the process of entering a specific product on the market.

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The System Designed for Elderly Vital Signals Monitoring

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Keywords **– monitoring system, ECG, complex systems, Mealy and Moore automaton.**

I. Introduction

Recent advances in medical information technologies as well as technological advances in wireless networking, microelectronics, sensors, and the Internet allow us to change the way health care services are deployed and delivered [1]. Focus on prevention and early detection of disease or optimal maintenance of chronic conditions promise to augmented existing health care systems that are mostly structured and optimized for reacting to crisis and managing illness [2]. The development and adaptation for use in practice of new methods for evaluation of complexity was one of aim of this work. It is likely that early assessment of complexity changes will enable to start earlier usage of preventive means with intention to preclude the manifestation of various disorders in human organism. Another possibility for performing of preventive task could be estimation of values of individual physical activity. This prospective method designed for safety of elderly at home is a new diagnostic technology, and development of this technology is one of ITEA2 08018 GUARANTEE project goals [3].

II. Materials and Methods

The monitoring system consists of three levels: the lowest level encompasses a mobile patient recorder (MPR), the second level is the personal server, and the third level encompasses a network of remote server for medical experts. The MPR consists of intelligent sensors for simultaneously recording and wireless transmission of three ECG leads, three accelerometer signals, plethysmogram and oxygen saturation channel. The personal digital assistant (PDA) with consists real time data analysis software. The remote server is used for off-line data analysis software and data base.

The architecture of human monitoring and analysis system is presented in Figure 1.

Fig. 1. Architecture of system

The ECG analysis algorithm consists of complexes identification, parameters measurement and classification of ECG complexes. Requirements for long ECG recordings recognition algorithms are: adaptation to a wide QRS complex amplitude change, adaptation to a wide variation of RR intervals, adaptation to various signal quality, elimination of artifacts.

Decision-making about person functional state is performed by principles which are based on methodology of distributed intellect. First of all the on-line analysis of processes is made, and subject to its results more detailed analysis of person functional state are performed off-line by using multi-stage non-linear analysis methods and evaluation of complexity changes as measure of human organism status.

The criteria of ECG parameters for elderly functional state evaluation are rule based and depend on individual elderly vital signs values. The monitoring system makes a main decision about patient state changes from the calculated parameters by using convolution of Moore and Mealy automata. According to received analysis results the software forms warning signals (green, yellow, red) to patient. In case of appearances of dangerous situation for patient, the software sends the results of analysis to physician.

III. Results

The mobile patient recorder was tested by elderly volunteers. Algorithms were developed by Microsoft Visual Studio 2008 Professional Edition. The operating system was Windows Mobile 6.5. The experimental program was developed for algorithm verification and correction in Windows 32-bit environment using the Borland compiler.

IV. Conclusions

The presented work reflects three main results: developed hardware of monitoring system, proposed data analysis, with decision algorithms and developed software.

The developed hardware of monitoring system consists of intelligent sensors for synchronous acquisition and wireless transmission of three ECG leads, three axes accelerometer, plethysmography and oxygen saturation data channels.

The new feature of developed human data monitoring system is capability to analyse multi processes in some functional connections of investigated persons. Integrated assessment of person functional state is adapted for user requirements in individual level. If patient is in danger or needs external help, the data could be sent to medical service center.

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The Biotelemetry Lessons Innovation – Low Power RF

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Keywords **- Low power RF, Biotelemetry, CC1111**

I. INTRODUCTION

The subject biotelemetry is designed as a practical subject for students of bachelor's course. The number of hours is 1 hour lecture and two hours of practical exercises per week. In this course, students are acquainted with different methods of data transmission.

The course is divided into ten chapters, which correspond to the number of lectures per semester. The first four chapters focus on the history of telemetry, an introduction to biosignal measurements, biosignal measurement methods, types of biomedical sensors and standards for the modulation signal. The next chapter discusses the steps of the A / D conversion. Another part of the lecture is devoted to the basics of communication such as serial and parallel data transfer, synchronous and asynchronous data transmission, multiplex, taxonomy networks, network topology and the ISO-OSI model. Other chapters deal with specific technologies and standards for wired and wireless data transfer. Students learn about the standards RS232, parallel communications, USB, FireWire, Ethernet and GPIB. The wireless technologies are recited mainstream technologies such as Bluetooth, ZigBee, Wi-Fi, GSM and GPRS. Finally, students are familiarized with the possibilities of practical applications and systems, remote home care [2].

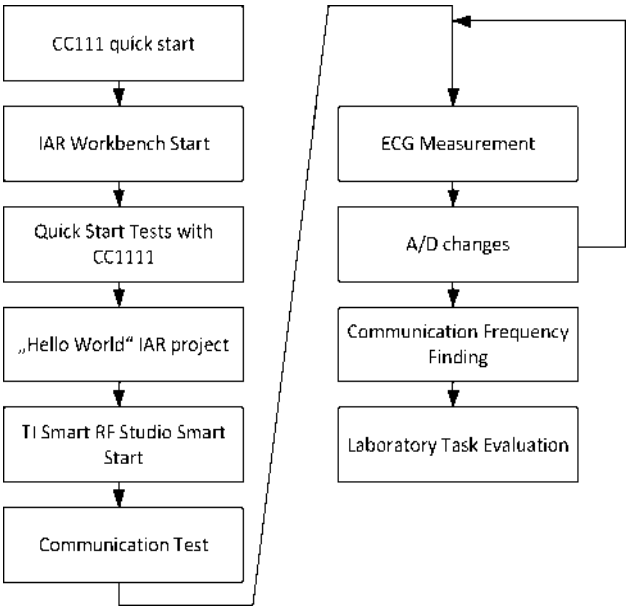
Practical laboratory tasks are an important part of the course since the beginning of teaching this course, dealing with types of signal modulation standards RS232, Bluetooth, ZigBee and wireless transmission of data on the ISM frequencies. Each of the jobs created by the connection uses wireless technology and medical devices or circuits for measurement of biological signals. All proposed and realized instrument is our laboratory of Biomedical Engineering. Most OEM modules are used for the measurement of biological signals such as temperature, blood pressure, ECG and plethysmography. They are also used for basic electrical wiring for example, ECG measurements, which were conducted in our laboratory. Wireless communication is realized by commercial wireless modules that can be built into industrial products. On the receiving side (PC) is used the board that students can see real hardware. Although each exercise is focused on other issues, there is a link between exercises within the meaning of the measured and the type of data transmitted - biosignals. Student can identify differences between similar technologies, their range and power consumption. Used equipment is designed for students to understand and secure, but also to resist their unqualified interference [1].

II. LABORATORY TASKS

A set of development modules and development kits CC111x with CC1111 for the purposes of laboratory tasks were purchased. In addition, a laboratory for the realization of the role of biological signal simulator was purchased, a source of test signals in the measurement of biological chain.

The bioamplifier circuit was designed and implemented, which allows one lead ECG measurement. Bioamplifier is built on Texas Instruments INA126 and OPA2335. Its properties are sufficient to fully purpose laboratory tasks. Supply voltage is 3V, the low drop over stabilizer. The measured signal voltage levels are 0-3V, which can be easily digitized CC1111 modules.

The whole scheme of laboratory task is displayed below.



I.

III. CONCLUSION

Although the Biotelemetry lessons are optional part of the study plan, it passes the standard 70% of students in the year of the field of biomedical techniques. The course also is taken by students of other disciplines, which is offered in this subject since the teachers can offer subjects. Innovation content of the subject is still relevant by reflecting the developments in telecommunications technology and its application in biotelemetry data. The task of the laboratory is ready for being tested and reactions of students are really positive.

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Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
The 1st Congress of World Engineers and Riga Polytechnical Institute / RTU Alumni

Novel Wireless Hybrid Electrode for ECG/EEG Measurements

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***Keywords* – ECG, EEG, Hybrid Electrode, Body Sensor.**

I. INTRODUCTION

Nowadays conventional ECG/EEG recording technologies exploit ubiquitously disposable Ag/AgCl gel based electrodes and the quality of the measurement largely rely on direct, low ohmic contact between the sensor and the subject's skin. However, applying conductive pastes or gels, has been a serious barrier to deployment. In contrast to wet electrodes, non-contact capacitive electrodes do not require ohmic connection to the body since they couple to the electric fields of the body capacitively, requiring no skin preparation. The main obstacle for the non-contact electrodes that still remains is the large and highly varying skin-electrode coupling impedance, mainly capacitive. Capacitive biosensors can tolerate very small capacitances to the source, and hence are very susceptible to displacement or lift-off from the body. To solve this problem we have conducted research on novel biopotential electrodes which provide high quality biosignals while requiring no skin preparation, producing no skin irritation, and allowing comfortable wear for extended periods.

II. MATERIALS AND METHODS

A novel hybrid wireless electrode was developed, which enables through-hair ECG/EEG recording without any skin preparation. In contrast to conventional EEG electrode technology, which relies on a low impedance contact to the scalp, the proposed hybrid biopotential electrode use a combination of high impedance resistive and capacitive coupling to the scalp, innovative processing electronics to reduce pickup and susceptibility to common-mode signals and a wireless data transfer. The proposed hybrid electrode consists of a sensing element, an ultra-high input impedance buffer, a common-mode follower, high pass filter and amplifier circuits. The overall electrode design is based on the works previously presented by Chi et al. [1-2] and Valchinov et al. [3]. Each sensor consists of a small round standard PCB of the size of a 2 Euro coin with a 26mm diameter which acts as a physical substrate. The biopotentials are sensed through a set of tiny 'spikes', connected to the cooper fill on the PCB's bottom layer. Each of the sensor spikes is small enough to reach the skin through hair without trapping hair beneath. As the contact impedance between the scalp and each spike can be as high 10^7 Ω, the amplifier electronics is placed as close as possible to the electrode and is actively shielded with an outer ring around the base of the sensing spikes and with an inner PCB plane just above the sensing spikes and the outer ring in order to limit interference caused by the pickup of external signals. The first front-end op-amp is configured as a unity gain voltage buffer and provides only a signal conversion and no gain where the active shield is driven by a buffered version of the input signal.

III. RESULTS

During the preliminary ECG test measurements the electrode fixation was provided by a custom made elastic compression vest. Two electrodes were positioned on the upper right and the lower left side of the ribcage, corresponding to a standard Lead II torso placement. A third ground electrode was placed on the lower right side of the ribcage. The subject was a healthy 25 years old male. Experiments were performed in a standard electrical engineering lab full of electric equipment and intentionally placed desktop PC, LCD monitor and a power line cord at approximately half a meter from the subject. Different sets of ECG data records were obtain from the subject while standing, walking, running and jumping with the electrodes placed on top of the skin or over a T-shirt in order to evaluate the electrode susceptibility to motion artifacts and coupling impedance. In all ECG records obtained, the relevant signal features are clearly visible and no 50Hz noise is observed. As expected, the signal remains mostly undisturbed while the subject is standing or walking. There are certain motion artifacts in the case of running or jumping but the relevant ECG features are still clearly visible and the signal baseline is stable. No difference of the signal amplitude is observed despite the extremely high source impedances when recording through clothing which theoretically might be expected to cause signal attenuation.

During the preliminary EEG test measurements the electrodes were attached to the scalp by means of custom made elastic headbands. Two sensors were placed on the forehead (Fp2) and on the back (O2) over the hair. The subject was sitting and asked to close his eyes and relax. Alpha wave activity is clearly seen in the time-frequency plot, as expected for awake, relaxed subject.

IV. CONCLUSION

The preliminary tests showed that by combining an innovative PCB, circuit and system design and a wireless data transfer, it is possible to obtain signals on top of the skin and through clothing or hair, suitable for medical-grade ECG/EEG applications. The proposed hybrid wireless electrode proofed to tolerate coupling impedance up to several hundred mega-ohms relatively insusceptible to its variation. The excellent interference rejection, motion artifact reduction and low profile makes the proposed electrode highly suitable for integration in wearable chest harness, cap or headbands and a potential solution for future mobile health applications.

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Development of New Mobile Telemedicine Screening Complex

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Keywords **– Telemedicine, health care, mobile, screening, diagnostics, e-health.**

I. Introduction

Public health is one of key priorities of any European Union country, including Latvia. This means not only high quality and high levels of treatment of diseases, but also the timely diagnosis and prevention. An important role here is regular preventive examinations that can be taken by the family doctor, if he is provided with the necessary medical technologies. Currently investigations and analysis are usually carried out by health care institutions, because only in very rare cases, family doctor has the necessary diagnostic equipment and skills of evaluation of the information obtained in the investigations. Often the tests are carried out at different times and in institutions, which may be located a considerable distance from the residence of the person under investigation. Thus additional time and resources of the patient and the employer's is being spent time on the way to examination centers and waiting for the results as well as for re-appointment with the doctor's for collection and assessment.

II. The Aim of the Project

To solve the above-defined problem, it is necessary to develop a new mobile telemedicine screening complex with analysis and advice center software, which will eliminate the existing system deficiencies and will be substantially better than the existing systems.

System overall schematic and information flow is shown below in Fig.1.

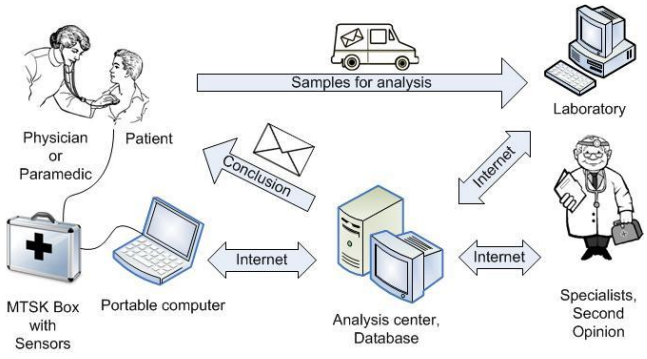

Fig.1 MTSK overall schematic and information flow.

III. Research to be Carried Out in the Project

For development of mobile telemedicine screening complex hardware and software the technical solution must be found for registration of at least 6 subsequent physiological parameters:

- Electrocardiogram (ECG);
- Spirometry (Spiro);
- Pulse oximetry (SpO2);
- Blood pressure, registration using non invasive method (NIBP);
- Digital thermometry (contact or contactless measurement of body temperature);
- Digital phonendoscopy (heart and lung-tone registration);

Industrial research of MTSK modules is based on team previous experience in local and international projects [2, 6].

In addition to mentioned above extended research needs to be done to include new features in MTSK:

- Methodology and the optimal solution for computer based vision and hearing test, including hardware.
- Development of new anthropometric data recording system.
- Exploring the possibility of setting up simplified strip express analysis module.
- Analysis of the feasibility of adding dermascope module.
- Fat-muscle ratio measurement method development by means of complex impedance measurement method or another.
- Study for MTSK interactive diagnostic questionnaire design.

IV. Results

MTSK Module research and development and experimental design is generally finished and includes modular design in level of tested schematics to record ECG, spirometry, audiometry, NiBP and SpO2. This research includes also wireless data transmission options and methods to provide data integrity and safety.

Research work is not finished and presented here are only preliminary results up to day. The results of research when finished and system pilot sample may be used to develop industrial model of MTSK. In this case new product will be offered, being significantly advanced and more economical in use, compared to those currently in the market.

Quality of goods or services will improve because the study of MTSK development plans not only to increase the number of recorded parameters, but also increase the quality of usage. This is resulting from the research of new and innovative solutions and information obtained in the analysis and interpretation of the project.

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New Successful Assessment Method of Hearing Aid Fitting

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I. INTRODUCTION

Nabelek, Tucker, Letowski have proposed to use the level of background noise tolerated by a hearing impaired person during a conversation, the so-called Acceptable Noise Level (ANL) for prediction of successful use of a hearing aid [1,2].

II. MATERIALS AND METHODS

We used (ANL) values for direct evaluation of the quality of hearing aid adjustment. Measurements were made in free field; acoustic noise level in the experiment room was ≤ 30 dB SPL. The distance between the subject and the source of sound was 1m. A group of 30 students of electroradiology at the Medical University, Poznan, aged 22 to 28, including 6 males and 24 females of audiologically normal sense of hearing were asked to take part in the study. They used two different hearing aids, binaural fitting. They were supposed to help establish the level of background noise disturbing the intelligibility of speech at the level of 50% and 80% [3]. The loudspeaker was emitting a list of words at the level of 65dBSPL together with the speech-resembling noise. The level of the speech-resembling noise was increased up to the decrease in the speech intelligibility to 50% or 80%. The results are shown in Figures and Tables.

III.RESULTS

One of the parameters directly describing the successful fitting [quality of hearing aid fitting] of hearing aids commonly used hitherto has been the gain in speech intelligibility (≥ 20%) in free field obtained as a result of hearing aiduse. Experimental study has shown that the gain of ≥ 20% is attained for Δ(ANL) greater or equal 2 dB. The values of ANLX% [dB], determined at the speech intelligibility level X% reveal great interpersonal differenced of the order of 16 dB for X=50% and 21 dB for X= 80%.

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The Signature of Addiction. Graphomotor Analysis of Psychomotor Performance in Heroin Users Undergoing Substitution Treatment with Methadone

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***Keywords* – heroin addiction, cortico-subcortical control loops, methadone, graphomotor signal analysis, psychomotor performance.**

I. Introduction

Heroin (diacetylmorphine) is a very harmful and extremely addictive psychoactive substance, an opiate analgesic derivative of the opium poppy. Using heroin leads to changes in the brain's neurotransmitter balance (dopaminergic signalling), and hence impairment in proper brain functioning, mainly affecting the subcortical parts of the forebrain – the striatum and the basal ganglia. This causes deterioration of psychomotor abilities, observable at the behavioural level. The striatum plays a role of a relay station forwarding information from the cerebral cortex into the basal ganglia –a group of subcortical nuclei involved in motor, cognitive and emotional control. Subsequently, the information is fed back into the cortex via the thalamus. There are at least five such control loops linking the subcortical nuclei with cerebral cortex: motor, oculomotor, dorsolateral prefrontal, lateral orbitofrontal and limbic. Any disfunction of these loops, as observed in several psychiatric disorders, as well as in psychoactive substance addiction, results in emotional, motor and cognitive impairment [1].

II. Matherials and methods

These impairments can be measured with psychomotor tests, such as the Trial Making Test part A and B, or simple graphomotor tasks, like the Digitalized drawing test (DDT) [2] or giving one's signature. These test were implemented on a graphic tablet compatible with a computer, where the data were collected with the MedTablet software and analysed. This method allows for quantitative and objective measurement of the biophysical signal and assessment of the psychomotor abilities of the patients, such as visual motor coordination and procedural learning. Performance on these tests was assessed in a group of heroin addicts (N=9) undergoing a substitution therapy with methadone (a synthetic opioid used for substitution treatment of opioid dependency), and a control group (N=10). Several parameters of the graphomotor signal were analysed for each test for every subject, namely: 1) mean velocity [MV], 2) mean momentary speed [MMS], 3) standard deviation (SD) of momentary speed [SDMS], 4) maximum momentary speed [MaxMS] 5) time of drawing [ToD], 6) length of drawing [LoD], 7) mean pressure applied [MPA], 8) (SD) of pressure applied [SDPA]. Differences in performance were assessed a) between the experimental and control groups, and b) among the experimental group before and 1 hour after administration of methadone (control: 1h break) performing 1-talied t-tests. Correlations between the graphomotor parameters changes and demographic information were investigated. Additionally, changes in the Fast Fourier Transform (FFT) frequency spectra of 1) deviation from the pattern and 2) momentary speed of the signal obtained before and 1h after methadone/break were analysed (range: 1-16 Hz).

III. Results and discussion

Statistical analysis of the graphomotor signal revealed lower MV, MMS and SDMS, and longer ToD for the experimental group as compared to control in TMT part A and B (before and after methadone), while the opposite effect was found in DDT and signature (before methadone only). This suggest impaired psychomotor performance on TMT tests (uniformly slower with more difficulties; additionally supported by lower MaxMS) and less accurate, faster completion of the DDT and signature (in the latter also higher MPA). Administration of methadone affected performance on DDT, leading to an increase of MaxMS, LoD and ToD (trend: 0,06). All findings were significant at $p<0,05$.

Correlation analysis revealed an association between the MPA and the 'addiction coefficient' (addiction period divided by the subject's age) ($\rho= 0,84$). Inverse correspondence was found between MPA and the size of the methadone dose, as well as MaxMS and the 'addiction coefficient' ($\rho= -0,77$ and $\rho= -0,72$, respectively).

Percentage changes of the mean spectral values for each frequency of the FFT signal, and of the initial total power (before methadone/break) (Fig. 2) were calculated. Generally, the whole spectrum, as well as single spectral bands increased in power in the experimental group, especially in the high-frequency part of the spectrum, suggesting more diverse, sharper drawing after methadone administration. The opposite was observed for the control group, indicating more stable performance upon repeated testing (in agreement with previous suggestions of procedural learning).

IV. Conclusions

The results found point at several differences in the psychomotor performance between the heroin users and the control group. Likewise, administration of methadone to heroin users seems to affect their psychomotor performance. As the study has a preliminary character, the results need to be replicated on a larger sample size. However, these findings look promising with respect to possible applications of the graphomotor signal analysis as a method for assessing the psychomotor changes in psychoactive substance abuse, as well as a tool for investigating the outcome of treatment of addiction. Thanks to this method, performance on the psychomotor tests may now be objectively and quantitatively measured.

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Dry Residual Urine IR Absorption Spectra

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Keywords **– IR spectroscopy; hybrid structures; absorption spectra; biocomplexes**

I. Introduction

IR spectroscopy is promising method in terms of nephrolithiasis diagnosing. Since the absorption spectrum of the sample is a superposition of spectra of its components, even the spectra of very complex mixtures (or systems) can be used for both qualitative and quantitative analysis for the studied sample. In comparison with other methods of IR spectroscopy in clinical trials has several advantages. First of all, one IR spectrum can be defined not only one pathological deviation from normal body systems. Presented method requires no additional chemicals, which reduces the cost of diagnosis.

II. Results and Discussion

In this paper are studied the IR absorption spectra of urea -, dry urine residue without deviation from the norm (II) and the presence of urate (III), phosphate (IV) and oxalate (V) salts.
Since urea is included to samples I, II, III, IV, V, there is logical to assume that some selected bands are caused by vibration transitions exactly in urea.

It is known that the urea molecule forms a resonance hybrid structures a, b, c (Fig. 1).

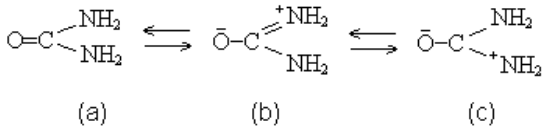

Fig. 1. The resonance structure of urea.

This resonant interaction leads to partial delocalization unshared electron pairs of nitrogen atoms and π-polarization of the carbonyl group C = O.

In the case of coordination through the nitrogen atom the contribution of (b) and (c) structures decreases, and this leads to frequency increasing of v stretching vibrations of C = O and reduce the frequency of oscillation C–N, and according to the bands shift of stretching vibrations of CN in the region of lower energies. In the case of cation adjunction through the oxygen atom, the contribution of structure (a) is reducing. The weakening of the C = O bond leads to a decrease in the frequency of stretching vibrations of C = O, but could not lead to significant changes in the frequency of stretching vibrations of NH.

In the case of urine without deviation from the norm and in the presence of pathological salts is fixed the shift of stretching vibrations of C = 0 in the low energy region relative to their vibration in pure urea. This suggests that the adjunction of cations to urea is going through the oxygen atom. This agrees well with the structural data of research linking urea. As studied in this paper of 26 crystal structures of urea adduct found in all the studied complexes cations are bond with oxygen. The bands of symmetric and asymmetric N-H stretching vibration shifted to high-frequency region in comparison with bands of pure urea, this shift can be explained by the breaking of hydrogen bonds connect molecules in pathological salt to urea. The possibility of acceding to the cations must be rejected through the amino group of urea, as in this case, these bands were subjected to shear in the low-frequency region.

Also in the spectra of infrared absorption dried urine residue are the following bands:
– urine without irregularities – 924 cm^{-1}, 871 cm^{-1}, 621 cm^{-1};
– urine with the presence of oxalate salts – 941 cm^{-1}, 886 cm^{-1}, 654 cm^{-1}, 547 cm^{-1};
– urine with the presence of phosphate salts – 969 cm^{-1}, 880 cm^{-1}, 631 cm^{-1};
– urine with the presence of urate salts – 874 cm^{-1}, 755 cm^{-1}, 653 cm^{-1}, 615 cm^{-1}, 582 cm^{-1}.

In cases of oxaluria in urine are observed enhanced oxalate concentrations, which are binding to calcium ions, forming two types of salt – and vevelit vedelit. Typically in renal calculus are found both types in varying proportions. According to selected bands – 941 cm^{-1}, 886 cm^{-1}, 654 cm^{-1}, 547 cm^{-1} are characteristic of calcium oxalate renal calculus. According to band with frequency 880 cm^{-1} can be identified as a combination of symmetric vibrations of C = O and deformation vibrations of the fragment O–C=O ($(\nu_s(C=O) \oplus \delta(O-C=O))$. Band with a frequency of 654 cm^{-1} attributed to a combination of stretching vibrations of the CaO fragment and stretching vibration of C-C ($\nu(CaO) \oplus \nu(C-C)$).

Accounting that oxalates is the final metabolic product, so they are present in urine without deviation from the norm, the band – 1262 cm^{-1}, 924 cm^{-1}, 871 cm^{-1}, 621 cm^{-1} - can be associated it is with oxalate. Shifted bands observed in may be caused by the interaction of oxalate with urea at which weakens the C = O and C–C bonds.

In disease of phosphaturia elevated levels of phosphates are observed in urine, which in its turn must occur in IR absorption spectra. For calcium phosphate stones is typical the presence of the band 870 cm^{-1} (indicating the presence of HP_4^{2}-group) and 1460 cm^{-1}, 1420 cm^{-1} and 875 cm^{-1} (indicating the presence of CO_3^{2}-group). Also by for phosphate stones are characteristic band at the 950 cm^{-1}. So bands allocated in the absorption spectra of dry residual urine in the presence of phosphate stones – 969 cm^{-1}, 880 cm^{-1}, 631 cm^{-1} – may be caused by stretching transitions in phosphates. In particular, the band 880 cm^{-1} can be identified as the deformation vibrations of P=O–H ($\delta(P=O–H)$).

Absorption bands with maxima at 2222, 2332 and 2643 cm^{-1}, which are not characterized separately for urea and CaO_x can be identified as a combination of vibrations of urea molecules (stretching vibration ν(C=O) with a frequency of 1680 cm^{-1}) and molecules CaO_x (frequencies 948, 649 and 548 cm^{-1}).

Saccadometry as a Novel Tool in Neuropsychiatric and Neuropsychological Assessment

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***Keywords* – saccadometry, neuropsychiatry, neuropsychology, assessment, eye movement**

I. Introduction

Over the period of 6 years of research of using saccadometry in medical diagnostics approximately 1,000 people have been tested. It is the largest study of the saccadic fixation measurement in neuropsychiatry performed in Poland.

II. Research

The research was carried out by the interdisciplinary scientific team in different clinical sites in Poland. Patients with neurodegenerative diseases i.e. Alzheimer's (AD) and Parkinson's disease (PD), psychiatric illness such as schizophrenia, depression and behavioral disorders e.g. ADHD/HKD, alcohol and opiates dependence have been examined. The psychopharmacological studies evaluated the effect of different psychoactive substances (eg. caffeine, methadone, morphine, alcohol) influencing the saccadic parameters. Various experimental protocols and measurement paradigms (gap & overlap tasks, antisaccade task, memory-guided saccade task, and predictive saccade task) were used. Saccadic parameters such as latency to initiate the saccade (RT), variability of saccadic RTs, gain (saccade amplitude/ target amplitude), duration, peak velocity & average velocity, slope, sharpness, Q (average peak velocity to average velocity ratio), and amplitude of the saccades were analyzed. Additionally the numbers of saccades per second, saccadic time to fixation time ratio, average fixation time, and average fixation amplitude were investigated.

III. Conclusions

To conclude, the measurement of saccadic refixation allows differentiation of alcohol-dependent subjects, AD, PD, ADHD /HKD subjects from healthy subjects and can be helpful as diagnostic tool. An important and innovative approach in this study in comparison to studies of other authors, who obtained similar results, is the use of selfcalibrating system adapted for clinical use, as well as quantitative analysis of the saccadic parameters. The applied measurement procedure is simple. The preparation of the system and measurement time do not exceed 30 minutes. The system can be used in both in- and outpatients settings by a trained psychologist or psychiatrist. Detailed knowledge of laboratory procedures is not required. Quantitative analysis of the individual saccadic parameters is a promising solution.

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The differential Oscillometric Method Can be Used for Recording Beat-to-beat Arterial Pressure Patterns from Radial Arteries

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Keywords **– Oscillometric beat-to-beat blood pressure, continuous noninvasive mean arterial pressure, vasoconstriction.**

I. Introduction

An application of the oscillometric method for beat-to-beat finger MAP measurement was reported in [1]. However, we did not find data in the literature on the use of the differential oscillometric method to measure beat-to-beat MAP profiles from radial arteries.

This study presents preliminary results of an experimental application of the differential oscillometric technique to record beat-to-beat MAP from radial arteries.

II. Methods and Materials

A. Experimental design and protocol

Continuous noninvasive recording of three variables was performed: finger beat-to-beat mean arterial pressure (MAPfin), radial beat-to-beat mean arterial pressure (MAPrad) and fingertip skin blood flow by laser Doppler flowmetry (LDF). The experiment contained three different physiological conditions: rest, light physical exercise and local cooling.

B. Signal processing and data analysis

The analog signals from the finger and radial MAP monitors as well as from the laser Doppler flowmeter were digitized by an analog-to-digital converter (16-bit accuracy, sampling rate 200 Hz) and transferred to the computer.

Similarity between the MAPrad and MAPfin patterns was assessed by observing them visually and by using Spearman's correlation analysis.

III. Results

The individual and group-averaged characteristics of correlation between MAPrad and MAPfin are listed in Table 1 (f.v.). The median of the correlation coefficient (r) for the whole group was 0.92, range 0.86 to 0.98. Episodes with exercise, rest and local cooling showed median values of 0.91, 0.93 and 0.87, respectively. All the individual correlation coefficients were highly significant ($p<0.005$).

Fig. 5 demonstrates differences between MAPrad and MAPfin in one subject who had an intensive vasoconstriction during local cooling.

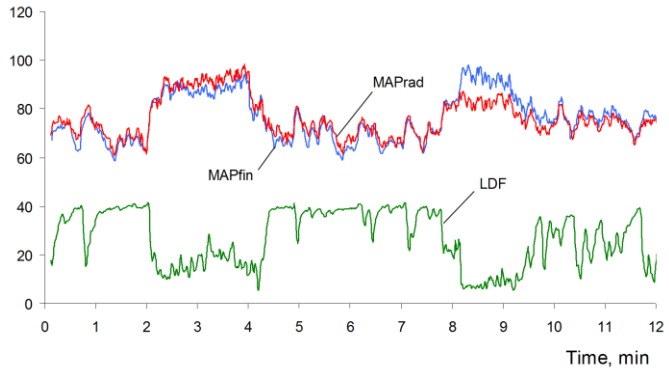

Fig. 5 Original beat-to-beat recording in Subject 1 demonstrating the influence of an intensive vasoconstriction during local cooling. Pressure signals are given in mmHg, the laser Doppler signal is in arbitrary units (au)

IV. Discussion

The study demonstrated that the measured radial beat-to-beat MAP recordings had a high similarity to related finger MAP recordings. MAPrad revealed responses in the same direction as MAPfin and almost any change in MAPfin was also seen in MAPrad. A little lower correlation was noticed for exercise and local cooling compared to the resting condition. However, this difference did not reach the level of statistical significance.

In a typical recording (Fig.3; f.v.) time series of finger and radial MAP were in good agreement with each other throughout all the stages of the experiment (r=0.96).

We suppose that a noticeable difference between the radial and finger MAP levels in Subject 7 (Fig. 4; f.v.) was caused by our little experience in radial cuff handling. In further measurements, it is reasonable to use palpation while keeping in mind that the optimum measurement point is usually located at the very distal end of the radial bone [2].

Subject 1 had a very intensive vasoconstriction during local cooling and, as a result, the MAPfin signal showed an inadequate response: the MAPfin signal was even higher than that of MAPrad (Fig. 5). The possible explanation is that the oscillometry was affected by the change of the pressure-volume relationship as shown in previous theoretical studies [3].

V. Conclusions

The study demonstrated the possibility of using the differential oscillometric technique to record beat-to-beat MAP from radial arteries. However, attention should be paid to the proper compression of the radial artery to avoid overestimation.

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Revealing Small Hidden Changes in Human EEG by Higuchi's Fractal Dimension

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Keywords **– EEG, EMF, Higuchi's fractal dimension.**

I. Introduction

During last decades understanding the brain activity has became a topic of major interest. As EEG reflects the ongoing activity, it is a valuable method getting objective information about changes in brain physiology. It is believed that EEG exhibits also complex behavior. Therefore the nonlinear measures can be a good alternative to more frequently applied linear methods.

As the effect of exposure to microwave radiation is extremely difficult to detect, the periodic exposure to microwave radiation is used in this study to influence human EEG. The aim of the work is to detect as small changes in EEG as possible by using two different modulation frequencies.

II. Materials and Methods

Subjects - a group of healthy volunteers consisting of 15 young persons (aged 21–24). The subjects were lying in a relaxed position, eyes closed. All subjects passed two recording protocols with microwave exposure and sham.

Exposure - The 450-MHz electromagnetic radiation was 100% pulse-modulated at 40 or 70-Hz frequency. 13-cm quarter-wave antenna was located close to the ear 10 cm from the skin on the left side of the head. The average field power density of the modulated microwave at the skin from the left side of the head was 0.16 mW/cm^2. The calculated spatial peak SAR averaged over 1 g has its maximum 0.303 W/kg.

Recording protocol - The protocol with exposure lasted 40 min. For every even minute of the recording the subject was exposed to microwave at modulation frequency 40 or 70 Hz. The pair of successive reference minute followed by exposed minute was an exposure cycle. Sham recording session used the same protocol, except that the microwave power was switched off.

Equipment - Cadwell Easy II EEG measurement equipment was used for the EEG recordings. The channels P3-P4 were chosen for analysis with the reference electrode Cz. The EEG signals were stored in 0.5–38 Hz frequency band at an 80-Hz sampling frequency.

EEG analysis - Higuchi's algorithm calculates fractal dimension (FD) of time series directly in the time domain [1]. It is based on a measure of length L(k) of the curve that represents the considered time series while using a segment of k samples as a unit. FD was calculated in 400 samples (5 s) window, and the window was shifted by 40 samples (0.5 s) with parameter k_{max}=8. As it was previously found, the electromagnetic field (EMF) effects appear mainly during the first 30 seconds of the segment [2]. Therefore the HFD was calculated for every first 30 seconds, giving 111 FD values for every microwave exposure half period and for every reference half-period.

Averaging over ten exposure cycles was performed.

III. Results and Discussion

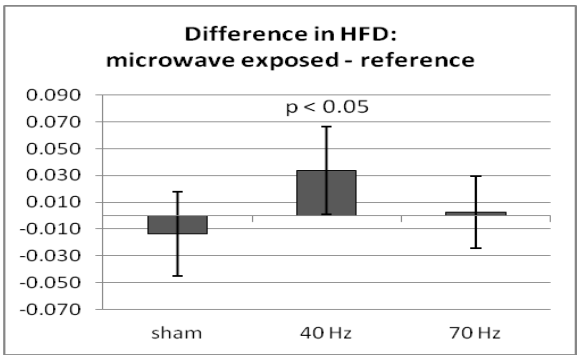

Fig. 2 Average difference in Higuchi's FD between microwave exposed half periods and reference half-periods: sham recordings, recordings at modulation frequency 40 Hz and recordings at modulation frequency 70 Hz.

As can be seen from Fig.2, the FD difference is negative for sham recordings. As there was no exposure, this indicates the normal behavior of Higuchi's FD in time. The statistically significant positive difference in FD can be seen at modulation frequency 40 Hz. This indicates that the FD is higher for microwave exposed segments compared to reference segments. Therefore, exposure leads to more complicated character of neuronal oscillations compared to resting conditions. The statistically insignificant difference between exposed and reference segments is close to zero at modulation frequency 70 Hz. Being insignificant, it can still indicate a trend of changes by keeping the subjects alertness at almost constant level in contrast to sham situation in case the FD was reduced.

The results indicate that the Higuchi's fractal dimension can discriminate the effect at 40 Hz modulation frequency. However, while increasing the modulation frequency to 70 Hz, no statistically significant effect was detected. Consequently, the Higuchi's fractal dimension was not able to detect trends of microwave effects on a group level at the higher modulation frequency where the linear method also failed. The results support the previous findings that the microwave effect depends on the modulation frequency. More specific algorithms are needed for discriminations of trends in further investigations.

IV. Acknowledgement

The research has been supported by the Estonian targeted financing project SF0140027s07 and by the European Union through the European Regional Development Fund.

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The Assessment of Saccadic Refixations Velocity in Opioid-addicted Subjects with the Use of Saccadometer Diagnostic System

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***Keywords* – Saccadometer diagnostic system, eyeball movements, opioid, addiction, methadone**

I. INTRODUCTION

This study aims to assess the velocity of eyeball movements (saccades) measured by Saccadometer diagnostic system in opioid-addicted subjects treated with methadone. The system allows performing strictly quantitative evaluation of saccadic dynamics measuring eye movement in the near infrared technology (Infra-Red Oculography). The voltage signal generated by eye movement sensor is converted into digital form in the shape of 12-bit samples at a frequency of 1 *kHz*, and then differentiated into the velocity signal of eye movement. Saccades are detected after exceeding the detection threshold of 5*deg/s* [1, 2, 3].

II. MATERIALS AND METHODS

Sixty eight patients (32 women, 45 men, mean age 39±7,7 years) from the substitution program were examined. In the research the effects of deep brain stimulation, carried out in order to change the saccadic parameters, have been analyzed. The psychopharmacological studies have investigated the effect of different psychoactive substances (e.g. methadone) on the saccadic parameters. The neural structures that control saccades comprise nearly every level of the brain. Thus neurological and physiological disorders have a variety of effects on the saccadic parameters. These effects may be divided into two types: saccadic velocity and saccadic latency [1, 3].

The saccadic refixations test - Letency test (LT) was conducted twice: before the administration, and about 1,5 hours after the administration of a therapeutic dose of methadone (mean daily dose of methadone: 71,9±(33,4)*mg*). In both parts of the test saccadic velocity was measured, which is perceived as the difference in time between the beginning of a saccadic movement and the drop in the velocity of eye movement below 5*deg/s*. The lower levels of the saccadic system – the brainstem, the motor neurons and their axons, endplates, and the muscles themselves – determine the saccadic time-course. Saccades are stereotyped movements, and saccadic velocity is notably constant under physiological conditions across all humans at a given age, comparable for instance to the constancy of core body temperature at 37°C. The movements are highly and specifically responsive to all kinds of disturbances when motor commands to the contractile muscular fibres are generated and delivered. Saccadic velocity is therefore the most sensitive indicator of even slight disturbances within the neuromuscular system [1].

III. RESULTS AND DISCUSSION

It was found that the average latency time before methadone administration is 204,2±(64,2)*ms*, whereas after the administration of a therapeutic dose of methadone average latency time is 207,8±(58,9)*ms*. There was a statistically significant difference in the average velocity of saccades (p=0,03) after the administration of a therapeutic dose of methadone. The results were verified by Student's t test for dependent samples (t=2,24).

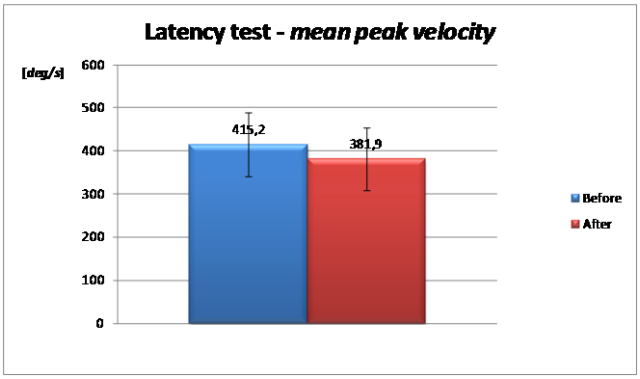

Fig. 1. The comparison of mean peak velocity of Latency test before and after the administration of methadone.

IV. CONCLUSIONS

The increase of saccadic refixations parameter values in opioid-addicted subjects after the administration of a therapeutic dose of methadone was observed. The statistical analysis revealed that the average saccadic velocity decreases significantly after methadone.

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Measurement of Changes in Skin Conductance Evoked by Musical Stimuli

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Keywords **– skin conductance, musical stimuli, autonomic nervous system**

I. Introduction

The relationship of music with emotions can be seen in almost all aspects of its use. Therefore, understanding the relationship between music and emotional reaction induced by it would create the possibility to use music as an effective stimulus for specific emotional states. Different properties of musical waveforms can cause different emotional response. A specific affective reaction may indicate the occurrence of certain characteristics of the listener's emotional state.

II. Aims

The aim of the study is to determine whether the tempo and intensity of sounds in music stimuli evoke skin conductance change. The observation of such similarities could indicate the existence of universal human patterns of affective response to specific features of sound. To determine the components of the music listener's emotional state in this study changes in the conductivity of skin were measured. The changes in skin conductance, showing activity of the autonomic nervous system, were treated as a marker of affective responses to musical stimuli.

III. Materials and methods

The study was conducted in 54 subjects. The age of the individuals was between 19-22 years. In the test eight different music waveforms were presented. During the presentation of musical stimuli electrical conductivity of skin was measured. It is assumed that the value of electrical conductivity (EC) is related to the autonomic nervous system activity while listening to musical stimuli.

IV. Results

The largest number of peaks were found when subjects were listening to a "mute" (*decrescendo*) musical stimulus, which significantly differed from the response to a "volume up" (*crescendo*), "acceleration and mute" (*accelerando & crescendo*) musical stimulus and the response to a part of the mass. The second one, in terms of the number of peaks, is a reaction to a *part of the mass*, which differs significantly from responses to the *basic theme*, "slowing down" (*diminuendo*), and "slowing down and mute" (*diminuendo & decrescendo*) musical stimuli. The stimulus which had the smallest number of peaks is the "slowing down" (*diminuendo*) stimulus and the *basic theme* stimulus. "Volume up" (*crescendo*) musical stimulus had a greater number of peaks compared to the number of peaks when listening to the *basic theme* and "slowing down" musical stimulus, but they were not significantly statistically different. The reaction to *the part of the mass* differed significantly from the response to the other stimuli such as: *diminuendo*, *decrescendo & diminuendo*, and the *basic theme*, which caused the least number of peaks. As for the number of peaks, one of the highest average amplitude is observed in response to *decrescendo*, which is significantly different from the responses to *diminuendo*, *diminuendo*, *decrescendo & diminuendo*. The highest average amplitude was found when listening to *a part of the mass*, which is not only statistically significantly different from the responses to *decrescendo & crescendo*. In contrast to the number of peaks the high levels of average amplitude of response were found for the *basic theme*. The highest value of decay of reaction was observed for *basic theme* and the second highest value of decay - for *accelerando*, but the difference between this reaction and the reaction to other music stimuli are not statistically significant. The third highest value of decay was found for *a part of the mass*. The higher was the value of the decay of reaction, the slower was the decay rate.

V. Conclusions

A clear response of the sympathetic nervous system to a certain musical stimulus does not mean that it is always related to emotions, or that it is a part of the conscious experience of subjects related to listening to these stimuli. Therefore, future studies should use the tools to identify the content of the subjects' experience when listening to stimuli.

Evaluation of Atrophic Edentulous Maxillary Alveolar Bone with Cone Beam Computed Tomography (CBCT) in Postmenopausal Women

Laura Neimane (RSU Institute of Stomatology), Andrejs Skagers *(RSU Institute of Stomatology)* and Anda Slaidina (*RSU Institute of Stomatology)*.

Keywords **– postmenopausal, bone density, osteoporosis, CBCT**

I. Introduction

The bone density detection in maxillofacial region is problematic [1,2]. There have been studies of osteoporosis signs found in dental panoramic tomography [3]. However, there is deficiency of studies when CBCT is used.

II.Materials and Methods

There were thirty one female patients included in this study. They were investigated with dual energy x-ray absorptiometry (DEXA) to measure bone density in peripheral bones and by the results of DEXA measurements patients were divided in to three groups: norm, osteopenic and osteoporosis group.

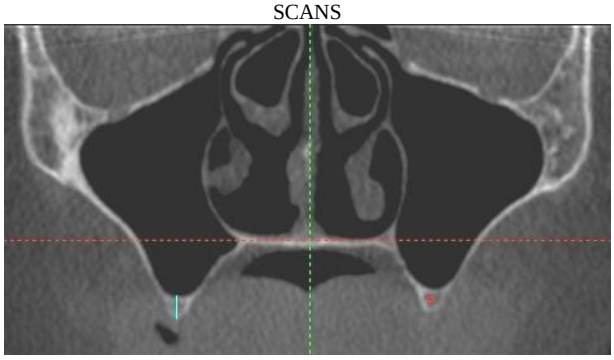
All patients were completely edentulous in the maxilla and they were examined with CBCT. Radiological examinations were done with I – CAT Next Generation (Imaging Science, USA). There was standardized protocol used for all patients: field of view 13 cm, 0.3 vox. The data were processed with I - CAT Exam Vision program.

The alveolar bone was measured in both sides of maxilla after reconstruction. The scans were similary reconstructed. The alveolar bone height (mm) and density (HU) was measured (Fig. 1). The density measurement field was 1 square milimiter.

The results were summarized with Microsoft Office Excel 2007 and statistically analyzed.

FIGURE I

Positioning and measuring of patient scans



III. Results

There were eleven (35%) patients in norm group, nine (30%) in osteopenic and 11 (35%) in osteoporotic group. The average age in norm group was 68.54 ± SD 10, osteopenic 74.22 ± SD 8.02 and osteoporotic 73.09 ± SD 7.14.

The alveolar bone heights in millimeters were measures in both sides of maxillary alveolar bone (Table 1).

TABLE I
The height of alveolar bone

	Right (mm)	Left (mm)
Norm group	**5.38 ± SD 3.72**	**4.71 ± SD 3.85**
Osteopenic group	**5.38 ± SD 3.10**	**6.49 ± SD 3.80**
Osteoporotic group	**6.50 ± SD 2.71**	**6.32 ± SD 2.85**

The alveolar bone density was measured in the same sites as height. The average bone density of all three groups is shown in Table 2.

TABLE II
The density measurements (HU)

	Right	Left
Norm group	**142.45 ± SD 224.78**	**200.73 ± SD 346.68**
Osteopenic group	**89.00 ± SD 185.42**	**130.22 ± SD 251.69**
Osteoporotic group	**38.55 ± SD 211.96**	**28.72 ± SD 116.92**

IV. Conclusions

In this study the bone heights between groups did not differ significantly. However, there were little bit higher scores for osteoporotic and osteopenic groups. The bone density is influenced by osteoporotic activity in the body. Osteoporosis more often is observed in female patients in postmenopausal age. It is accepted that osteoporosis is systemic condition which is characterized by loss of bone mass and mineral density and increased risk of bone fracture. The CBCT scans are commonly performed before dental implantation. The individual anatomical variation and amount of the bone can be seen. In this study there were no statistically significant difference found between groups in bone density measurements. However, there was a positive tendency, supporting DEXA results that osteoporotic group had lowest mean value and norm group highest.

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Spectral Imaging Used in Determining the Age of Bruises Depending on the Bilirubin Concentration

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***Keywords* – Bilirubin, bruises, mapping of distribution of skin chromophores spectral imaging.**

I. Introduction

Nowadays one of the most important aspects in medicine is fast and non-invasive diagnostics. Optical methods, including spectral imaging are one of them. The aim of this research is to determine bilirubin concentration difference, estimate it to define when exactly the bruise was made or how old it is. [1]

II. Materials and Methods

RGB imaging device was used as a simple multispectral camera for image acquisition. Bilirubin concentration distribution maps were obtained from R, G, B image cube. Bilirubin absorbtion is in the Blue (B), channel and the Red (R) channel can be used as a reference, because both: bilirubin and blood absorbtion is close to the minimum. The Green (G) channel can be used for correction to exclude the blood absorbtion. MatLab program was used for data processing.

The acquired data gives a great investment in bilirubin concentration statistical estimation, taking into account that more than 250 images of bruises were taken and analyzed of different persons in various parts of the body where the properties of bruising differ. [2]

III. Results

Figure 1 shows a simple example of the development of bruise observed, the pictures have been analyzed and the bilirubin concentration assessed. The results show that mostly the bilirubin reaches its maximum peak on day 8 depending on a bruising place (how close to the bone), and then vanishes within ~10 days.

IV. Conclusions and Recommendations

This research mainly will benefit legal medicine expertise field where currently in Latvia the only non-invasive method for bruise assessment is the visual assessment method. The spectral range wavelength from 470 to 640 nm can be used can be used in mapping the skin chromophore bilirubin.

This simple method can be used to estimate the concentration of bilirubin in bruising of human skin after the accident.

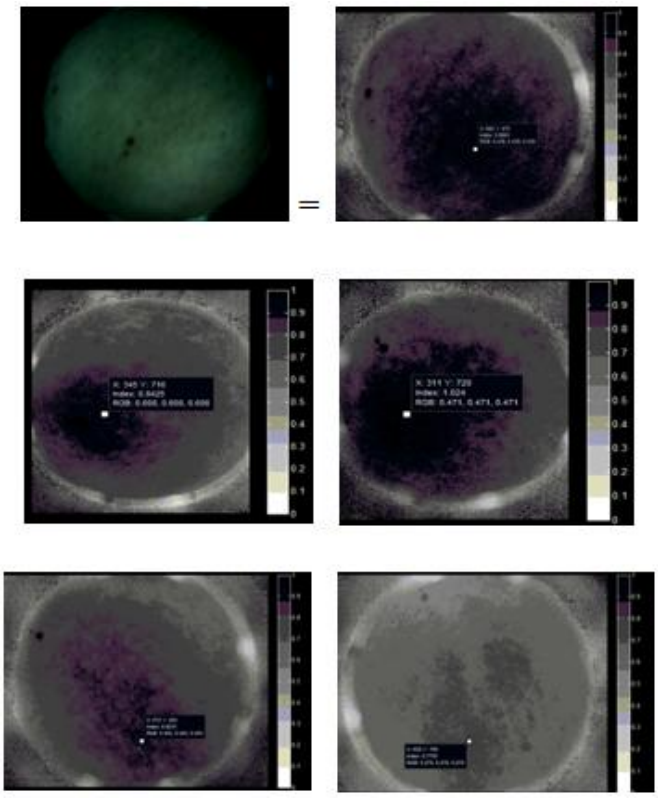

Fig. 1. Bilirubin concentration difference in time

From the left side: Color photo; Maps of 3, 5, 8, 10 and 14 days after accident

Bruise on left leg, female 27 years old, II skin type

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A Surface Smoothing Method for a 3D Model of a Medical Object

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***Keywords* – smoothing algorithm, medical object, visualization.**

I. Introduction

The 3D visualization of a medical object is an important aspect of medical image analysis and research. Analysis and visualization of different medical images, which were obtained by computer tomography (CT) or magnetic resonance imaging (MRI), is important to medical research and clinical practice. The ability to visualize the orientation, position, size of structures in medical images can be vital to researchers and physicians. In relation to this, a necessity to solve the task of 3D visualization of the region of interest emerges in computer diagnostics.

Although there are methods that allow segmentation and visualization of the medical image [1][2], the existing approaches of 3D visualization are not always able to provide a high-quality smooth surface of the 3D model. The resulting 3D models have a distinct aliasing effect.

II. Proposed method

The surface of a 3D model is usually described by vertices that are joined into triangles. The basic principle of the smoothing algorithm is to adjust the position of these vertices to even out the sharp edges that might appear between the triangles.

The proposed method works by sequentially taking every vertex in the 3D model and finding all the vertices that are connected to this vertex. Then a new vertex is determined, which is located exactly in middle of all the vertices that are connected to the original vertex. Finally a new 3D model is created by using all the newly generated vertices, while preserving the connections between the original vertices.

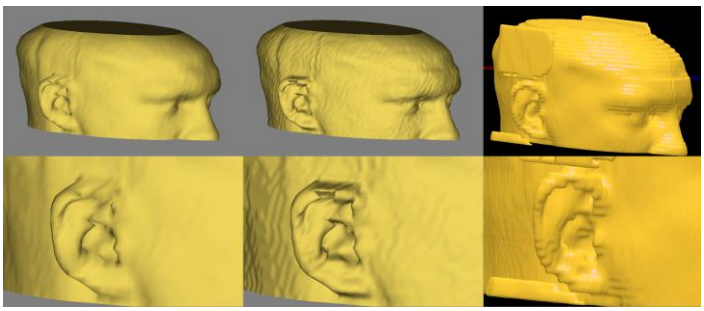

Fig. 1 Comparison of different models. Left - Triangulation (polygonal) model, middle – proposed method, right - 3D Doctor.

III. Experiments

The proposed method was tested on a real medical object. The object in the experiment was a model of a human head fragment, which was created from an array of 31 medical images, acquired with the computer tomography.

The result of the proposed method was compared with the original 3d model, which was created using the triangulation algorithm and a model created by the 3D imaging software 3D-Doctor [3]. Figure 1 illustrates the comparison of various models.

IV. Conclusions

This paper proposes a method to smoothen the surface of a medical objects 3D model.

The proposed method shows considerable visual improvement when used on the model created with the triangulation algorithm or the marching cubes algorithm. The proposed method was also compared with the 3D imaging software 3D-Doctor and it gave a better visual result. The surface of the model is smoother without an aliasing effect. Overall, the proposed smoothing method shows stable results in visualization and may be implemented in medical software to provide better 3D visual quality of the reconstructed medical object.

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Digital Breast Tomosynthesis with Monochromatic Beam for Low Contrast Features

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***Keywords* – tomosynthesis, synchrotron radiation, multiple projection algorithm, reconstruction, acquisition parameters**

I. Introduction

Digital Tomosynthesis (DTS) is a tomographic technique, which permits acquisition of a limited number of projections over a limited angular range. The 2D projections acquired at the detector can then provide 3D information of the imaged object [1]. Reconstruction algorithms as well as the acquisition arc and the number of projections per arc are critical for the quality of reconstructed slices. This study aims to investigate the effect of these parameters on the image quality of tomosynthetic slices containing low contrast features such as masses, obtained from several acquisition sets with synchrotron radiation.

II. Materials and Methods

Initially, a software version of the CIRS model 011A breast phantom (manufactured by Computerized Imaging Reference Systems, Inc., Norfolk, VA) was designed with the phantom modelling module of the XRayImagingSimulator [2]. It is a tissue-equivalent breast phantom with homogenous background containing masses of gradually increasing dimensions and was used to find the optimal number of projections for acquisition arcs varying from 20° to 60° degrees. Experimental studies were then performed based on the optimal combinations of these two parameters for five arc lengths shown in Table 1.

TABLE I

Acquisition geometry

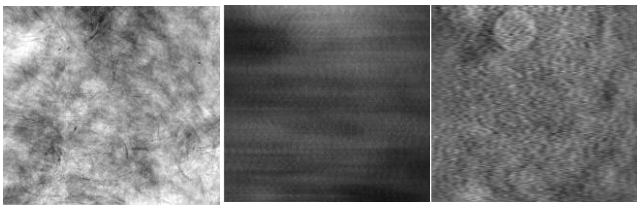
Acquisition arc	24°	32°	40°	48°	56°
Number of projection	7	9	11	13	15

The experiments were performed at the SYRMEP beamline at ELETTRA Synchrotron facilities, using a complex breast phantom named MAMMAX, with heterogeneous background containing four masses of 6mm. For all acquisition schemes, the mean glandular dose to the breast phantom was constant and set to 2.5 mGy. Breast tomosynthetic images were reconstructed from the projections using simple and filtered multiple projection algorithm (MPA) [3]. In case of filtered MPA, a sinc filter was used and an optimization study was performed to adjust the filter's parameter with respect to the characteristics of the features to be detected.

III. Results

A. Comparison of *s-MPA* and *f-MPA*

A planar image of the MAMMAX phantom is depicted in Fig. 1(a), while the DTS tomograms of the low contrast features from the same phantom reconstructed with simple and filtered MPA are shown in Figs. 1(b) and 1(c) respectively. In the planar image the studied mass was not detected while it is well visualized in the DTS tomograms especially in the filtered image.

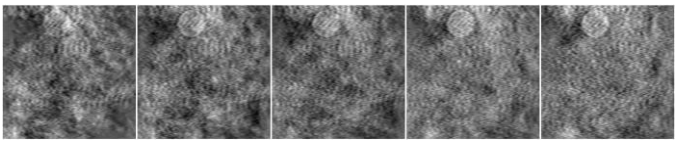


(a) (b) (c)

Fig. 1 MAMMAX phantom (a) planar image (b) tomogram reconstructed with simple MPA (c) tomogram reconstructed with filtered MPA

B. Evaluation of image quality with the acquisition arc

Figure 2 shows the DTS tomograms reconstructed for the five acquisition geometries used.



arc 24° arc 32° arc 40° arc 48° arc 56°

Fig. 2 DTS tomograms containing the low contrast masses for arcs 24° -56°

IV. Discussion and Conclusions

Filter optimization in respect to the type of feature characteristics is important before the reconstruction. Evaluation shows superior visibility of reconstructed features using the appropriately optimized filtered algorithm (Fig. 1c) and improved quality for extended arc lengths (Fig. 2). The above visual observations were quantitatively verified by CNR and ASF analysis.

V. Future Work

A future study will focus on the investigation of these parameters on the image quality of tomosynthetic slices obtained from real breasts. Specifically, this study will be conducted with simulated projection images acquired from several real breast volumes of different composition, in which we have embedded an irregular mass of 6 mm. The projections will be reconstructed with DTS for several acquisition parameters and will be compared with 2D images simulating mammography (FFDM).

VI. Acknowledgements

This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

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The Modelling of Cells Membrane Electrodynamics

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Keywords **– graphene, modeling, biomembrane, electrical forces, conductivity.**

I. INTRODUCTION

In recent years researcher very active investigated just one atom thick crystalline and plane (2D) systems. An example on the crystalline element is the buckyball also known as C60 that were discovered in 1985.There are not only C60 but a whole family of related molecules. Carbon atom are connected by electrical (quantum mechanical) forces and form a periodical structure.

Examples of plane 2D systems are graphene, graphane and graphyne. Because the physical processes in such systems are in starting positions there are no the review monographies but all interesting effect one can have by click items in internet . Main characteristics of such 2D systems are just one atom thick layer and periodic character of structure. Graphene and graphyne are electrical conductor.. The conductivity is realized by electrons.. There are some new specific effects that allow electrons to be massless and transfer along film surface with very high speed. The graphene has a hexagonal structure but the graphyne is some mixture of hexagonal and tetraedal. In comparison with graphene and graphyne the graphane is electrical isolator. It is because their electron bonds are saturated by some atom (usually H) absorbed on the surface of film. There are no free electrons and no electrical conductivity. Another interesting effect is on the film surface locally exists region strained in a particular way that make influence on electron transfer character. Electrons start rotate around the strained zone and physically it is like existence of strong local magnetic field.

II. MATERIALS AND METHODS

Because there is analogy between electrical and magnetic characteristics in modelling experiments small magnetic balls are used. In these cases main forces between balls are dipole-dipole interaction. Magnetic balls of diameter 5 mm and maximum of induction 100 mT are used. We will start with the model of C60 molecule known as buckyball. There are 20 hexagonal and 12 pentagonal elements that make approximately round surface fig. 1.

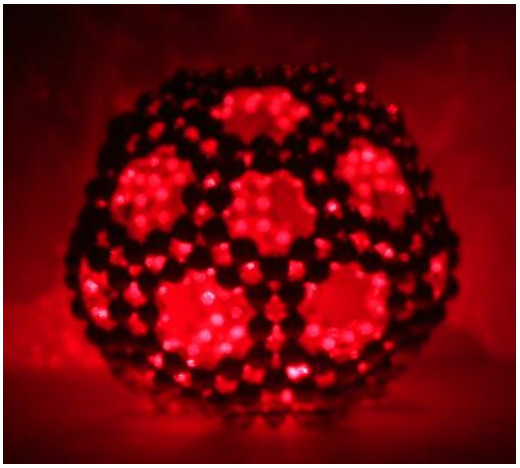

Fig.1:The model of magnetic buckyball with definite symmetry.

Special question is how to destroy the cell membrane. In the modelling experiments it was realized by taking out separate elements step by step. Another way was by increasing the pressure inside the cell that will initiate the cells decay in separate elements. In modelling experiments it is possible to make the two layers model as well as onion type one.

III. CONCLUSIONS

The carbon film investigation is just in starting position and every day there are some new surprising physical results. We concentrate on some interesting processes that could take part in biomembranes. The structure of carbon sheet as well as C60 is made by atoms. In biomembranes we have molecular complexies. In the modelling experiments we used macro dipoles. It looks that there is a physical analogy and not be influence of the dimension scale. The modelling experiments with magnetic dipoles allow extending the results also to systems with electrical dipoles. There are enormous experimental and theoretical materials in cells membranes science and discussed results could only serve as ideas that will stimulate future investigations.

Variable Magnetic Field and Pulsed Red Light as Factors Influencing Respiratory Burst of Neutrophils *In vitro*"

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Keywords: **variable magnetic field, red light, respiratory burst, neutrophils**

I. INTRODUCTION

The aim of this study was to investigate the effect of the red light (630 nm) and variable magnetic field upon reactive oxygen species (ROS) production by neutrophils *in vitro*.

Neutrophils are highly specialized white blood cells contributing to the immune response. Their basic function is the destruction of phagocytised microorganisms by respiratory burst, one of intercellular destruction mechanisms of pathogens. The mechanism of the respiratory burst consists in a more than ten times increase of the consumption of oxygen, as well as in the production and release of large quantities of superoxide radical anion ($^{\cdot}O_2^-$) outside the cell [1]. The dismutation of this radical causes the formation of hydrogen peroxide (H_2O_2) which was the object of interest of this research.

II. MATERIALS AND METHODS

Blood from healthy volunteers was used for the purpose of the study. Lithium heparin was used as the anticoagulant.

Samples were irradiated by the pulse of red light with wavelength of 630 nm or placed in the variable magnetic field of ELF range for 30 minutes.

Physiotherapy treatment device Viofor JPS was used as a generator of the red light and the variable magnetic field. The mean induction of the variable magnetic field equaled 26.7, 44.5 and 89μT. The values of densities of the red light energy were: 1.17, 1.20 and 1.23 [J/cm^2]. The fundamental frequency of pulses of red light/magnetic field was 180 ÷ 195 Hz. The pulses were administered in the form of packets of pulses (12.5 ÷ 29 Hz), groups of packages (2.8 ÷ 7.6 Hz) and series (0.08 ÷ 0.3 Hz). The form of impulses was close to the peak-shaped. M2P3 program according Viofor JPS device was applied, which means an application with intensity increasing to the chosen value. After reaching the chosen intensity, the value of impulse strength decreases. This process was repeated periodically.

The efficiency of respiratory burst (the production of H_2O_2) in individual cells was estimated via the flow cytometry by using the intracellular oxidative transformation of DCFH-DA (2'7'-dichlorofluorescindiacetate) to the fluorescent DCF (2'7'-dichlorofluorescin). The intensity of DCF fluorescence refers to the quantity of produced hydrogen peroxide. The respiratory burst was induced with PMA (phorbol 12-myristate 13-acetate), in order to produce submaximal stimulation of the respiratory burst.

III. RESULTS

The magnetic field and the red light caused statistically significant changes of hydrogen peroxide production by unstimulated and PMA-stimulated neutrophils. However, statistically significant decrease of ROS production by neutrophils under the influence of magnetic field was observed only for the mean induction of 26.7 μT. The red light was more effective causing statistically significant decrease of DCF fluorescence while all of densities values were used.

IV. DISCUSSION

The variable magnetic field or the red light affects the cell differently. The absorption of light by molecules causes electronic excitation [2]. The oscillating external electric or magnetic field will exert an oscillating force on every free ion on both sides of the plasma membrane as well as on the ions within channel proteins [3]. Therefore the interaction mechanism of the red light and the variable magnetic field on neutrophils respiratory burst could be different. This could explain the observed differences in obtained results.

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Cardiosynchronous Transcutaneous Electrical Nerve Stimulation

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***Keywords* – electrical nerve stimulation, blood pressure, heart rite**

I. Introduction

Cardiosynchronous transcutaneous electrical nerve stimulation device is a new technology. In our studies to test the concept of new electrostimulator, we used electrical nerve stimulation 200ms after R-wave with 125ms long bipolar pulse package to decrease Rate - Pressure product, as previously it was proved in preliminary experiments. The aim of the present study is technical elaboration of the innovative ECG R-wave triggered transcutaneous nerve stimulation prototype device to further perform the feasibility studies of such a neurostimulation technology.

Recent studies [1] have demonstrated that augmentation of the sympathetic activity can be reduced if the intermittent sensory stimulation impulse is applied during each cardiac cycle with the time delay 200-400ms after ECG R-wave. Moreover previous pilot study showed that applying of such a cardio synchronous stimulation mode to the afferent nerve endings in human canal result in significant lowering of arterial systolic blood pressure if the initial arterial pressure values were elevated.

Up to now there is no such noninvasive neurostimulation device with being able to decrease high sympathetic neural system activity and myocardial oxygen consumption. There is a TENS device developed by CardioLa [2]. The device stimulates skeletal muscles and makes heart load easier by additional pumping of blood due to caused contractions. It is not possible to use it in long term because muscles get tired. Therefore a stimulator for long term use is needed.

II. Materials and Methods

According to aim the prototype of device for transcutaneous nerve stimulation was developed by INTEGRIS, Ltd and RTU, Latvia and tested in pilot experiments in RSU, Latvia.

Equipment used in pilot experiment is: ECG monitor with R-wave pulse output – Cardiac Trigger Monitor, Model 3100, IVY, USA, Fig.1(1);; Digital Storage Oscilloscope – TDS 2002B, Tektronix, USA, Fig.1(2); ECG Phantom 320, M&S, Germany (only for preparations work); Experimental Synchronous Programmable Electrostimulator (Experimental stimulator) developed by INTEGRIS, Ltd and RTU, Latvia.

Stimulation was done for the person who had initial average systolic blood pressure 153 and heart rate 84 to test and prove concept.

Pilot experiments block schematic is shown in figure 1.

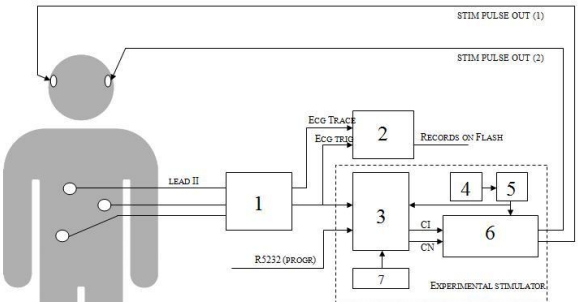

Fig. 1. Pilot Experiment block schematic

Pilot experiments were made for 2 simulation patterns after the R-wave:

In first experiment simulation provided 25 pulses (0.5ms positive pulse, 0.5ms negative pulse, 4ms pause) 200ms delay after R-wave, pulse current 6mA ±5%.

In second experiment stimulation provided 25 pulses (0.5ms positive impulse, 0.5ms negative impulse, 4ms pause) no delay, directly after R-wave, pulse current 9mA ±5%.

The ECG signal was obtained from chest electrodes (lead II) and simulation signal was applied to vagus nerve by special ear electrodes (Fig.1) that were made only for this experiment.

Systolic blood pressure, diastolic blood pressure and pulse rate was measured once per minute for 25 minutes during the stimulation. From measured data we calculated (1) Rate-Pressure Product RPP (as beats per minute (bpm) multiplied (*) by systolic blood pressure in mmHg), what characterizes heart workload and myocardial oxygen consumption.

$$RPP = SBP \times PR / 100 \qquad (1)$$

III. Results

Pilot experiments showed that innovative ECG R-wave triggered transcutaneous nerve stimulation prototype device was working properly and was user friendly. Device is programmable to obtain different pulse length, delay time (7 different patterns) and pulse amplitude.

Prototype device was used in two pilot experiments for vagus nerve stimulation with 200 ms delay after R-wave and right after R-wave. Stimulation with 200ms time delay causes approximately 12% RPP decrease in last 10 minutes. Moreover second experiment where stimulation was right after R-wave, RPP did not show changes.

IV. Conclusion

1) According to our aim new transcutaneous nerve stimulation prototype device was designed and built having possibility to synchronize it with ECG monitor. Experiments proved possibility to change delay after R-wave, pulse package length and pulse amplitude. Device is programmable so we could change all the pulse parameters and the number of pulses in package.

2) Primary hypothesis was partially accepted during pilot experiment, RPP dynamic depends on stimulation mode. The most rapid decline was when the intermittent burst stimulation was 200 ms after R-wave.

3) Experiments should be continued with different pulse parameters and delay time (patterns) to obtain optimal results.

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Effects of Heat Stress on the Blood Pressure and Heart Rate Variability in Young Men

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Keywords **– heat stress, head-up-tilting, continuous non-invasive mean blood pressure, heart rate variability, blood pressure variability.**

I. Introduction

Cardiovascular autonomic function tests (including head-up-tilting test) have been widely used to assess sympathetic and parasympathetic functions.

The aim of this study was to explore the effects of heat exposure on heart rate (HR) and mean blood pressure (MBP) variability in response to an orthostatic test (head-up-tilting, HUT) in healthy young male persons.

II. Methods and Materials

A. Experimental design and protocol

Eighteen healthy military college cadets and university students participated in this study. HUT was performed in the climatic chamber twice, one in normal condition (air temperature 22°, relative humidity 35%) and the other in the heat (42°C, relative humidity 18%). The HUT protocol comprised three ten-minute phases: 1) supine baseline, 2) tilting at 70° and 3) resupine.

B. Signal processing and data analysis

Non-invasive beat-to-beat MBP was measured by the differential oscillometric device [3]. HR was computed as the inverse of the inter-beat interval (IBI) and expressed in beats per minute (bpm).

For the analysis of the MBP variability, the low frequency power (LF MBP) at frequency range 0.04–0.15 Hz and high frequency power (HF MBP) at frequency range 0.15–0.4 Hz were calculated with the use of Fast Fourier Transformation. For the IBI time series we used a similar approach.

III. Results

Group-averaged values of IBI, HR and MBP in the supine as well as in the tilted position are given in Tab. 1 and Tab. 2 (f.v.).

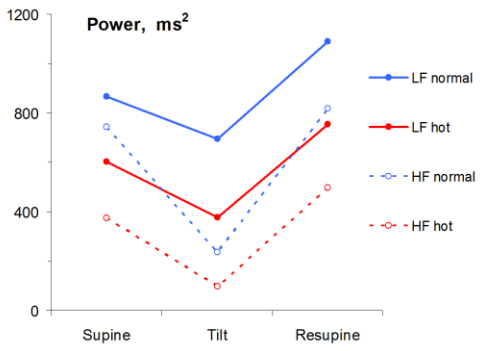

Figure 1 High and low frequency components of HRV during supine rest, during passive 70° head-up-tilt and during resupine after tilt. Blue line normothermia, red line – heat stress

The group-averaged values of HRV and BPV analysis are presented in Fig. 1 and Fig. 3. Hyperthermia caused a noticeable decrease in the absolute values of LF and HF components of HRV power (Fig. 1).

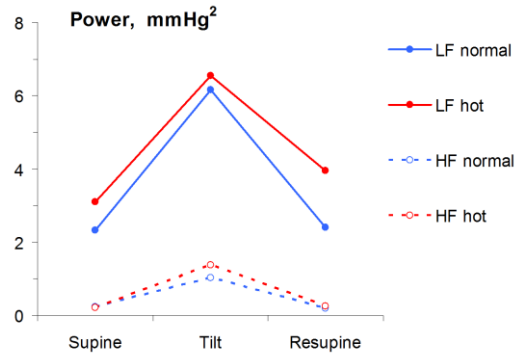

Figure 3 High and low frequency components of BPV during supine rest, during passive 70° head-up-tilt and during resupine after tilt. Blue line – normothermia, red line – heat stress

IV. Discussion

Our study demonstrated that during head-up-tilting, HRV decreased as heart rate increased (Fig. 1): this is a consequence of an increased sympathetic activation and reduced vagal control of heart rate. During tilt, the LF component of HRV becomes largely predominant. The total power (i.e. variance) is markedly reduced during tilt and consequently LF and HF powers are both decreased when expressed in absolute units. The use of normalised units (nu) clearly indicates the altered relation between LF and HF during tilt (Fig. 2) (f.v.). In normal subjects, a change from supine to stand causes a shift to greater sympathetic over parasympathetic regulation of cardiac function with a corresponding increase in sympathovagal balance.

V. Conclusions

Heat stress increased HR in the supine and tilted positions as well as the tilt-induced changes in heart rate. A noticeable decrease in the absolute values of LF and HF components as well as in rMSSD and pNN50 reached the margin of statistical significance for the tilted position. At the same time, no statistically significant changes in normalised spectral indices of HR and absolute spectral indices of the MBP variability were observed.

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Activity of Host Defense Proteins in Rabbit Bone After Pure Hydroxyapatite and Tricalcium Phosphate and Mixed Tricalcium Phosphate/Hydroxyapatite Implantation

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Keywords **– biomaterials, rabbit, Interleukins, human human β – defensin**

I. INTRODUCTION

Inflammation process has significant role in biocompatibility modelling process. Bone loss induced by inflammation is one of the complications after biomaterial implantation into the hard tissue. Proinflammatory cytokines interleukin-1 (IL-1) show proosteoclastogenic effects in response to implant-derived wear particles [1]. Interleukin-8 (IL-8) as neutrophil chemotactic factor is often associated with inflammation. IL-8 has been cited as a proinflammatory mediator in gingivitis [2]. Interleukin-10 (IL-10) is an anti-inflammatory cytokine with pleiotropic effects in immunoregulation and inflammation. There is no complete data about time dependent expression of cytokines and defensins into the bone tissue after implantation of biomaterials.

The aim of this experiment was to research the changes on distribution and appearance of immune defense profile proteins – Interleukins-1, -8, -10 and human β defensin2 in the lower jaw of rabbits after implantation of pure hydroxyapatite and tricalcium phosphate and mixed tricalcium phosphate/hydroxyapatite produced under different temperatures.

II. MATERIAL AND METHODS

Six Californian male rabbits were used for this study (permission of Animal Ethics Committee of Latvian Food and Veterinary Administration, No. 24, 02.07.2010.). Biomaterials produced in Riga Technical University Biomaterial Innovation and Development centre were used in experiment.

The rabbits received general and local anaesthesia. Intraosseal implantation of following biomaterial in lower jaw tissue was performed: hydroxyapatite (HAP) granules burned under 1000^0C, Tricalcium phosphate/hydroxyapatite (TCP/HAP) burned under 1150^0C and 1000^0C, pure Tricalcium phosphate (TCP) burned under 1150^0C and 1000^0C. After 3 months euthanasia of rabbits by air embolisation was performed. Blocks of bone and soft tissue from experimental and control side were taken out and prepared for routine morphological study by use of haematoxylin – eosin and for detection of the Interleukins: Interleukin 1; -8; -10 (IL-1, IL-8, IL-10) and human β – defensin 2 (HBD) by use of biotin-streptavidin immunohistochemistry. Quantification of immunohisto-chemically positive structures was done using semi – quantitative evaluation method.

III. RESULTS

Biomaterial ingrowth regions during tissue block elimination process was observed in experimental tissue with HAP granules, with both type of TCP/HAP and with TCP material burned under 1150^0. Routine histological examination showed new bone developing zones in experimental tissue with above mentioned biomaterials as well (Fig.1-f.v. in results). Our study showed low variability of distribution of HBD2 and IL-1, -8 and Il-10 (Fig.2 – 6; f.v. in results).

IV. DISCUSSION

Experimental tissue with such biomaterials as HAP granules and TCP (burned under 1150^0C) showed influence to increase IL-10 expression. The expression of IL-1 was moderate in experimental and control tissue. The research of Ninomiya (2001) demonstrates that HAp and HAP/TCP particles are capable of stimulating the expression and secretion of cytokine IL-1 that increase bone resorption, and suggests that particulate debris from implants using these coatings may also increase osteolysis and loss of implants [9].

V. CONCLUSION

Biomaterials – pure and mixed HAP and TCP produced under different temperatures don't make significant difference to IL-1, IL-8, IL-10 and HBD2 production. Bone developing zones and low expression of anti-inflammatory cytokines in experimental tissue with both type of HAP/TCP and with TCP material burned under 1000^0 C possibly indicates better biocompatibility for this material than others used in our study.

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Electrochemical Detection of Interaction Between 6-thioguanine and DNA

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***Keywords* – 6-thioguanine, electrochemical DNA biosensor, pencil graphite electrode, drug-DNA interaction**

I. INTRODUCTION

6-Thioguanine (6-TG), is one of the most important anticancer therapeutic agents used in the clinical treatment of acute childhood lymphoblastic leukemia, inflammatory bowel disease, Crohn's disease, AIDS, and some other pathology [1, 2]

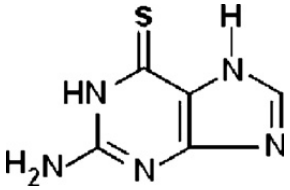

Fig.1.Chemical structure of 6-TG.

Various methods have been used to determine 6-TG, including chromatography [3], luminescence and spectrofluorimetry . In comparison to other techniques, electrochemical (bio)sensing techniques provide more sensitive, cost effective and selective detection platforms for drug, DNA, or protein interactions.

II. MATERIALS AND METHODS

All experimental measurements were carried by using AUTOLAB – PGSTAT 302 electrochemical analysis system
supplied with a FRA 2.0 module for impedance measurements, and GPES 4.9 software package (Eco Chemie, The Netherlands). For electrochemical measurements, the differential pulse voltammetry (DPV) was used. The three electrode system was consisted of the pencil graphite electrode (PGE), an Ag/AgCl/KCl reference electrode and a platinum wire as the auxiliary electrode. Fish sperm double stranded DNA was used in our study. Diluted solutions of DNA was prepared using 0.50 M ABS (pH=4.8). 6-TG was prepared using 0.50 M PBS (pH=7.4).

III. RESULTS AND CONCLUSIONS

In this study, we investigated electrochemically the interaction between 6-TG and double stranded DNA (dsDNA) by using disposable pencil graphite electrode (PGE). Guanine and 6-TG oxidation signals were measured via differential pulse voltammetry (DPV) before and after interaction process and consequently, the changes of guanine and 6-TG signals were evaluated.

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Drug Transport to Brain: Molecular Descriptors as the Way for Effective Drugs Creation

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Keywords **– blood-brain barrier, structure-property relationships, 1.4-benzdiazepipe derivatives, somnolent, "Levana IC".**

I. INTRODUCTION

The possibility of passing through the Blood-Brain Barrier (BBB) is the most important demand for cerebrally acting drugs, since even pharmacologically active substances can be inefficient under physiological conditions when being unable reach the action biophase. If earlier the ability of drugs to permeate hystohematic barriers was the parameter, determined nearly at the end of the research, now it, as one of the drug`s properties, can be predicted and estimated in the frames of the quantitative structure-activity (properties) relations (QSA(P)R) computation method. For the reliable and thorough results the input teaching database should usually include the physics-chemical properties of drug, its ability penetrate through the BBB, transport ways and mechanisms, ets, in correlation with the molecular descriptors.

As the BBB had been defined to be the critical link in the drug entering to the brain, its permeability to cerebrally acting substances became one of the main properties, indicating their efficacy.

The aim of this work was definition of the molecular descriptors and their evaluation for better BBB permeability.

II. MATERIALS AND METHODS

Using the radioactive-labeled substances (low-chain aliphatic alcohols and their derivatives – aldehydes and acids) the permeability through the murine BBB was estimated as the concentration brain/blood ratio of compounds after various routes of administration by the method of liquid scintillation counting was made. The substances were administered as buffer solutions (especially in the case of acids).

III. RESULTS

In the range of low-molecular weight substances (alcohols, aldehydes, acids, aminoacids) chemical groups (-COOH, -OH) have been defined which presence in molecule positively influence the permeability through the BBB [1].

It was shown that some molecules undergo metabolism, forming more BBB permeating compounds (alcohol transformation to acids via aldehydes). In the metabolic chain "alcohol-aldehyde-acid" different "concentration-permeability" relations for each compounds were noted.

The Blood/Brain Ratio for these substances depends not only on the physics-chemical properties of molecule, but also includes active transport mechanisms through the BBB, as for the organic acid anions transport [2]. On the base of obtained data (Table 1) the structure of novel somnolent drug "Levana IC" (Fig.1) was suggested. The reversibly ionized residue of the succinic acid in this molecule determines both solubility in hydrophilic medium of the cell (and intercellular space) and ability to permeate the lipid (hydrophobic) areas.

TABLE I

COMPARATIVE BLOOD/BRAIN RATIO DATA FOR LOWER ALIPHATIC ALCOHOLS, ALDEHYDES AND ACIDS

Molecule	Blood/Brain rati
Alcohols	
Methanol	0.32 ± 0.01
Ethanol	1.01 ± 0.15
Propanol	0.48 ± 0.017
Butanol	0.37 ± 0.02
Aldehydes	
Formaldehyde	0.56 ± 0.05
Acetaldehyde	2.15 ± 0.5
Butylaldehyde	1.97 ± 0.48
Acid	
Formic	0.7 ± 0.03
Acetic	15.2 ± 2.9
Buturic	1.79 ± 0.26

In addition to this, the transport of the Levana IC to brain involves active organic acid transport, representing as a substrate the "acetic" part of molecule.

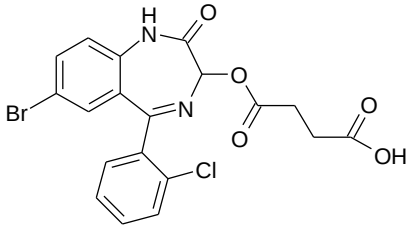

Fig 1. The structure of novel somnolent drug "Levana IC".

In the brain Levana IC undergoes the hydrolysis forming the lipophilic active component.

IV. CONCLUSIONS

In the range of low-molecular weight substances there were defined chemical groups (-COOH, -OH) which presence in molecule positively influence the permeability through the BBB.

It was shown that some molecules undergo metabolism, forming more BBB permeating compounds.

On the base of obtained data the structure of novel somnolent drug "Levana IC" was suggested.

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X-Ray Radiation Statistics Towards Quality Assurance In Digital Radiography

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***Keywords* – digital radiography QA, x-ray beam statistics.**

I. Introduction

Quality assurance (QA) of x-ray equipment is extremely important part of extensive quality control system in hospitals. Since most of diagnostic radiography is digital today, there is a great possibility to make an express quality check of x-ray equipment using fast digital approach.

When the signal of the detector is directly proportional to the number of the detected photons, the distribution of the signals among the detectors of the entire set after its exposure obeys Poisson statistics too. The present article is directed to explore a possibility to exploit this for quality assessment in x-ray digital radiography.

II. Matherials and Methods

Digital x-ray machine "Digital Diagnost" was in use. The digital flat-panel x-ray detector "Pixium 4600" detector was employed [1]. The x-ray images were acquired using a manual operation mode. Both large and small focal spots of the x-ray tube were employed. The Source Detector Distance was 1m and the irradiated field was collimated to 7x7 cm for each exposure. X-ray image were collected in the DICOM format and transferred further to TIFF format to analyze brightness distribution. The brightness of each image pixel and the distribution over the brightness were used. The acquired statistic was verified to be the subject of the Poisson or Gauss distributions [2]. The Kolmogorov-Smirnov criterion λ was employed [3]. The criterion λ was compared with the tabulated value λ_t at the significance level 0.05. If $\lambda < \lambda_t$ the hypotheses on the trusting statistics was accepted. Thus the criterion λ was the index that statistics corresponds to the Poisson law (higher value of λ means that statistics less match the Poisson law). The theoretical Poisson and Gauss distributions were derived employing the parameters calculated from the experiment (average, standard deviation). This was compared with the tabulated value λ_t at the significance level 0.05. If $\lambda < \lambda_t$ the hypotheses on the trusting statistics was accepted. Thus the criterion λ was the index that statistics corresponds to the Poisson law (higher value of λ means that statistics less match the Poisson law). The theoretical Poisson and Gauss distributions were derived employing the parameters calculated from the experiment (average, standard deviation).

III. Results

The cumulative distribution functions (CDF) brightness was found for different size areas for different kilovolts and focuses (Fig 3) on the brightness analyses base.

The results show that CDF conform Poisson distribution best when the x-ray image is acquired at 81kV, small focus and the 100x100 pixels large.

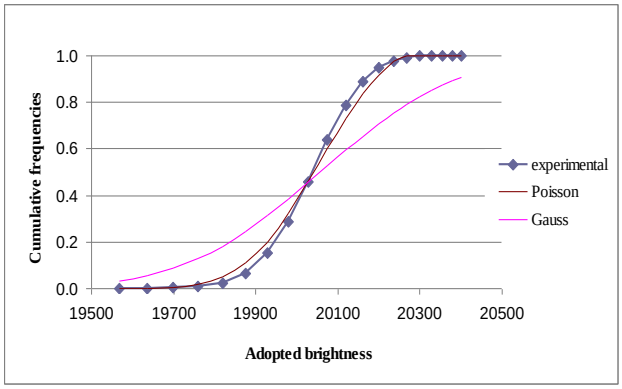

Fig. 3 The CDF for small focus, 81kV, 100x100 pixels area

When milliampers (mA) were enlarged the value of λ became smaller (Fig.10).

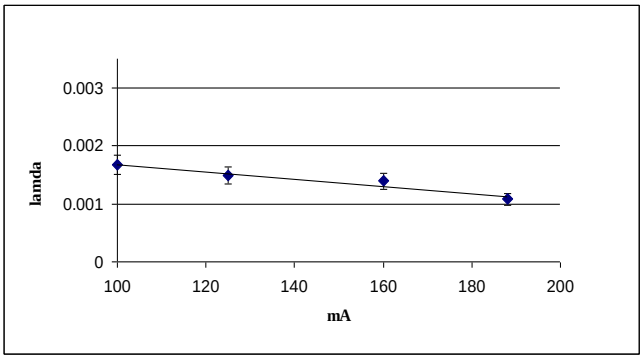

Fig. 10 Parameter λ in dependence on Ma

IV. Conclusion

The Poisson statistics based approach to analyze brightness statistics of the digital image is demonstrated to estimate quality of x-ray digital radiography machines. The approach could be in use by the medical staff for the express day-to-day monitoring of the x-ray digital radiography machines quality deviations.

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Anthropomorphic female pelvic phantom

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Keywords **– CyberKnife, 3D Virtual Brachytherapy, anthropomorphic phantom.**

I. INTRODUCTION

The treatment performance for the pelvic oncological diseases [1] of both gynecologic and metastatic lesions including pelvic bones with utilization of robotic radiosurgical CyberKnife G4 system is getting as very promising. It was decided to choose the Fiducial Tracking as the Tracking method or Spine Tracking in case when there was the tumor of pelvic bones with tracking through the lumbar vertebra [2]. Till now these methods are not sufficiently proved and tested to guarantee the geometric precision of dose delivery and accuracy of subscribed dose distribution if one uses an applicator or when distance between point of tracking and treatment point is more than 10 cm.

II. METHODS

At the department of Nuclear physics, Taras Shevchenko National University of Kyiv in cooperation with the Medical Center "Cyber Clinic of Spizhenko" we developed the anthropomorphic female pelvic phantom with the option for fast change and adaptation of geometry and measurement points. Phantom is designed for different types of detectors (ion chambers, radiochromic films, thermo luminescent dosimeter) application and provides their spatial localization at various parts of the phantom for more complete and detailed precise control of dose delivery. The lateral outside of phantom consists of thin acrylic layer (its shape and size is close to the pelvic part of the body). The using of different types of anatomical parts of the body and detector systems is provided by its fixation at the end replacement plugs (front acrylic covers). The internal volume of phantom chamber is filled in with water.

III. RESULTS

Comparison of calculated doses with the measured ones by detectors, and the Monte Carlo simulations are in progress and results with analysis will be presented at the conference.

IV. CONCLUSIONS

Application of this phantom allows its mobile usage not only for workup, tests of the 3D virtual brachytherapy methods and treatment of the pelvic bones' tumors with the Spine Tracking, but also for various tasks including staff training and examination.

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New Alignment Device for Positioning The Ionization Chamber to Defined Depth in Water Phantom

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Keywords **– relative dosimetry, alignment device, absolute dosimetry, commissioning of medical accelerator.**

I. Introduction

The positioning of the ionization chamber into defined depth in water phantom is important part of relative and absolute dosimetry during commissioning of the medical accelerator. In this paper the main idea of the new positioning method is described. The comparison with similar alignment devices of some know companies are presented.

II. Materials and Methods

Described "non-contact with water surface reflection of measuring tip" (MT) method use the advantage of high sensitivity of vertical movement (relatively to its virtual reflected image in mirror of water surface) of measuring tip (Fig1. a), which is due to fact that visible relative distance between tip and its virtual reflected image in mirror of water surface changes two times faster than movement of the tip itself. MT method, in fact, is modernized alignment device of Petri Sipilä (PS) from STUK (Finland).

Measuring tip was made of fluoroscopic film (width W=1,00±0, 01 mm). The tip is attached on the ionization chamber, which is located into the "calibration position" when the visible distance (2d) between tip and its image in the mirror of water surface (Fig1. a) was equal to tip width (W), i.e. W=2d ("imaginary square" is seen, Fig1. c). After a short training human eye could easily notice small changes in distance, when measuring tip was shifted from "calibration position" even by 0,1 mm (Fig., b). So, we can speak about ~0, 1 mm accuracy of this method.

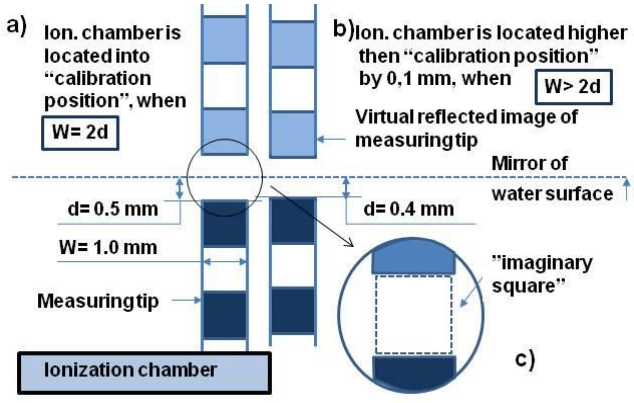

Fig. 1. Main idea of "measuring tip" (MT) method.

Also important reality is that the integrity of the water surface is disturbed by waves (generated by up and down movement of ionization chamber) and "adherence" (contact) of measuring instrument to water surface (CwW) can happen causing unwanted interfering effects of liquid-air-tip interface. That's why the proposed method is based on noncontact with water (NonCwW) surface concept and is therefore quite precise (Table.1.).

III. Results

MT device was compared with devices of know companies: PTW-Freiburg, TRUFIX® system (cone alignment tool, [1]) and IBA [2], white cylindrical cap with crosshair attached to ionization chamber, and, as well, with PS device. You can see (Table.1) that using step motors in beam analyzer and CwW concept reduce the accuracy of zero positioning by twice. The possibility to keep under control by physicist (CbPh) the accuracy of connector between alignment device and ionization chamber is also presented. As you see, the worst accuracy of the connector showed the tool of PTW, but, on other hand, it earned "positive points" due to its friendliness to user when different types of ionization chamber have to be used.

TABLE I

Comparison of alignment devices

Feature	PTW, TRUFIX®	IBA	PS	MT
Accuracy of zero positioning Continuous motor Step motor Points	CwW ±0.05 mm -0.10 mm **	CwW ±0.20 mm ±0.20 mm *	CwW ±0.05 mm -0.10 mm **	NonCwW ±0.05 mm ±0.05 mm ****
Accuracy of connector- **Total accuracy** Subtotal Points				
"Friendly" to user	NonCbPh ±0.20 mm *	NonCbPh ±0.05 mm ***	CbPh ±0.05 mm ****	CbPh ±0.05 mm ****
Total points				
converter (alignment device-> ion. chamber) Step motor Points				

IV. Conclusions

Due to non-contact with water surface concept, MT positioning method showed more accuracy then known methods of ionization chamber mechanical alignment and can be applied for examination of positioning devices in use or, as independent tool, for setting depth of ionization chamber in radiation field with high dose gradient (for example, electrons, dose gradient ~6%/mm).

V. References

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Neutron Field Outside the Room of Linear Medical Accelerator

Kinga Polaczek-Grelik, Patryk Gandor, Andrzej Orlef *(Medical Physics Department, University of Silesia, Poland)*

Keywords **- medical linear accelerator, neutron fluence, neutron ambient dose equivalent, semiconductor spectrometry, occupational dosimetry.**

I. INTRODUCTION

Neutron radiation field around radiotherapeutic high-energy linear accelerator (linac) is strongly dependent on construction materials chosen by manufacturer and an operating energy. The cross section of nuclear photo effect (g,n), in which neutrons are mostly produced, has a threshold character and structure characteristic for each isotope. Neutron dose outside the radiotherapeutic room depends not only on the strength of neutron production by a particular linac, but also on the topology of the facility, i.e. room surface area *S*, wall composition, maze shape and length *L*, bunker door construction, which contribution is often difficult to estimate. Moreover, standard readout of personal TL dosimeters does not give accurate information about the neutron component of the dose.

II. EXPERIMENTAL

The aim of this work is to assess the occupational neutron dose in the pilothouse during emission of 20 MV X- ray beam by the Clinac 2300 medical accelerator.

A. Material

Four linacs were involved in the study. The geometry of therapeutic rooms and different gantry positions were considered. All studied linacs were installed in rooms with one- band maze of about 8 m long, ended with heavy doors containing paraffin layer surrounded by lead coating. Accelerators in Table 1 were numbered according to the seniority. Measurements of neutron fluence and ambient dose equivalent H*(10) 50 cm from the outer side of the therapeutic room door were performed during emission of 20 MV beam with the rate of 600 monitor units per minute, for the gantry positions of 0° and 90°. Irradiation field was set at 10x10 cm2, and SSD=100 cm. Additionally, H*(10) was measured at the linac's operational console for the X-ray beam direction of 270°. Notation of gantry movement is clockwise.

B. Method

Two methods of neutron ambient dose equivalent determination were used. LB123 monitor gives the information about H*(10) rate of neutrons from thermal up to 20 MeV energy range. High-purity germanium (HPGe) semiconductor spectrometry system, dedicated for in situ measurements, provided the information about neutron fluence on the base of prompt gamma neutron activation analysis (PGNAA). Registered activation spectrum in the energy range 60 - 2800keV is presented and described in Figure 2 (fv.). The quantitative analysis of 595.85keV peak accompanying the nuclear reaction 73Ge(n,g)74Ge (o=15b), involving slow neutrons (Emean=0.21eV), was performed. Subsequently, using paraffin moderators with the thickness of 6 cm and 8 cm, fractions of intermediate and fast neutrons (Emean=0.05MeV and Emean=0.55MeV) were estimated. The shape and thickness of neutron moderators were adopted from [2]. The response of HPGe spectrometer was calibrated with the use Pu-Be source of a known neutron fluence. On the base of neutron fluence results, ambient dose equivalent H*(10) was estimated with the use of conversion coefficients calculated on the base of equation given by AAPM Report 19 [3].

III. RESULTS

The main results of ambient dose equivalent measurements are presented in Table 1.

TABLE 1 NEUTRON AMBIENT DOSE EQUIVALENT RATE AS SEEN BY TWO METHOD (LB123 AND PGNAA) FOR FOUR STUDIED LINACS WORKING IN 20 MV MODE. THE UNCERTAINTIES ARE INCLUDED IN PARENTHESIS.

Linac no.		1	2	3	4
S [m^2]		155	137	138	127
L [m]		8.17	8.05	7.98	7.98
H*(10) at 50 cm from the treatment room door [mSv/h]					
0°	HPGe	1.541(9%)	1.615(6%)	1.825(5%)	1.512(7%)
	LB123	0.833(2%)	1.020(4%)	2.500(6%)	1.940(2%)
90°	HPGe	0.531(14%)	1.499(8%)	0.827(6%)	1.576(7%)
	LB123	0.642(3%)	0.960(4%)	1.880(2%)	1.580(4%)
F at 50 cm from the treatment room door [cm^{-2} $*^{-1}$]					
0°	HPGe	47.3(9%)	66.2(6%)	83.1(5%)	62.6(7%)
90°	HPGe	28.8(14%)	50.9(8%)	72.2(6%)	57.8(7%)
H*(10) at the operator console [mSv/h]					
270°	HPGe	0.027(18%)	-	-	-
	LB123	0.029(20%)	0.056(4%)	0.017(15%)	0.016(19%)

IV. DISCUSSION AND CONCLUSIONS

H*(10) 50 cm in front of the door increases as the dimensions of the linac room decrease. In more recent projects of the bunkers the care about lowering the dose at the operational console is noticeable, while the increase of H*(10) in the vicinity of the door is observed in comparison with older bunker projects. In the case of linac no 1 the neutron field is shaped differently because that room was adopted for 20 MV linac after the 23 MeV accelerator withdrawal.

The neutron dose outside the treatment room decreased when the therapeutic beam was directed at the wall opposite to the door (90°). Moreover, a small or wedged therapeutic field and gantry position of 270° (beam directed on the pilothouse wall) increased the neutron dose in the pilothouse. However, in any of studied cases the annual dose limit for occupational exposure (3 |mSv/h) was not exceeded. Furthermore, at the operator's console the dose is 1-2 orders of magnitude lower than in front of the accelerator room door. This could be used as the clue, which positions should be avoided be the staff during operation of linac in high-energy mode. Obtained results have shown that PGNAA of HPGe spectrometer could be used in characterization of low rate neutron radiation field in therapeutic facility in terms of occupational neutron exposure. This is confirmed either by the consistency with results of LB123 or by a good agreement with results obtained by others.

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CT Dose Index Test with Standard Phantoms

Nelda Kreislere (*Riga Technical University*) and Aldis Balodis (*Riga Technical University*)

***Keywords* – CT dose index (CTDI), head and body phantom, dose distribution, uncertainty.**

I. Introduction

The aim of study is to find out how measuring the absorbed dose depends on the different axial scanning technologies and how they affect the measured value using standard dose test method with CT dose head and body phantoms.

Computed tomography one of the most pressing tasks is to dose reduction. [1] Parameters associated with received radiation doses and depend on the hardware technical support are: slice thickness, the distance between slice, interlayer, examination region, exposure factor and gantry tilt. Image quality and radiation dose affect patient received dose in examination.

Computed tomography manufacturers given base CT Dose Index (CTDI) values are highly dependent on scanning parameters and characteristics of the scanner. Therefore image quality and radiation dose affect patient received dose in examination and it may not always be assessed quantitatively, when measured with CT dose test phantoms. However, to achieve this objective requires more and more new approaches for the determination of the dose rate CT, and in assessing the information provided by different manufacturers, firstly, of the CT dose index (CTDI), that can compare with the standard methods and the assessment of the patient dose. [2]

To determinate CT dose index in CT dose phantom there are nothing says about the limits of the scan length of the phantoms, not exceed the permissible uncertainty related to possible scatter of the phantom side the edge.

The aim of study was to find out how during measuring the absorbed dose in phantoms depends on the different axial scanning technology and the changing nature of the measured value over all phantom length using standard CT phantoms and as well clarify difference between measured weighted CT dose index and the given manufacturer (base) values.

II. Materials and Methods

The measurements were made using single slice CT scanner Siemens Somatom AR.SP, pencil type ionization chamber with active length 100 mm, which were connect with test device Victoreen 4000+, the CT Dose Phantom, which consists of 15 cm thick solid PMMA disks measuring 16 cm (head) and 32 cm (body) in diameter.

All measurements were made on the basis of IEC 60601-2-44 [3], measuring the absorbed dose, and then calculating the CT dose index.

The radiation dose profile along a line perpendicular to the plane of a single axial CT scan shows a peak where the primary beam slices through the CTDI phantom. A CTDI100 value is obtained if integration limits of ±50 mm are used (1).

$$CTDI_{100} = D \cdot K_1 \cdot \frac{L}{slice} \qquad (1),$$

where D- measured dose (mGy), K_1-calibration factor, L- ionization chamber- 100mm active length (mm), slice (mm).

Scanning was made with a variety of slice thicknesses 2, 3, 5, 10 mm over the entire length of the ionization chamber, with the same table feed.

III. Results and Discussion

Equable absorbed dose distribution was obtained during measurements when ionization chamber was positioned freely in air without other absorbent. We found that the equable measurements can be made anywhere in the ionization chamber (f.v. Fig.1).

However the results obtained using CT phantoms show that the CT dose index ($CTDI_{100}$) measured with a 100 mm long active measuring length phantom makes 30 - 35% uncertainty in the head phantom (Fig.2) and up to 50% uncertainty in the body phantom (f.v. Fig.3), compared to the middle of the phantom measurements with a measuring 100 mm long section ends.

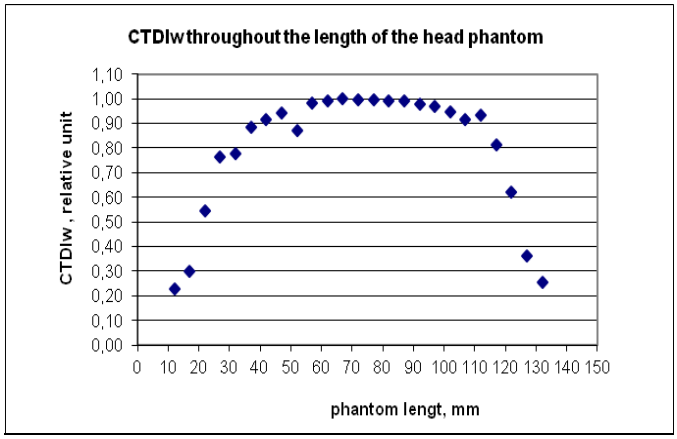

Fig.2 Absorbed dose distribution of the head phantom at the slice thickness and table feed of 5 mm, max value of CTDIw = 82,50 mGy.

IV. Conclusion

Study has shown that the absorbed dose distribution uncertainty for measurements along the length does not exceed 5% of the head phantom. A phantom of 40 mm mid-range and a 45 mm body phantom could be applied.

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Time Dependent Deterioration of the X-ray Dental Diagnostic Equipment

Yuri Dekhtyar (*Riga Technical University*), Alena Kamenetskikh (*Ural State University of Railway Transport*), Maksims Polakovs (*University of Latvia*) and Maksims Sneiders (*Riga Technical University*)

Keywords **– dental x-ray equipment, time, degradation.**

I. Introduction

Statistics presented by NMS GRUPA Ltd. demonstrates that the Trophy ELITYS (25%) (*further in text – ELITYS*) is the most popular dental x-ray with high frequency and the Trophy IRIX 70 (13%) (*further in text – IRIX 70*) – with half-period generators in Latvia.

Time dependent degradation of x-ray machines gives a strong impact on quality of diagnostics. However, there are no data on time dependent degradation.

The goal of the study was to explore time dependent behavior of dental x-rays ELITYS and IRIX 70 dose providing parameters such as:

- X-ray tube voltage [kV]. Quality of this parameter has an influence on a spectrum, image quality, and an absorbed dose.
- X-ray exposure time [ms] - influences the absorbed dose.
- X-ray tube output [mGy/mAs] influences the absorbed dose.
- Air KERMA [mGy] – influences the absorbed dose [1].

II. Materials and Methods

Selection of the parameters has been done on the demands by the Republic of Latvia Cabinet of Ministers No. 97 of March 5, 2002 "Regulations on protection against ionizing radiation in medical exposure" [2].

Statistical processing of the collected data (arithmetic mean, experimental standard deviation) has been determined in accordance with EAL Publication EA-4/02 [3].

The correlation of the approximation of the x-ray machine parameters with respect to time has been verified by linear and polynomial (2nd and 3rd order) functions. The "least squares" method has been applied to confirm the best approximation.

III. Results

The results are presented in Figure 3.1.*High frequency generator type – ELITYS*

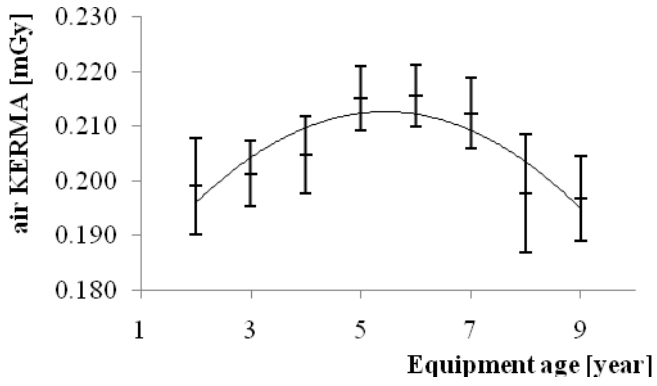

Fig. 1. The influence of the age of equipment on air KERMA

Air KERMA follows the polynomial 2nd order correlation with a parameter maximum on equipment`s 5-6 year age, during first 4 years increases by 7.4%. During next 4 years results decreases by 8.8%.

A. Half-period generator type – IRIX 70

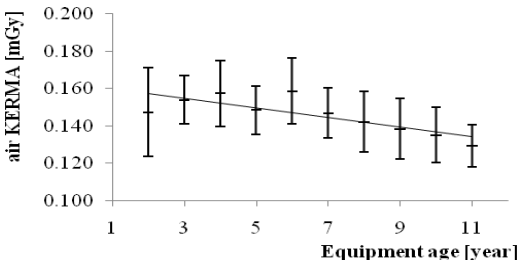

Fig. 2. The influence of the age of equipment on air KERMA

The linear approximation has been confirmed for air KERMA. Air KERMA follows the linear correlation and during 10 years decreases by 14.3%.

IV. Conclusions

1. Degradation of dose characterizing parameters were explored for dental x-ray ELITYS with high frequency generator type for over 8 year of the equipment age.
2. Deviation of the parameters comparing first and last year (the 8 year of equipment exploitation) of studied equipment is shown in Table 1.

Table 1. Deviation of the parameters

Dose characterizing parameters	Deviation, %
x-ray tube voltage [kV]	- 1.1
x-ray exposure time [ms]	+ 0.4
air KERMA [mGy]	- 1.0
x-ray tube output [mGy/mAs]	- 2.0

3. Degradation of dose characterizing parameters were explored for dental x-ray IRIX 70 with half-period generator type for 10 year of the equipment exploitation (Table 4.2).

Table 2 Deviation of the parameters

Dose characterizing parameters	Deviation, %
x-ray tube voltage [kV]	- 1.2
x-ray exposure time [ms]	+ 0.5
air KERMA [mGy]	- 12.3
x-ray tube output [mGy/mAs]	- 14.3

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Characterization of a SiPM-based Wavelength-Shifting Fibre Gamma Camera Using ^{99m}Tc

Filipe Castro, António Soares, Luís Moutinho and João Veloso *(Physics Department of Aveiro University, Portugal)*

***Keywords* – gamma camera, wavelength-shifting fibres, SiPMs.**

I. Gamma Camera Design

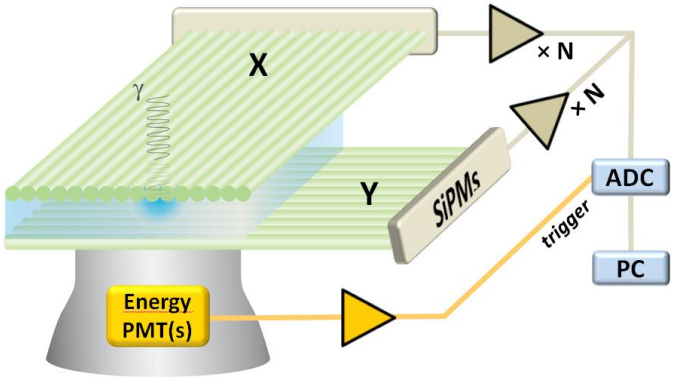

Fig. 1. Schematics of the SiPM-based WSF gamma camera.

The gamma camera we are developing consists of a CsI(Na) crystal with both faces covered by two perpendicular sets of wavelength-shifting fibres (WSFs). 2D position is determined by using silicon photomultipliers (SiPMs) to measure the profiles of light created by the WSFs as a result of scintillation light absorption. One or several PMTs on one side of the crystal provide the energy signal, which is also used to generate a trigger for acquisition. This concept has the advantage of using N+N instead of N×N photodetectors to cover an identical imaging area. Envisaged applications are in scintimammography and sentinel lymph node detection, where compact high-resolution gamma cameras are needed to improve the early detection of smaller tumours.

II. Components and Experimental Setup

A 10×10 mm^2 prototype has been assembled and tested:

A. Monolithic scintillator and wavelength-shifting fibres

A 50×50×3 mm^3 CsI(Na) slab was encapsulated with embedded fibres. CsI(Na) has high density and atomic number providing good detection efficiency, with high light output of 38,5 photons/keV peaking at 420 nm with decay constant of 630 ns. Fibres are 1 mm round and multi-cladded, BCF-91A, with trapping efficiency > 5,6%. Absorption peak matches well to CsI(Na) emission and their peak emission is at 494 nm. 10 central fibres (out of the 50) in each direction were used.

B. Silicon photomultipliers

1 mm^2 Hamamatsu S10362-100-11U, higher gain model, with PDE of about 40% for 494 nm, excluding effects of crosstalk and afterpulses. The 10 SiPMs in each direction were biased together, adjusting voltages for 1-2ºC temperature change during acquisition. Initial temperature was 20ºC.

C. Readout electronics, data acquisition and imaging

Front-end readout electronics for SiPMs and energy PMT, as well as trigger circuit, were developed in-house, signals fed to CAEN V785 ADC and sent to a PC. For each valid event, (x,y) position was determined by the maximum SiPM signal in each direction. This simple algorithm has proven good results.

III. Calibration with ^{57}Co (122 keV)

Calibration is required before imaging especially to correct for gain differences between SiPMs biased at same voltage. For this end, a diagonal (x=y) scan was performed with a ^{57}Co source collimated by a 4 mm thick Pb sheet with 1 mm hole. The scan allowed measurements presented in Fig. 2, which show good position linearity of the system after calibration, achieving an intrinsic position resolution of ~ 3 mm FWHM and energy resolution of ~ 23% for the 122 keV of ^{57}Co.

IV. Imaging with ^{99m}Tc (140 keV)

A 1 mm hole was horizontally drilled in PMMA and filled with a ^{99m}Tc solution, which was then imaged using a parallel-hole collimator. Energy resolution is 21% at 140 keV, while intrinsic spatial resolution is less than 2 mm FWHM, considering the results and collimator resolution of 2.3 mm.

A camera of 10×10 cm^2 (200 SiPMs) is being developed.

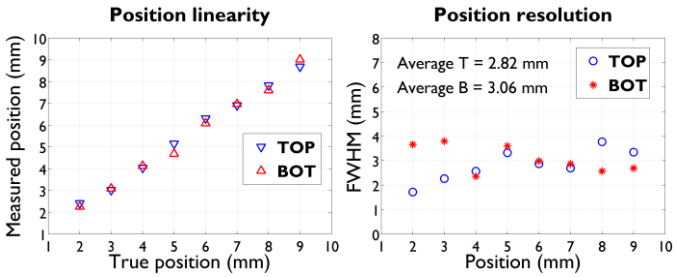

Fig. 2. Position linearity and resolution measurements with ^{57}Co.

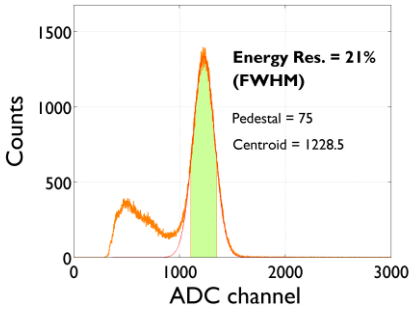

Fig. 3. ^{99m}Tc energy spectrum showing 10% energy window used for imaging.

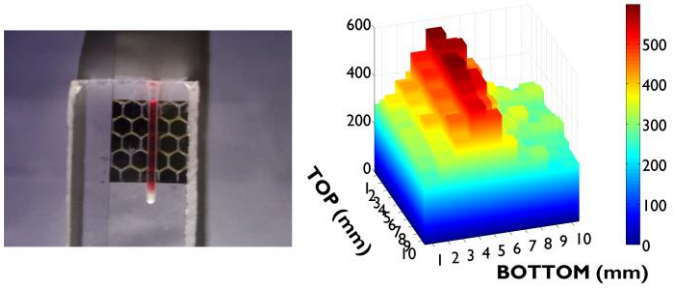

Fig. 4. ^{99m}Tc sample and 3D histogram of image obtained with the prototype.

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Prospects for Use of Gravity Anomalies as Recreational Resources

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Keywords **– anomalous gravitational field, gravitational anomalies, recreation.**

I. Introduction

Recovery of the population performance is one of the necessary and important tasks of the state. Today, it can be solved by use of the existing and creation of new health resorts and recreational areas (coastal, climatic, mountaintop, mineral waters-based, mud-based and etc.). It is known that relaxation process does not always bring to strength and performance recovery. In some cases, a negative effect is observed after the holidays even to admission to hospital. It follows that areas able to ensure therapeutic effect for a certain type of diseases and improve health of the whole organism, are of particular interest. These territories are the gravity anomalies.

II. Study of Effects of Gravitational Field to Organisms in XX-XXI

Beginning of studies of the effect of the anomalous gravitational field (AGP) on the human body was caused by the mankind's desire to go beyond the Earth's gravity and begin exploration of the outer space. For this purpose it was necessary to find out how the body reacts to changes in intensity of the gravitational field.

Trials showed the results that decrease in the gravitational field intensity is accompanied by grown destructive processes in the body, but increase in AGF intensity has a positive effect on the body. But to what extent and what magnitude of AGF intensity is most favourable for the body? [1]

III. Dependence of the Natural Population Increase on Intensity of the Anomalous Gravity Field

Natural population growth rate (N_1) serves as a criterion for favourable effect of external factors on the body. As long as N_1 has a positive value effect of external factors can be considered favourable. Negative N_1 figure evidences of negative impact of environmental factors to the organism [2]. Studies carried out by RTU TURAP in 2009-2010 showed that the N_1becomes negative for negative values of the gravitational field [2]. Further investigation has revealed three areas of body interaction with the environment: optimal zone (20 ÷ 40mGal), adaptation zone (0 ÷ 20mGal) and the pathology zone (less than 0mGal).

IV. AGF in Latvia and its Use Potential for Recreation

AGF intensity in Latvia varies from (+45 mGal) - in Saldus area to (-38mGal) in Limbaži area. Area of the territories with positive AGF considerably exceeds the ones with negative intensity (Figure 1).

Positive gravity anomalies are of interest for recreation and treatment. The largest of them can serve as "therapeutic areas". [3] There it is possible to recommend establishment of long-term institution for all year round recreation.

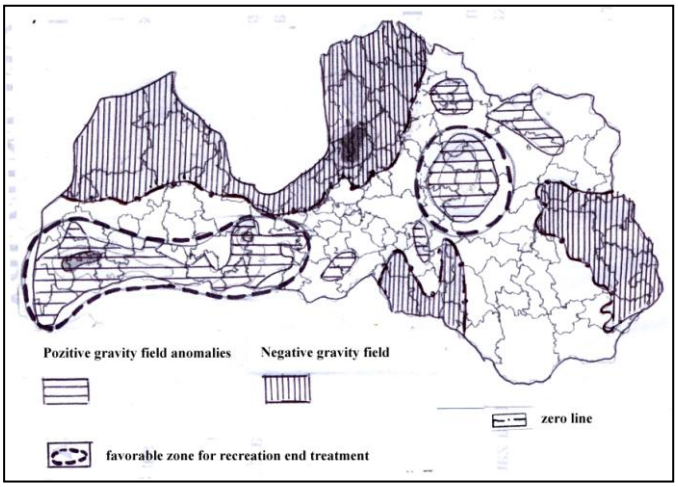

Fig. 1. Map of gravity anomalies in Latvia

The largest positive anomalies are found in Nīgrande, Dobele Vecpiebalga with the intensity (+26 mGal) to (+45 mGal).

Gravity anomalies in Latvia can provide significant health benefits: strengthen the immune system, contribute to calcium assimilation and improve the musculoskeletal system functioning, etc. Development of the positive gravity anomalies as places for recreation and health promotion, their popularisation in Latvia and abroad will ensure high health care and economic effects for the country.

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Effect of Physical Training on Psychomotor Speed in the TMT A and B Test in Athletes

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Keywords **– physical effort, cognitive functions, graphomotor efficiency, Trial Making Test part A and B**

V. Introduction

Physical effort – especially long-term or high-intensity, increases the activity of not only skeletal muscle but also central nervous system, and circulatory and endocrine systems. Regular physical activity improves concentration of attention, logical thinking, quick decision-making, and memory [1,2].

This study aims to assess the impact of physical training on psychomotor velocity in athletes.

II. Materials and Methods

Participants: 43 people who participated in sports camp (group of young football players).

The average age of respondents was 16,65±0,75 years old (min.15, max.19), the mean time of training 3 years, the average number of training sessions in week 3 and duration of training at least 1.5h.

The examination was conducted twice: before and about 1.5 hours after physical training. Graphomotor efficiency was assessed by the Trial Making Test part A and B (TMT A and B) performed in a magnetic field with the use of MedTablet software. The average time of drawing [s] was measured.

Trial Making Test waas composed of two parts A and B. In both parts there were 25 circles distributed over the paper. The first part of the Trial Making Test consisted from circles from 1 to 25. Part B included both - numbers (from 1 to 13) and letters (A - L). Patient's task was to draw lines between circles in correct order - in part A - to connect the numbers (1-2-3-4 etc.); in part B - to connect the numbers and letters (1-A-2-B-3-C etc.) [3].

III. Results and Discussion

It was found that the average time of TMT before physical training in part A was 35.74±(14,77)*s*, in part B *is* 67.93 ±(25,91)s, and after training the average time in part A was 26,70±(11,94)s, in part B was 48,91±(16,81)s. There was a statistically significant difference between the average time of drawing before and after physical training in part A TMT (p=0.0025) and part B TMT (p=0.0001). The results were verified by Student's t test for dependent samples.

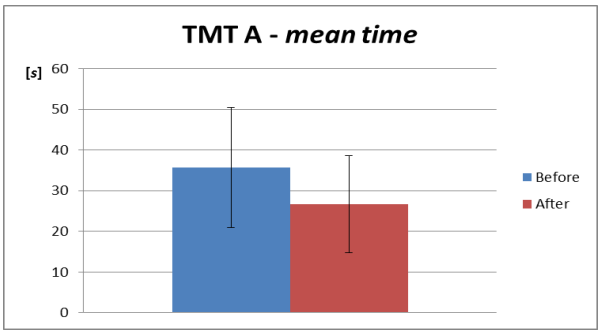

Fig. 1. The comparison of mean time of drawing of Trial Making Test part A before and after physical training.

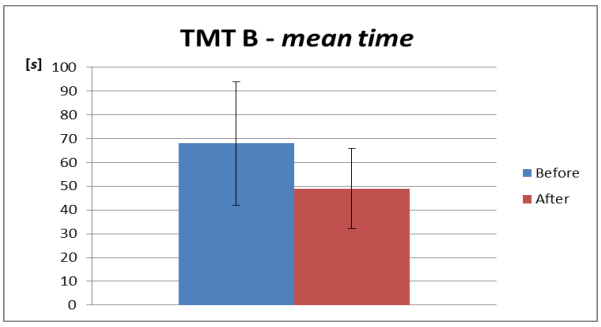

Fig. 2. The comparison of mean time of drawing of Trial Making Test part B before and after physical training.

IV. Conclusions

Psychomotor velocity measured by TMT A and B test after the physical training increased significantly.

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Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
The 1st Congress of World Engineers and Riga Polytechnical Institute / RTU Alumni

Accelerometer Network for Human Posture Monitoring

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Keywords **- posture monitoring, sensor network, accelerometers, wearable technology**

I. Introduction

Scoliosis is a medical condition in which spine is curved form side to side and also vertebrae are rotated around spinal axis [1]. It starts as some minor defect, but during rapid growth (usually teenage girls) the spinal defect is amplified. After the rapid growth cycle has ended, there are no effective means of correction short of surgery. The most common treatment is a hard material back brace which forbids the growing teenager from assuming the unwanted spinal posture, which would contribute to the growth of deformation. These braces must be worn for up to 23 hours a day and are both expensive and uncomfortable.

In recent years acceleration sensors have become both small in size and low-cost. These accelerometers can provide accurate inclination measurements. In this paper we propose a smart wearable device consisting of accelerometer network aligned in grid formation as an alternative to hard braces. This kind of system could monitor spine deformities in real time and provide biofeedback. In addition this data can be logged for later review by medical staff.

Although several different solutions have been presented [2,3], most of them have considerable limitations which restrict detailed posture measurement and analysis. Our approach aims to remedy these shortcomings by greatly increasing the number of sensors used.

II. MethodS

Our device consists of 16 custom built sensor boards arranged in regular grid formation. Sensor data is acquired by ^C MSP430 using SPI interface and sent to PC for analysis (Fig. 1). Sensor network is attached to human back using elastic bands. Each sensor corresponds to one segment.

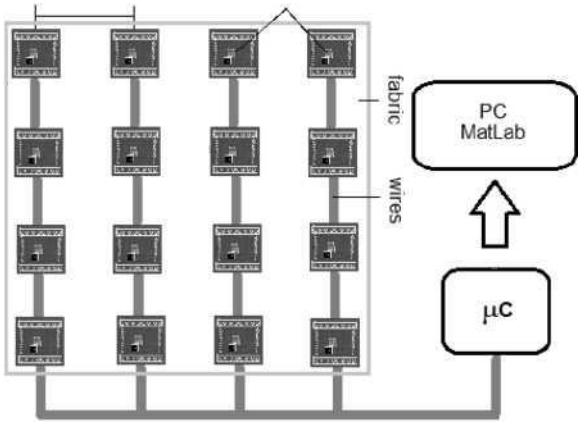

Fig. 1. Device structure scheme.

In static conditions accelerometer readings contain acceleration only due to gravity. Using this phenomenon it is possible to obtain inclination angles of each sensor. By comparing individual inclination angles we can obtain relative sensor positions and approximate the shape of human back.

For sensor mounting error compensation, calibration algorithm described in was performed.

III. Results and conclusions

Experimental system and data processing algorithm for back model approximation was developed and tested. System consists of 16 accelerometers and ^C. Data processing is performed on specially designed software in MatLab environment. Examples of test postures and corresponding approximated back surfaces can be seen in figure 2.

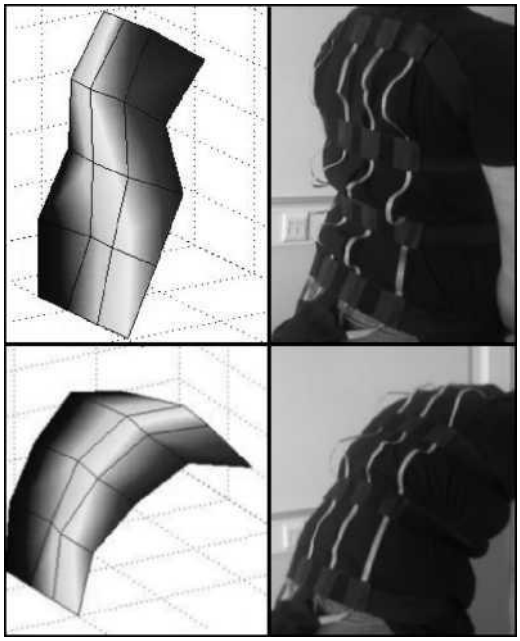

Fig. 2. Test postures and approximated human back models. Top - normal upright position, bottom - bending forward position.

Tests proved accelerometer network validity for human posture monitoring. Obtained data can be used for patient biofeedback or logged for later analysis. In addition increase of sensor amount and optimization of data processing algorithm could significantly improve system performance.

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Bionics in Planning of Habilitation for Children with Cerebral Palsy

Evgueni Dukendjiev (*Atypical Prosthetic Laboratory)*

***Keywords* – bionics, time/energy, habilitation, cerebral palsy.**

I. INTRODUCTION

The process of habilitation of paediatric cerebral palsy is possible only through imperative locomotor activity of a child with the help of external energy and information, i.e., by using a locomotor robot.

II. METHOD AND RESULTS

Assessment of integral deficit of muscular and controlling activity (which needs to be compensated by external energy and information) comes down to defining the difference between biomechanical and neurological activity in health and in disease by comparing a set of parameters of chronological age in health with the actual child's chronality parameters. The difference between these values creates the aggregate amount of deficit (Δ) followed by the amount of free time (D) and the amount of external energy (E) necessary for habilitation.

According to the method suggested by G.Doman [1] the patient's neurological age is determined by two criteria – manual competency and mobility in actual reality and in comparison to those typical for a specific age. The difference Δ_{GD} [in months] between neurological and chronological age serves as quantitative indicator of the deficit of controlling activity. According to the author's method, biomechanical age is determined by several criteria: mass, height, amplitude of flexion-extension angles of the legs, legs shape, and proportions of the body dimensions in the course of growth, which are compared to chronological parameters. The difference Δ_{ED} between biomechanical and chronological age serves as quantitative indicator of the deficit of muscular activity. The overall deficit is determined by adding up the components

$$\Delta = \Delta_{GD} + \Delta_{ED}[\text{months}] \quad (1)$$

The lane of the locomotor robot should move at the minimum speed of V=0.1 [m/s]. The overall distance is determined by the choice and combination of various locomotion types $S = S_1+S_2+S_3$ [meters]. Locomotive sessions should coincide with the time of consumption of external biochemical energy, i.e., there should be five of them. Duration of an individual session (d) is calculated as follows:

$$S[m]:V=0.1[m/s]=D[c]:5\text{sessions}=d[s]x60x60=d[\text{hours}] \quad (2)$$

To the functional time $t_ф$ the time for communication, bathroom, etc., in the amount of at least $\Delta t_0=0.8\ t_ф$ should be added. After that the time balance for one day is calculated as follows:

$$t_ф + \Delta t_0 + D \leq 12 \text{ hours} \quad (3)$$

Change in the value of the components is possible providing that the overall resultant amount is constant depending on the condition of a child and the habilitation stage.

III. DISCUSSION

In case of the deficit exceeding 2 years (Δ=24 months) the computations are already made on the basis of minimum required time of sessions in one day. It is formally assumed that free time is equal to 12 hours and the number of physiologically required sessions is five. Then, the conditional duration of a session is calculated by the following formulas:

$$\Delta[\text{months}] \times 30\ [\text{days in one month}] = \Delta[\text{days}] \quad (4)$$

$$\Delta[\text{days}] \times 12[\text{hours}] \times 60\ [\text{min}] \times 60\ [\text{sec}] = \Delta[\text{sec}] \quad (5)$$

$$\Delta[\text{sec}] : 5\ [\text{sessions per day}] = d[\text{sec in one session}] \quad (6)$$

After that the chart is drawn that is patterned and the time balance for one day is obtained. In case of the late start of habilitation process and significant pathologies present the time balance may turn out negative. In that case it becomes necessary to increase the overall duration of habilitation process despite the fact that the obtained results are not going to achieve the intended effect.

For planning the process of habilitation and design of the robot it is necessary to determine the energy expenditure during locomotions on the robot. At a first step the net metabolic capacity ($Ë_в$) is determined, which corresponds to energy expenditure per time unit, where the amount of energy consumption during rest is subtracted from gross registered metabolic capacity by the formula suggested by Mahadeva A.O.

$$Ë_в\ [\text{kcal/min}]=0.047Q + 1.024 \quad (7)$$

where Q[kg] – the child's weight.

The formula is valid at the lane speed of up to 1.34[m/s]. Obtained values serve the basis for planning external biochemical energy – the child's feeding schedule. For calculation of the amount of external physical energy during walking on the lane the calculation table 22 designed by Zatsiorsky V.M. [2] is used. The pace speed of V = 0.1 ÷1.8 [m/s] requires net metabolic capacity $Ë_в$ from 1.13 to 9.97 [W/kg]. Accordingly, during the session that lasts d[sec] the amount of energy required is:

$$Ë_в[\text{W/kg}] \times d[\text{sec}]=E_{session}[\text{W/sec}]=0.27E_{session}[\text{kW/hour}] \quad (8)$$

IV. CONCLUSIONS

For compensation of the overall deficit the external energy for the biotechnical system "child-robot" is required .

$$E[\text{kW/hour}]= \Delta[\text{sec}].\ Ë_в\ [\text{W/sec}]x\ 0.27.$$

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Assessment of the Dynamics Parameters of the Dominant Hand Movement in Patients with a Nervous System Disorders

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Keywords **– central nervous system diseases, graphomotor skills, analysis of biomechanical signals**

I. Introduction

In opioid dependence patients the impaired psychomotor function has been observed. The study compared the characteristics of the dominant limb tremor signal for two different types of tasks: drawing geometric figures and the own signature.

Precision mapping of geometric figures requires the full involvement of centers of the nervous system responsible for eye-hand coordination. The signature is written in an automatic way, and its form and character are associated with repeated and long-term repetition of similar movements. A signal representing the spectral analysis of upper limb tremor during psychomotor testing can be used as an objective measure supported diagnostic process.

II. Aims

The aim of the study was to assess graphomotor and psychomotor skills and eye-hand coordination in different patients groups: patients with schizophrenia and patients treated with substitution therapy in opiate addiction, both HIV (+) and HIV (-). Results were compared to healthy control group. Studies allow an objective assessment of qualitative and quantitative analysis of the dynamics of movement and tremors of the upper.

III.Materials and methods

70 opioid-addicted patients were examined twice, immediately before and about 1.5 h after oral administration of therapeutic dose of methadone. Among them 38 were HIV positive and 32 were HIV negative. 30 patients with schizophrenia and 15 healthy group patients were also examined.

The original test implemented on a tablet was used. The most accurate mapping of geometric shapes printed on the sheet, by drawing on dominant hand contour was the task for patients. Patients were also asked to sign up on the test sheet. The original test implemented on tablet was used. Designed software allowed an analysis of the motion's parameters: force levels, the time of the task, speed and acceleration of the plot, the amplitude and frequency of hand tremors. Results were compared with healthy group.

IV. Results

The analysis of opioid-depended patients showed a reduction of the amplitude of tremors in the spectrum of variations in 13 of the 16 components after administration of single dose of methadone in the drawing task. All the components in the spectrum of the instantaneous velocity tremors were reduced also. In the signature task a significant reduction in the average amplitude of tremors for medium and higher spectral components (from the 4th up) and a reduction in the amplitude of tremors in the spectrum of instantaneous velocity for most precisely analyzed components were observed.

There was slightly lower amplitude of tremors for a basic component in the spectrum of tremors' deviation in the healthy group compared to patients with schizophrenia. At the same time slightly increase in amplitude of tremors for 2, 3 and 8 component of the spectrum was observed. In significant task a significant reduction in tremor amplitude in the spectrum of variation for the components in the middle range (5Hz to 9Hz) and significant change in the spectrum of tremors of force levels for the constituent from 2Hz to 5Hz and 7Hz to 16Hz was observed.

Analysis of the spectra of tremors in the task of drawing figures indicate a slight deterioration in the stability of the execute motion (increase in amplitude for the lower component in the spectrum of tremors) in patients with HIV(-) and statistically significant improvement in the stability of motion in patients with HIV(+) (reduction of amplitude variations for all components, $p < 0.05$).

V. Conclusions

A single dose of methadone in opioid-addicted individuals reduced dominant hand tremors, particularly in the 1st spectrum component frequency for the drawing test. This indicates an improvement in graphomotor and psychomotor functions. Comparison of the dynamics of motion in patients with schizophrenia to healthy subjects in the control group indicated a significant impairment of graphomotor and psychomotor efficiency. Particularly, the most differentiate these two groups refers to parameters quantitatively measured the level of tremors the dominant hand tremors, mostly in the fundamental frequency. Administration of a single, therapeutic dose of the substitution will improve stability of the performed motion which has been observed particularly in HIV positive patients.

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The Prospects Composites Based on Polymer Materials as Implants for Orthopedics and Traumatology

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I. Introduction

Experts in the field of medical materials are constantly creating new materials to enhance the process of regeneration of bone tissue. Promising in this respect are the (co) polymer composites with calcium phosphate.

II. Research objectives

To study the biological properties of these composite materials: (1) copolymer polyhydroxybutyrate (PHB) polyhydroxy valerate (PHV) and (2) copolymer tetrafluo-roethylene with vinylidene fluoride (TFE \ VF) with the addition of hydroxyapatite (TFE\VF – HA).

III. Materials and methods

Experimental samples of PHB / PHV were three-dimen-sional porous matrices with a monomer ratio of hydroxybutyrate and hydroxyl valerate 86 mol% and 14 mol%, respectively. Experimental samples of TFE / VF – HA were a composite volume, printed on the disks of titanium alloy, with a ratio by weight of polymer (TFE / VF): filler (HA), 70:30, 50:50, and 30:70 %.

The composites were sterilized using ethylene oxide and their osteogenic properties were studied *in vivo* in male mice of a line BALB / C using the test "bioreactor *in vivo*" in our modification. Toxicological tests, apyrogenicity and sterility of composite materials were carried out in accordance with ISO 10993.

IV Research results

Study of tissue response to subcutaneous implantation of PHB / PHV showed their high biocompatibility: no signs of inflammation or a weak encapsulation, indicating a slight local irritation of the connective tissue. In thin sections of the structure of the cellular matrix of PHB / PHV disordered located unstained polymer scales were present, among which were the open pores of different shapes and sizes. The pores were filled with non-uniform loose unformed connective tissue with areas of adipose tissue. Biodegradation of copolymer proceeded by multinucleated giant cells of foreign bodies. However, the growth of bone tissue was observed. In addition, the metal substrate without the biomechanical properties of bulk PHB / PHV did not meet the requirements for bone grafts.

Further, as the matrix copolymer TFE / VF was studied, due to its following properties: high chemical resistance, good physical and mechanical characteristics, heat resistance and thermal stability and biological inertness. Polymers of this type are used for the manufacture of implantable devices that are in prolonged contact with a living organism, such as prostheses for the surgical treatment of hernias Uniflex.

Histological sections revealed bone and bone marrow cavities filled with red bone marrow. In porous samples (TFE / VF, HA 30:70, 50:50 wt.%) there was bone growing into the pores of the coating. In the low-porous material (TFE / VF, HA 70:30) the growth of bone tissue occurred on the surface to form a composite bone plates without bone marrow.

V. Conclusions

1. Materials subjected to sterilization with ethylene oxide, are non-toxic, sterile and apyrogenic and do not have local irritating effects.
2. The probability of formation of ectopic bone formation in the test depends on the content of hydroxyapatite in composite material. Therefore, the copolymer PHB / PHV is not suitable as implants for bone tissue
3. The best indicators of elasticity and adhesion strength (ψ = 12,1 × 106kg/m2) have a composite TFE / VF-HA containing hydroxyapatite 30 wt.%.
4. Most likely the formation of bone tissue has a composite TFE / VF-HA containing hydroxyapatite 70 wt.%.
5. According to the results of tests *in vivo* and *in vitro* composite TFE / VF-HA containing HA 50 wt.% is optimal for biological material and mechanical properties for the growth of the bone / bone marrow.

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First Principles Studies of Hydroxyapatite Structure and Properties

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Anna Bystrova and Yuri Dekhtyar (Riga Technical University)

***Keywords* – Hydroxyapatite, *ab initio* and semi-empirical calculations, molecular modeling, properties and surface peculiarities.**

I. Introduction

Results of first principles calculations of Hydroxyapatite (HAP) nanostructures in combination with computational molecular modeling by various methods are presented. The detailed explorations of the bulk and surface HAP properties are analyzed in this review. HAP structures and properties were studied from first principles approaches using *ab initio* Local Density Approximation (LDA) method in combination with various quantum-chemical (QM), including semi-empirical (PM3, etc.), Density Functional Theory (DFT) and molecular mechanical (MM+, OPLS, BIO CHARM) methods from HypemChem 7.5/8.0 package. The optimizations of lattice parameters and atoms positions were performed for hexagonal and monoclinic HAP structures with different orientation of hydroxyl group in HAP OH-channels.

II. Results

The obtained structural and energy LDA data allow us to compute HAP bulk modulus: B ~ 82 GPa for used Ca-pseudo-potential and wave function with 2 electrons of the shell approximation (WF1); and B ~ 96 GPa for 10 electrons of the shell approximation with involved d-electrons (WF2) of Ca atoms. These data are well comparable with known experimental and calculated data. On this base we calculated the density of state (DOS) for several approximations with different charges Q of bulk lattice unit cell. For initial state with Q = 0 we obtain the value of forbidden zone gap Eg = 5.68 eV for WF1 and Eg = 5.44 eV for WF2. These results are good agreement with experimental and computed data and well correspond to that fact, that for case of WF2 with the involved 10 electrons, Ca atoms create most strong interactions in the HAP nanostructures. The biggest value of bulk modulus confirms this conclusion too. From other side obtained data allow us to make the first estimation of the influence of bulk charges on the surface charged state of HAP structures and the changes in the HAP work function. It is necessary for further detailed study of the established most strong interaction of charged HAP surface with living cells (such as, e.g., with osteoblasts in bone tissues). Another task of this our work was focused on the using of the computed *ab initio* structural HAP data with variation of lattice parameters for modeling of the interaction of HAP with citrate species at the different concentrations (ratio [Citrate:Ca]). Obtained data show clearly the positioning of the interacting sites for citrates molecules on the HAP surface and allow us to propose the new mechanism for the formation of the various HAP nanostructure shapes under influence of various citrate quantities in the initial starting solution for HAP precipitation. Additionally, in this work the new computed data for HAP nanoparticles with size and shape variations, which are used for modeling of its interactions with carbon nanotubes was analyzed. These data are very important for further multifunctional nanotechnological and biomedical applications of HAP nanostructures.

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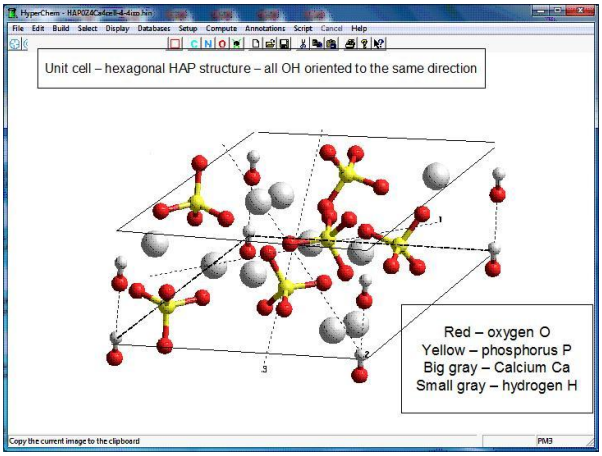

Fig.1. AIMPRO optimized models of hexagonal HAP unit cell structure in molecular HyperChem image's presentation.

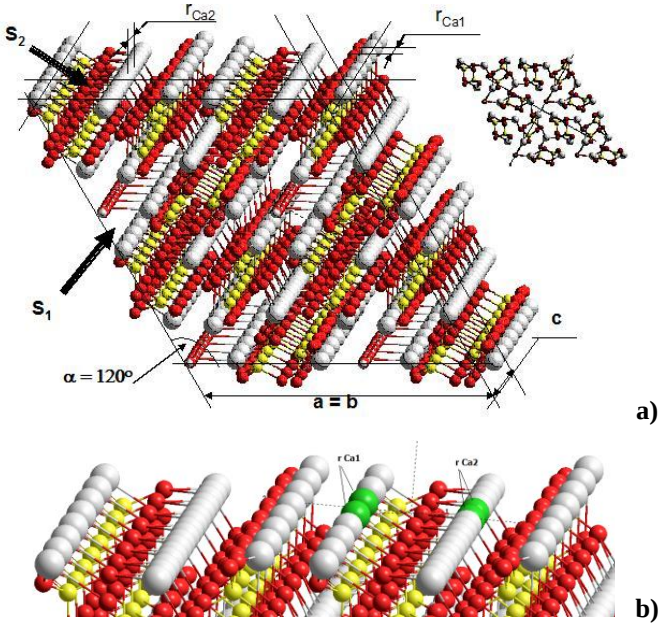

Fig.2. Molecular model of HAP cluster constructed in the HyperChem on the base of preliminary AIMPRO optimized crystal structure and all atomic positions: a) iso-projection image, b) main Ca positions on HAP surface (Ca1 and Ca2).

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New Biphasic Calcium Phosphate in Orthopedic Surgery: First Clinical Results

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***Keywords* – Biphasic calcium phosphates, ceramics, bone defects, bone substitutes.**

I. INTRODUCTION

Numerous studies have already revealed the superior osteoinduction of implanted biphasic calcium phosphate (BCP) bioceramics consisting of hydroxyapatite (Hap) and β-tricalcium phosphate (TCP) over pure HAp [1]. In current study the BCP ceramic granules with HAp/β-TCP ratio of 90/10 were selected. Objective of this study was to evaluate the first results of BCP ceramic granules with HAp/ β-TCP ratio of 90/10 as bone substitute for reconstruction of the bone defects in orthopedic surgery.

II. MATERIALS AND METHODS

A. Preparation of BCP ceramic granules

Calcium deficient hydroxyapatite (CDHAp) was synthesized by aqueous precipitation technique, where calcium hydroxide and phosphoric acid was used as raw materials following the reaction $Ca(OH)_2 + H_3PO_4 \rightarrow Ca_{10-x}(HPO_4)_x(PO_4)_{6-x}(OH)_{2-x} + H_2O$. The filtered precipitates were formed into granules, dried and sintered at 1150 ^oC for 2 hours. The sintered granules were sieved using vibrational sieves to gain the granular fraction in sizes from 1 to 1.4 mm.

B. Clinical cases

This study is a retrospective evaluation of twelve randomly chosen clinical cases of patients who had undergone surgeries with BCP implantation. Follow up period range from 2 to 8 months, on average 4.5 months.
Three patients were male and nine female. Age ranged from 22 year to 84 year with mean age 62.2 years.
Bone defects were classified according to the etiology - orthopedic (5 patients), traumatic (4 patients) and due to osteomyelitis (3 patients). Regarding morphology, defects were divided into cavity bone defects and segmental bone defects were measured on the digital x-ray images.

C. Clinical and radiographic evaluation

The classification of results was based on clinical (functional, scored 0 to 3) and radiographic (integration of the biomaterial and callus formation, scored 0 to 3) assessments.

The final results represent sum of both parameter scores: 0-2 poor results, 3 moderate results, 4-5 good results and 6-excellent results. Classification and evaluation method was similar as in recent publications [2].

III. RESULTS

A. Clinical results

Combined scores were calculated in each group: cause and morphology of defect. Our overall results showed that in short term 7 out of 12 patients had good results and rest 5 patients had moderate results.
The size of defects ranged from 1 cm to 32 cm, average 6.42 cm, and median 3 cm.
The amount of bioceramics used to fill bone defects on average was 22.5 grams (range 5 g to 60 g).
Comparing patients with different cause of bone defects we found that the best results are after elective orthopedic procedures with good results in four cases out of five. Trauma patients had good results in two cases out of four. Among three cases with osteomyelitis one was with good and two with moderate results.
Regarding size of the bone defect we find better results for patients with bone defect less than 3 cm. In this group five out of seven had good results. We also should take into account that patients with bigger bone defects had more invasive surgery that influences the overall result.

IV. CONCLUSIONS

The best results were obtained from patients after elective orthopedic procedures and patients with bone defects less than 3 cm.
Our bioceramics is good alternative to fill small and large bone defects both in cortical and cancellous bone areas and could be good alternative for bone defect reconstruction.
First results are positive and we will keep follow up for these patients to collect late clinical data of bone defect healing and biomaterial osseointegration.

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Novel Synthesis Method and Biomedical Applications of Doped and Undoped Hydroxyapatites and Fluoroapatites

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Keywords **– Calcium apatites, synthesis, saline melts, biomaterials.**

I. Introduction

The need for reliable and economically expedient biomaterials for treatment of changes and diseases of the musculoskeletal device increased during the last years. Calcium Hydroxyapatite (CaHAP, $Ca_{10}(PO_4)_6(OH)_2$) is the main mineral component of bone fabric and a synthetic form of one of most widely used biomaterials for skeleton reconstruction due to the lack of local or system rejection. Calcium Fluorapatite (CaFAP, $Ca_{10}(PO_4)_6F_2$) is an important component of tooth enamel, and materials on its basis are used for fight against caries and for tooth prosthetics [1].

II. Experimental part

A. Synthesis of apatites in saline melts

Calcium apatites (further CaHAP and CaFAP) are received by the way of synthesis in saline melts developed earlier [2], combining the main advantages of the "dry" (rapidity of process) and "wet" (completeness of reaction and a rather high degree of dispersion of products) methods. The phase structure and parameters of lattices of phases of the received materials are defined by the X-ray diffraction phase analysis (Fig 1 f.v.). The IR – spectra (Fig. 2 f.v.) of both samples have similar character, namely: in the interval of 3300- 3700 cm^{-1} there is an intensive diffuse ("hydrate") band, and also characteristic bands in the intervals of 500- 1500 cm^{-1} and a 1500-1700 cm^{-1}, peculiar to the vibrations of atoms in PO_4^{3-} and CO_3^{2-} ions respectively. Possibility of application of nano-sized CaFAP for the removal of reasons of hypersensitiveness of tooth dentine is shown [3]. The two microphotos (Fig. 3) show that cells of tubules blocked up from the surface with nanoparticles of fluorapatite material differs very little in appearance from the basic material.

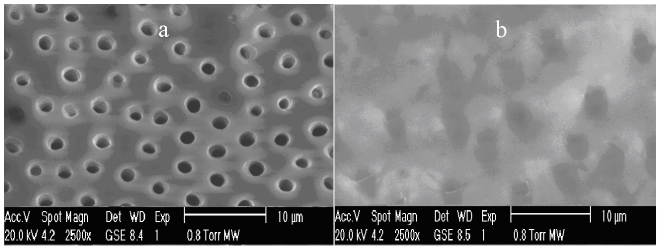

Fig. 3 Microphotos of a zone of a hyper sensitive dentine of tooth before (a) and after laser penetration (b)

B. Surface modification of CaGAP CaFAP with Ag^+, and Pd^{2+} ions

In this paper, Silver-containing apatites as promising biocompatible materials with antimicrobial properties, as well as Palladium-containing apatite as anticancer biocompatible materials and catalysts are obtained usually, by Ag^+ and Pd^{2+} sorption from solution.

As the result of Ag^+ sorption the parameters the *a* and *b* lattice of CaFAP are markedly increased, and the *c*-lattice parameter is somewhat reduced. The sorption of Pd^{2+} leads to some reduction of all crystal lattice parameters of CaHAP.

It is suggested that for the combination of Ag^+ and Ln^{3+} ions, the following relation applies:

$$z_{Ag^+} + z_{Ln^{3+}} = 2z_{Ca^{2+}}, r_{Ag^+} + r_{Ln^{3+}} = 2r_{Ca^{2+}} \quad (1)$$

where *z* and *r* are an ionic charge and radius, respectively, will make it possible to break a barrier of discrepancy and incompatibility of ions of "guest" and "owner".

Reduction of modified Ag apatites with hydrazine, according to the scheme:

$$4Ag^+ + N_2H_4 \rightarrow 4Ag\downarrow + N_2\uparrow + 4H^+ \quad (2)$$

Reduction of Palladium by hydrazine (3) occurs to the same scheme as previously stated for Silver (2):

$$2Pd^{2+} + N_2H_4 \rightarrow 2Pd\downarrow + N_2\uparrow + 4H^+ \quad (3)$$

III. Conclusions

In the addition to a previously proposed method of synthesis in the saline melt KCl-NaCl (700 º C), a new, low-temperature method of synthesis from a nitrate saline melt, facilitates the formation of a product with a high content of apatite nanoparticles. It is shown that nano-dispersed CaFAP offers new paths in medical practice for the treatment of dentine hypersensitivity. Also the ion-sorption of Silver and Palladium ions by apatites from solutions, followed by reduction of obtained Silver and Palladium-apatites, can be called promising for medicine, in particular as antimicrobial and anticancer drugs.

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Hydroxyapatite-based Coatings Containing Silicate Ions for Medical Implants

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Keywords **– RF-magnetron sputtering, calcium phosphate coating.**

I. Introduction

This study reports on hydroxyapatite (HA) coatings and HA-based coatings doped with silica ions, which possess both a higher resorption rate in comparison to pure HA, and an improved bioactivity.

Plates of Ti, Ti6Al4V and 316 L SS were used as substrates. The targets consisted of a powder of Si-containing HA (Si-HA) and Ca10(PO4)6-x(SiO4)x(OH)2-x (x=0.5 and 1.72) were used. Thin nanostructured CaP-based coatings were deposited by RF-magnetron sputtering (RFMS) at the power level in the range 30-290 W, negative substrate bias up to 100 V, a pressure of 0.1 Pa for 30-180 min [1]. The thin coatings were characterized by EDX, ESEM, XRD, IR spectroscopy, and pull off test.

Biological trials on Si-HA films were done *in vitro* with culture of prenatal stromal cells of human lung (PSCHL, FL-42 line) obtained from Bank of Stem Cells Ltd. (Tomsk). We used carcinogen-free cell populations of different shape and size with limited life period, maintaining a stable karyotype during passages. The cells were free from foreign viral (AIDS, hepatitis, herpes etc.) and fungous agents. After defrosting, the cell viability as tested with trypan blue 0.4% according to ISO 10993-5 was 91-93 %. The discs tested (surface area 1.77 cm2) were placed into wells of 24-well plates (Orange Scientific, Belgium); and cell suspension in the concentration of 30000 viable karyocytes in 1 ml of osteogenic culture medium was added. Cell culture on plastics was used as growth control.

II. Results and Discussion

The as-deposited Si-containing CaP-based coatings were dense, pore-free and their composition resembled that of the precursor target composition. The chemical and the phase composition as well as thickness and structure could be varied by a particular set of deposition control parameters. A low rf-power density (0.1-0.5 $W \times cm^{-2}$) resulted in amorphous or low crystalline CaP-coating structure whereas an increase in rf-power level (>0.5 $W \times cm^{-2}$) induced the coating crystallization. The negative substrate bias allowed varying the Ca/P ratio in the range of 1.53 to 4. The adhesion strength of the coatings was higher than 40 MPa, i.e. it met the requirements of ISO 13779. PSCHL had diverse morphological forms in the case of short-term (4 days) contact with coatings tested. For example, 85-90 % of cells had a round or ellipsoid shape. Fibroblast-like cells were observed in the areas of significant microroughness. Cells also spread into the valleys of artificial surface. Such cells in the surface valleys showed a high expression of alkaline phosphatase (ALP). ALP is considered as general marker of maturation and osteogenic differentiation of stromal stem cells.

Incorporation of silicate-ions into the composition of the smooth RFMS-deposited HA coating increased by 2.5 times (Pu<0.001) the release of calcium in vitro into the electrolyte (0.9 % sodium chloride solution) (Table 1) at the same HA and Si-HA coating roughness (Ra < 1 μm).

TABLE 1. The Ca^{2+} concentration after 7-days of dissolution of samples with RF magnetron sputter deposited coatings in the 0.9 % sodium chloride solution at 37°C with 30 mg/L of gentamycini sulfas, X ± m, p

Number of group	Samples, n=6	Ca^{2+} release into solution, % of control
1	Magnetron sputtering on Ti scaffold, HA coating	354 ± 68
2	Magnetron sputtering on Ti scaffold, Si-HA coating	947 ± 74* <0.001

*Note: as controls there were extracts of titanium scaffolds without the coatings; *) is the statistically significant discrepancy according to Student's t-test.*

Moreover, the tissue plate formation increased from 0 % (in case of HA) up to 50 % (in case of Si-HA coatings 3 out of 6 implants promoted ectopic osteogenesis). The histological composition corresponded to the bone tissue with lacunes filled with red bone marrow (Fig. 1).

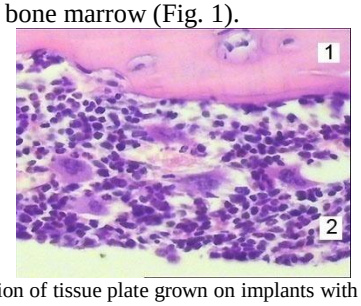

FIG 1. Cross section of tissue plate grown on implants with RFMS-deposited CaP coating in heterotopic test with mice. 1 - bone tissue; 2 - bone marrow. Stained with hematoxylin and eosin (magnification ×200).

III. Conclusions

Si-containing RF-magnetron sputter deposited coatings are prospective to be used in clinical practice, i.e. in stomatology or craniofacial medicine, where the initial material surface porosity for a further bone in growth should be preserved. The coating allows us to enhance the surface bioactivity compared to pure HA.

IV. References

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Engineering of the Hydroxyapatite Cell Adhesion Capacity

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Keywords **– hydroxyapatite, doped hydoxyapatite, osteoblasts, electrical charge engineering.**

I. Introduction

In spite of the high success in understanding of human cells interaction with bone replacing bioimplants in a human there are still biocompatibly problems. These often are connected with eligible human cells incapability for attachments to the implant surface that influence regeneration of bone tissue.

Following the general adhesion theory attachment of the cell to the bioimplant is controlled in particulary by an electrostatic force contributing interaction between the cell and the implant. Generally the electrical communication could be engineered owing to a surface electrical potential of the implant. The potential could be supplied by the both external sources and the surface itself.

Hydroxyapatite (HAP) is the popular material for the bioimplants. The technologies that are typically in use to engineer the electrical charge of the HAP employ its electrical polarization due to the external electrical field or because of radiation. In both cases the opposite surfaces of the HAP based implant are acquiring the unlike (in sign) charges. Therefore differently charged implant surfaces could induce cell processes in the opposite directions, that is undesirable. Therefore the considered technologies are restricted.

However to reach the uniformity of the electrical charge distribution a reconstruction of the HAP ion subsystem of the entire surface layer could provide polarization vectored from/to the bulk. By this way the uninformety of the charge distribution could be reached.

To improve biocompatibility and stability of HAP properties the doping is applied.

The article is targeted to demonstrate a possibility of technology for electrically functionalization of the surfaces of differently doped HAP (Ar, Sr, Si).

II. Methods

The first principles methods to study proton transfer peculiarities in HAP were employed in. Ab initio quantum-chemical calculations (with HyperChem and Gaussian98 code, HF, 6-31G(d)) were held to investigate the optimized HAP structure and energy barriers on possible proton transport ways.

When HAP is disposed in a high pressure hydrogen atmosphere conditions, a strong gradient of the proton concentration directed from the bulk to the surface is supplied. As the result the proton of the HAP increased a probability to transfer from the surface location to the bulk, the stable, negative charge depositing on the surface.

III. Results and discussion

The Attachment of the cells Fig. 1 demonstrates a correlation of the number of the cells attached to HAP in dependence on the hydrogenation forced increment of φ and doping of HAP.

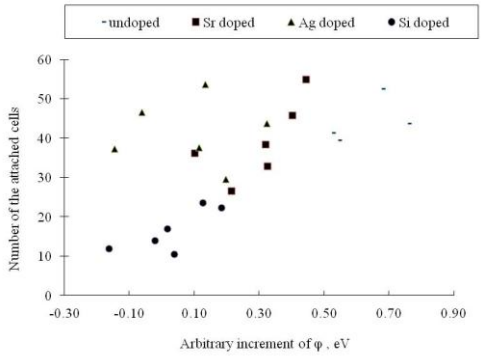

Fig. 1. Correlation of the number of the cells attached to HAP in dependence on electron work function increment and doping.

The results generally evidence that the number of the attached cells increases in dependence on φ increment. However the strongest correlation is demonstrated by Si and Sr doped HAP. Perhaps these materials are more advanced for surface charge engineering.

A. Experiment with the animals

Hydrogenation of the implant model surface layer increased its φ on ~ 0.1 eV. As the result MSCP differentiation directions was influenced. Connective tissue growth was improved. Probability of following ossification with growth of the membrane reticulated bone was 20 %. Decrease of φ on the above value led to primary formation of the bone from the marrow MSCP.

IV. Conclusions

1. The reached hydrogenation technology was able to engineer electrical charge of the HAP surface that has an influence on osteoblast attachment.
2. The Si and Sr doped HAP were more advanced materials for surface charge engineering
3. Hydrogenation of HAP based implant model influenced directions of MSCP differentiation. Connective tissue growth was improved.
4. The hydrogenation technology could be employed for the controlled engineering of the HAP surface charge to enhance osteoinduction.

ACKNOWLEDGMENT

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The Comparison of the Magnetic Field Effect on the Electric Permittivity of the PDMS Ferromagnetic Gel and the Collagen Ferromagnetic Gel

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***Keywords* – ferromagnetic, PDMS, collagen, magnetite, magnetodielectric effect.**

I. INTRODUCTION

A polymer ferromagnetic gel is an assembly of ferromagnetic particles, suspended in the flexible polymeric gel. The possible biological and medical application of such material depends on the biocompatibility of both, the polymer matrix and the ferromagnetic dopant agent. The comparison of the magnetic field effect on electric properties of ferrogels based on synthetic and natural polymers is of a particular interest.

Fabrication of ferromagnetic gel based on collagen gives the opportunity to carry out experiments simulating the behavior of real tissue contaminated with ferromagnetic material. It is worth to notice, that collagen is one of the most important and abundant protein of human body.

II. MATERIALS AND METHODS

Among many biocompatible gel-forming polymers, the PDMS (poly(dimethyl siloxane) and the fish skin collagen were used. The ferrogel based on the PDMS contained the randomly distributed magnetite (Fe_3O_4) in the form of nano-sized particles. The addition of conducting metallic particles enhances the effective electrical conductivity of the PDMS gel (2 pSm^{-1} at 20 °C), which was higher than that of pure PDMS.[1]

The second material, the fish skin collagen (FS - fish skin; *family: Cyprinidae*) obtained by means of acidic hydration process, contained randomly distributed magnetite (Fe_3O_4) grains of size 6-9μm. The iron oxide particles were distributed due to adhesive forces in the polymer matrix. Also in this case, the addition of ferromagnetic grains increased the electric conductivity.

Electric permittivity was measured in the frequency range of 400 Hz–5 MHz using the HIOKI 3523-50 LCR HiTESTER and a homemade measuring cell. Measurements were carried out at 21 °C at magnetic field. The magnetic induction uniform varying magnetic field: 0T-0.5T-0T was measured by means of a Resonance Technology RX21 type teslameter with an error of $\Delta B=\pm 1$ mT.

The anisotropy of electric permittivity was determined for the uniform magnetic field parallel and next, perpendicular to the electric field. The electric field was applied along the axis of the sample.

Information on grain size distribution and the volume fraction of magnetite in ferromagnetic gel was obtained by the analysis of the hysteresis loop. The mean diameter of magnetic particles suspended in the PDMS polymer matrix was determined to be equal to 8.9 nm and its standard deviation equaled 1.5 nm. The shape of the hysteresis loop resembles one, typical for the superparamgnetic materials [2]..

III. RESULTS AND DISCUSSION

The dispersion of the electric permittivity of the PDMS ferromagnetic gel, revealed the maxima at approximately 92 kHz and 2.5 MHz. After the application of the homogenous magnetic field, the anisotropy of the electric permittivity revealed the mutual parallel orientation of the magnetic field, electric field and the axis of the sample. The effect was temporary and disappeared, when the magnetic field was reduced to B=0T.

For the collagen ferromagnetic gel, the determined hysteresis loop, however of small surface area was typical for ferromagnetic materials. The dispersion of electric permittivity decreased with frequency, gained a minimum at 100kHz and a maximum at approximately 500 kHz. The effect of the magnetic field on electric permittivity was not noticed[3].

Found in the ferromagnetic PDMS gel the magnetodielectric effect is an indication of the coupled magnetic and elastic order and is usually described for multiferroic systems. The effect is presumably related to interactions between the external magnetic field and magnetite particles, which are coupled by adhesion forces to a ferrogel network. The effect may be related to interfacial polarization and rearrangement of magnetic particles within the polymeric network. The fact that the the electric permittivity of the PDMS ferrogel was temporarily influenced by external magnetic field can be used to control its electric properties.

IV. CONCLUSIONS

Electric permittivity of the PDMS ferrogel, contrary to the collagen ferrogel, was found as magnetic field dependent.

This crucial difference is presumably related to the difference in the size of the used magnetite that is nano-particles used in the PDMS, micro-particles used in the collagen gel and lower viscosity of the latter.

The observed, for the PDMS ferrogel, effect was reversible and dependent on the mutual orientation of E, B and sample's axis. Magnetite-doped fish skin collagen gel revealed weak ferromagnetic properties.

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Synthesis and Affinity for BDR CNS 3-(cis-arylidene)-1,4-benzodiazepin-2-ones

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Keywords – **3-arylidene- and 1-metoxycarbonylmethyl-3-arylidene-1,4-benzodiazepin-2-ones; central and peripheral benzodiazepine receptor**.

I. Introduction

There are two known classes of benzodiazepine receptors: central and peripheral.

CBDR agonists possess pronounced anxiolytic, anticonvulsive, sedative, hypnotic and other types of activities [1].

PBDR are associated with different biological functions of both human and animal organism, including geme biosynthesis, cholesterol and porphyrin transport, mitochondrial oxidation, apoptosis, cell proliferation, immunomodulation, steroidogenesis and others [2].

Modern research has shown that such neuropathological states such as multiple sclerosis, stress, epilepsy, Alzheimer's and Huntington's diseases and brain damage are associated with the expression of PBDR [2].

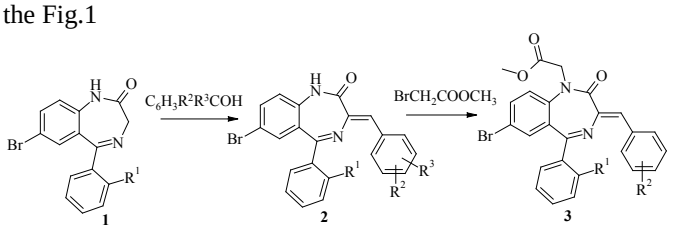
Thus, the PBDR specific ligands are promising drugs for the diagnosis and treatment of various pathologies and may help in establishing a pathogenesis basis of the psycho-neurological cancer diseases as well as the fundamental mechanisms of ligand-receptor interaction.

Previously [3], we have shown that some of 3-arylidene-7-bromo-5-(2'-chloro)phenyl-1,2-dihydro-3*H*-1,4-benzodiazepin-2-ones are PBDR selective ligands. Among them 3-*cis*-(4'-chloro)benzylidene-7-bromo-5-aryl-1,2-dihydro-3*H*-1,4-benzodiazepin-2-one was found as the most perspective. The presence of 3-arylidene fragment of either chlorine or bromine atom in the *para*-position plays an important role in the manifestation of affinity and selectivity for PBDR, as compared with CBDR [3].

In the present research, potential new ligands of central and peripheral benzodiazepine CNS receptors – *cis*-3-arylidene-7-bromo-5-aryl-1,2-dihydro-3*H*-1,4-benzodiazepin-2-ones (**2 – 3**) were synthesized and their affinity for both CBDR and PBDR of rat brain was studied.

II. Materials and Methods

Compounds **2** and **3** were synthesized according to the Fig.1



R^1 = H, Cl; R^2 = H, 4-OCH_3, 2-F, 3-F, 4-F, 2-Cl, 3-Cl, 4-Cl; R^3 = H.

Fig. 1 Synthesis of *cis*-3-aryliden- and 1-metoxycarbonylmethyl- *cis*-3-arylidene 7-bromo-5-aryl-1,2-dihydro-3*H*-1,4-benzodiazepine-2-one

Compounds 2 were obtained by the condensation of 1 with aromatic aldehydes in the presence of base. [3]. 1-Metoxycarbonylmetyl derivatives 3 have been synthesized through the interaction of compounds 2 with methyl monobromacetic acid ether in the presence of base.

Affinities of compounds 2 and 3 for CNS benzodiazepine receptors were determined *in vitro* using the radioligand analysis method and assessed by the ability of these compounds to displace competitively the radioligands: [^{3}H]flumazenil and [^{3}H]PK11195 from their places of specific binding to benzodiazepine receptors of central and peripheral types of sinaptosomal and mitochondrial fractions of rat brain membranes, respectively.

III. RESULTS

Thus, one can note that in the number of investigated series of 5-phenyl- and 5-*ortho*-chlorophenyl-3-arylidene-7-bromo-1,2-dihydro-3*H*-1,4-benzodiazepin-2-ones the following trends in the influence of positions of bromine and chlorine atom in arylidene fragment on the affinity for BDR can be traced:

ortho – Br >> meta - Br ≥ para - Br (affinity for CBDR) [3]
meta - Cl > ortho - C l > para - Cl (affinity for CBDR)
para - Br >> ortho - Br > meta - Br (affinity for PBDR) [3]
para - Cl >> ortho - Cl > meta - Cl (affinity for PBDR)

The highest ability to form ligand-receptor (CBDR) complex was found for compounds 2A (R^1 = Cl, R^2 = 3Cl, R^3 = H) and 2B (R^1 = Cl, R^2 = 3Cl, R^3 = 4Cl). These compounds are at a concentration of $1 \cdot 10^{-6}$ M compete actively with the commercial radioligand for its specific binding sites to CBDR. These compounds inhibit the specific binding of [^{3}H]flumazenil to CBDR in74.1% and 76.0%, respectively. This group of compounds is characterized by a low affinity for PBDR.

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Investigation of Degradation Behavior of Mg-1Ca Alloy for Biomedical Application in Different Simulated Biological Medium

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***Keywords* – magnesium alloy, biodegradable materials**

I. Introduction

Studies regarding biodegradable materials have shown that magnesium alloys are potential biomaterials for orthopedic application due to their major advantage to biodegrade in biological medium [1]. Calcium was selected as an alloying element for experimental materials considering that the degradation products are expected to be non-toxic [2]. This paper evaluates the interaction of Mg-Ca alloy with simulated biological medium through the evaluation of biodegradability.

II. Materials and Methods

A binary Mg-Ca alloy with 1% calcium content was chosen as experimental material. Ingots of commercial available high purity magnesium (99.96 %) and calcium (99.8%) particles were used as starting materials. Experimental samples of circular shape and 2mm x10mm size were polished on metallographic papers and washed with ethanol. For immersion tests three different mediums were used: Phosphate buffer solution (PBS), Hanks' Balanced Salt Solution (HBSS) and Dulbecco Modified Eagle Medium suplimented with fetal bovine serum (DMEM + 10% FBS). Mg-1Ca alloys were immersed in 50 ml solution each (total surface area to volume of solution =314mm^2:50mL) at 37 ˚C for 3, 7, 14, 21 and 30 days. The samples were weighted before and after the immersion. For microstructural characterization of the experimental samples was used an Olympus BX51 optical microscope and a Philips XL30-ESEM scanning electron microscope. Also, the chemical composition determination was performed using EDS.

III. Results and Discussion

The degradation process of experimental Mg alloy was evaluated during the immersion period on the basis of loss/gain weight. Also, the surface macro-morphologies of investigated alloys were analyzed using SEM. Immersed samples show different patterns of degradation depending on the type of medium and an accelerated corrosion process with increasing immersion time. In the case of phosphate buffered solution (PBS) fine crystals deposit on the surface could be noticed. Chloride ions from saline solution exhibit a reduced action on the alloy due to formation of a partially protective Mg $(OH)_2$ layer. For the samples tested in Hanks' Balanced Salt Solution (HBSS) we observed a different pattern of degradation with rapid accumulation of corrosion products and loss of integrity up to the end of the test. Corrosion products formed were adherent to the surface and EDS results showed that these products were mainly formed of magnesium hydroxides, phosphates and carbonates. The SEM micrographs and EDS result of Mg-1Ca alloy samples after immersion in PBS (A), HBSS (B) and DMEM + 10% FBS (C) for 21 days are shown in figure 1. When we used Dulbecco Modified Eagle Medium suplimented with fetal bovine serum (DMEM + 10% FBS) we observed that the proteins seem to form a passivation layer on top.

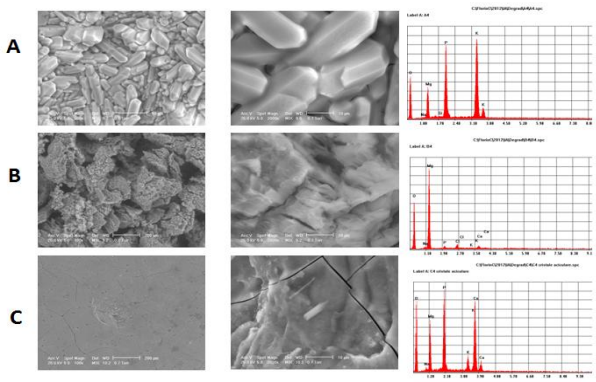

Fig. 1. SEM micrographs and EDS result of Mg-1Ca alloy samples after immersion in PBS (A), HBSS (B) and DMEM + 10% FBS (C) after 21 days

IV. Conclusions

The aim of this study was to evaluate the effects of different mediums on magnesium alloys and to determine the optimal degradation medium. Regarding this issue both phosphate-based and cell culture medium were used to study the influence of amino acids and vitamins and also proteins present in the added amount of fetal bovine serum. This cell culture condition was introduced to simulate a more physiological corrosion environment.

Metal ions released from the alloys subjected to degradation can cause reaction of surrounding tissue on short or long term, but degradation products of Mg-1Ca alloy are toxic free.

Best results were obtained in case of Dulbecco Modified Eagle Medium suplimented with fetal bovine serum (DMEM + 10% FBS). Hanks' Balanced Salt Solution (HBSS) proved to be the most agressive medium given the highly porous surface morphology and the fact that experimental sample almost desintegrated after 30 days.

Considering the immersion test results the experimental Mg-1Ca alloy appear to be suitable for medical applications.

V. Acknowledgements

Authors recognize financial support from the European Social Fund through POSDRU/89/1.5/S/54785 project: "Postdoctoral Program for Advanced Research in the field of nanomaterials".

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Influence Parameters for Performances of Polysulfone Hemodialysis Membranes

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Keywords **– polysulfone membranes, hemodialysis, influence parameters, surfactants, nanofillers.**

I. INTRODUCTION

One of the most important membrane process is the hemodialysis, due to its crucial importance for the humanity [1]. The dialysis membrane contains pores that allow small molecules such as water, urea, creatinine, and glucose to pass through the membrane readily, but the red cells, white cells, platelets and the most plasma proteins are retained [2]. This paper presents an experimental study through some parameters that can affect or influence the performances of these membranes in terms of specific fluxes through these membranes or in terms of specific retention of interest chemical species or toxic cations.

II. MATERIALS AND METHODS

Several factors were studied, such as the influence of initial solution polymer concentration for membrane formation, the use of surfactants in casting solution, the use of nanofillers for composite membranes synthesis (carbon nanotubes, fullerenes, magnetic nanoparticles and other polymers, such as polyaniline, polypyrrole and polyethyleneimine).

For the synthesis of membranes a commercial polysulfone was used (Ultrason S3010, provided from BASF) and as initial solvent was used only N-methyl-pyrrolydone (NMP). For the study of initial concentration of polymer solution, three concentrations were analyzed: 12%, 15% respectively 18% polysulfone in NMP.

The influence of membrane porosity was studied by using different anionic and cationic surfactants for the modelling of membrane pores. As nanofillers, commercial nanotubes and fullerenes (for the retention of heavy metals) and magnetic nanoparticles (synthesized after a modified Massart method [3]) were used (also for the retention of different chemical species).

The polymer-polymer type composite membranes were synthesized by a new method (phase inversion accompanied by chemical reaction) in the case of polysulfone-polyaniline and polysulfone-polypyrrole [4] composite membranes and by dynamic filtration in the case of polysulfone-polyethyleneimine composite membrane.

The specific fluxes through synthesized membranes were studied using synthetic blood solution and physiological serum.

III. RESULTS

The influence study of initial polymer solution concentration revealed that with the increasing of concentration a flux decrease appears (from approx. 110 L/m^2h physiological serum for 12% polysulfone in NMP to approx. 20 L/m^2h physiological serum for 18% polysulfone in NMP).

The modeling of membrane porosity could be very finely controlled by the use of appropriate surfactant (anionic or cationic. From the same polymer solution (12%), the flux of physiological serum could be varied from 110 to 130 L/m^2h by using a proper surfactant in the casting solution.

The composite membranes with nanofillers were used for the retention of different heavy metals cations which can appear in blood in severe intoxications (like lead, mercury or copper). The principal of these membranes is based on the adsorption of these cations at the surface of these nano-species through elctrical charges of these species.

The polyaniline and polypyrrole form composite membranes were used for the selective separation of proteins, amino acids or other biological interest species. The selective separation was directed by the adjustment of pH value (by protonation or deprotonation of ionic conductive polymers). The amino-acids were also separate to the iso-electric point also by the adjustment of pH at the membrane interface.

IV. CONLUSIONS

The presented work exposed some experimental data related the parameters that can affects the separations during hemodialysis of blood by the use of three different directions: the influence of initial solution polymer concentration for membrane formation, the use of surfactants in casting solution, the use of nanofillers for composite membranes synthesis (carbon nanotubes, fullerenes, magnetic nanoparticles and other polymers, such as polyaniline, polypyrrole and polyethyleneimine). The obtained results revealed that the separations can be lead and controlled at a certain parameters and the process can be extremely efficient for the patients with chronic kidney desease.

Acknowledgement: Authors recognise financial support from the European Social Fund through POSDRU/89/1.5/S/54785 project: “Postdoctoral Program for Advanced Research in the field of nanomaterials”.

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Mechano-electrical Coupling in Microtubules

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Keywords - Microtubules, Cancer, Electromechanics.

I. Introduction

Microtubules (MTs) exhibit extraordinary electric and elastic properties. Since spontaneous mechanical oscillations were predicted and experimentally proven on almost every level of cellular structure, we may assume that MTs and their networks also vibrate to some extent. Oscillations of electric charge bound into the structure of MT will generate oscillating electric field.

II. Calculation of Generated Field

We analyzed properties of this field *in silico* using Microtubule Resonance Dipole Network Approximation method. This method is, in general words, based on approximation of charge bound in the structure of MT by elementary electric dipole. Dipole moment is modulated according to displacement of each element and total electric field is calculated as a vector summation of all contributions. We calculated oscillating electric field generated by single MT and networks of MTs, including for instance mitotic spindle.

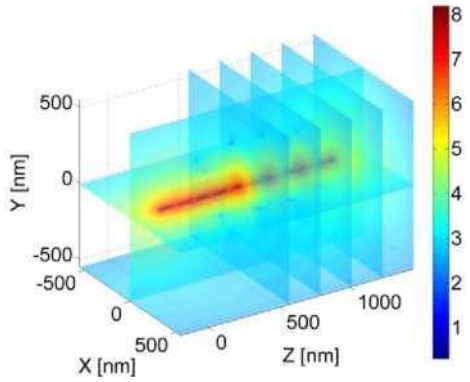

Fig. 2. . An example of intensity of electric field generated by longitudinal vibrations of MT.

We also estimated power radiated from cellular network of MTs and its radiation characteristics. Results obtained are important for design of experimental device for measurement of cellular electromagnetic field. Technological requirements for such a measurement may be fulfilled only by means of nanotechnological approach.

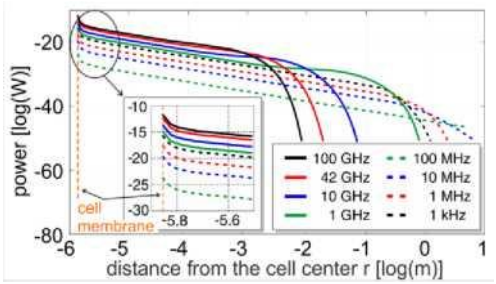

Fig. 2. Estimated electromagnetic power radiated from a cell.

II. Initial Measurement

Our initial measurement using ultra sharp *Pt* wires disclosed electrical oscillations of yeast cells in low kilohertz range where the electrical activity is correlated with mechanical oscillations measured by atomic force microscopy (AFM). Experimental results proved significant difference between cultures in different phase of the cell cycle.

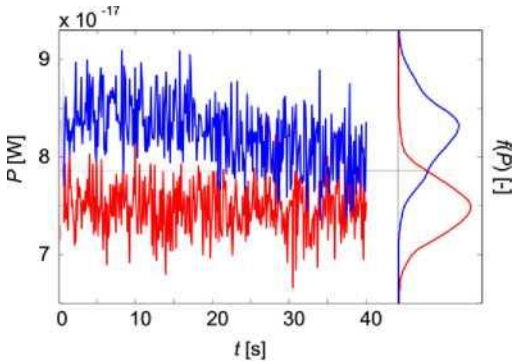

Fig. 2. Time evolution of electromagnetic power measured for synchronized (blue) and non-synchronized (red) yeast cells *Saccharomyces cerevisiae* in the range 0.4^1.6 kHz.

The electromagnetic activity is also well correlated with the cell cycle in the low megahertz range, but the sensitivity of our setup for these frequencies provided only threshold conditions which do not enable deeper analysis.

III. Implications for Morphogenesis and Cancer Diagnostics

Implications of mechano-electrical vibrations of MTs for morphogenesis and information transfer reside in the force effect of electromagnetic field and direct effect of mechanical vibrations. Our results, together with recent experimental findings, indicate that the effect of generated electric field enables long range mass transport in the case of resonant interaction. The effect on the charge transfer is physically feasible too.

Dysfunction of mitochondria in cancer cells (Warburg effect) implies decline of the zone of the strong static electric field and of the space charge layer of protons around mitochondria. These changes are followed by disruption of the level of water ordering. This, together with decreased efflux of the non-utilized energy from mitochondria, changes damping of mechano-electrical vibrations of MTs. This effect, we have shown, may have application in diagnostics of early cancer.

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Modeling and Optimization of Cell Growth and Proliferation in Biodegradable Scaffolds for Vascularized Tissue Engineering

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Keywords **- tissue engineering, biological growth, mathematical modeling, biodegradable scaffolds, vasculatization.**

I. Introduction

Biodegradable scaffolds are the most promising structures for tissue engineering (TE). The scaffolds are complex porous structures with special properties like biocompatibility, strength, lighweight design with adequate pore sizes for easy penetration of the growing cells, extracellular structures and vascular vessels through the pores. Tissue engineered bone, cardiac, tendon, blood and lymphatic vessels, cartilage, ligaments, skeletal muscle have been constructed and successfully implemented in animals and humans [1]. Mathematical modelling of cell growth and vascularisation is important for TE design and optimization.

II. Mathematical Model

Biological tissues and multiphase media consist of different types of cells and extracellular substances. New matter for growth and development are brought by delivering liquids (blood, plant sap, trophic fluids). Living bodies are open thermodynamic systems and continual models of the growing tissues exchanging mass and energy with environment are the most suitable for TE problems [2]. The growing continuum is composed of extracellular multicomponent matrix ($a = 1$), interstitial ($a = 2$) and delivering ($a = 3$) liquids and several types of cells with different growth rates ($a = 4,5,...$) (fig. 1). Growth is determined by mass delivery, energy consumption, mass and energy exchange between the phases and phase transitions, for instance between the delivering and consuming phases 3 ^{1,2,4,5}...; (4,5}^3; 2^3; 3^2 etc. Growth is provided by increase of amount of the phases $a = 1,4,5,....$ If scaffold is made from a biodegradable material it is also considered as a separate phase ($a = 0$) and phase exchange 0^{2,3} describes kinetic of biodegradation.

The mass, momentum and energy balance equations for the phases takes into account the phase exchange, external forces (gravity, microgravity, centrifugal and electromagnetic fields) and interphase forces:

$$p^a = {}^{k\text{-}fa}_{e^a}\text{-v.}\,(p^a c^a (V^a \text{-} \gamma_I P^a v^a / \gamma_j P^{a))} \qquad (1)$$

$$\frac{\partial \rho^a}{dt} + \text{v.}(p^a V^a \; o\text{V}^a) = \text{v.}P^a + R^a + M^a + p^a f^a \qquad (2)$$

$$\frac{d p^a E^a}{} + \text{V.}\,(p^a v^a E^a) = \text{V.}\,Q^a + V^a R^a + p^a f^a) + \qquad (3)$$

where p , C and v are phase densities, concentrations and velocities, d^a , M^a and N^a are interphase mass, momentum and energy exchange, P^a is stress tensor, f are external forces, R^a are interphase volumetric forces, Q^a is energy flux.

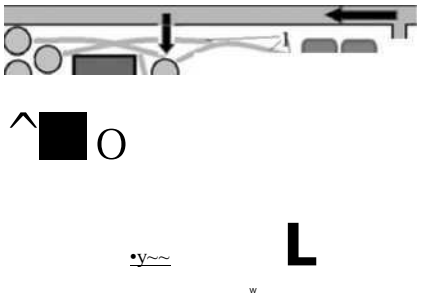

Fig. 1. Extracellular fibers (1), interstitial (2) and delivering (3) fluids, two types of cells (4,5) growing into the scaffold (0).

Additional equations for the internal variables describing structure formation and scaffold degradation have been introduced in the form

$$\frac{dr^a}{dt} + (v^a \text{V})r^a = G+ (r^a, v^a,...) - G\text{-}^p(Y^a, v^a,...) \qquad (4)$$

$$\frac{dL}{d} = F\,(r_s, C^a, v^a) \qquad (5)$$

where r^a is the structure parameter (size and shape of the fibers, connecting bridges, aggregates, granules etc, $G+$ and $G-$ are positive and negative sources of structure formation, r_s describes the scaffold surface, τ is characteristic degradation time, F is a given function of degradation kinetics. Internal energies $U^a = U^a\,(S^a, C^a, skj)$ and entropies S^a of the phases, strain rate tensors ejj for solid phases have been introduced and from (1)-(4) the entropy balance equation

$$\frac{dS}{} = -divJ_S + cr_S,$$

where $S = S$ J_S and $c_S = X\,Y$ $k\backslash rk$ are entropy flux and entropy production, X^k and Y^k are thermodynamic forces and fluxes have been obtained. The relationships Y^k (X^k) determining the constitutive relations for the model (1)-(4) have been obtained and analyzed for different types of multi-phase growing media [2].

Dependence of F on C^a and v^a in (5) gives an opportunity to control and optimize TE processes. The tissue growth inside the degradable scaffold is considered as liquid percolation in the porous structure of the scaffold with increasing porosity. Optimal TE growth is achieved when scaffold degradation is balanced by new tissue growth.

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Chemically Inert Nanoparticles Affect Hemopoietic and Stromal Cells Microenvironments in Vitro

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Keywords **– artificial specimens, hemopoietic islets, stromal stem cells, cytokines, surface free energy.**

I. Introduction

To explain a fundamental and contradictory phenomenon of self-maintenance and differentiation processes of hemopoietic stem cells (HSC) R.Schofield (1978) [1] put forward a hypothesis on a hemopoietic niche (specialized stem cell microenvironment) as an essential matter for the maintenance of stem cell phenotype. Outside the niche hemopoietic stem cells (HSC) differentiate into committed hemopoietic precursors in the specific microterritory, so-called hemopoietic islets (HI).

State of the art leads to asking the question: What does the concept of the stem cell niche really mean today? [2]. Stem cell fate is controlling by microenvironment nanotopography. Nanoparticles with a diameter < 50 nm penetrate through marrow barrier [3]. So, some mechanisms of stem cell and microenvironment interconnection can be revealed with the help of well known nanoparticles as nanoirritants of hemopoietic and stromal cells microenvironment.

In this regard, we evaluated cellular and molecular processes developing in vitro during direct contact of nanoparticles with mice HI and artificial niches for osteogenic differentiation of human stromal stem cells (SSC).

II. Specimens Preparation

A. Materials

Nano-sized carbon encapsulated iron powders Fe(C) (diameter<10 nm) and FeSi(C) (diameter<20 nm) were prepared in Institute of Metal Physics (Ekaterinburg, Russia) by dint of metal evaporation with its following condensation in flow of inert gas containing hydrocarbons.

Pure titanium discs (diameter 12 mm, thickness 1 mm) with bilateral CP coating were used as artificial substrate for stromal stem cells cultivation. Coatings were applied on titanium by means of anode-spark (microarc) oxidation method in 10 % phosphoric acid solution containing suspension of nano-sized (20 – 40 nm) synthetic HAP particles with stoichiometric composition $Ca_{10}(PO_4)_6(OH)_2$. Specimens were designed in Institute of Strength Physics and Materials Science, SB of RAS (Tomsk, Russia).

B. Cell Techniques

Nanodispersions (3 mg/l) were added into HI or HPSLC suspensions.

Quantitative composition of hemopoietic islets (HI) was investigated in 1-hour cultivation with nanoirritants.

The numbers of apoptotic and necrotic cells and intracellular levels of reactive oxygen species (ROS) were determined.

Culture of human prenatal stromal lung cells (HPSLC, “Stem cells bank” Co Ltd., Tomsk) was studied on pure titanium discs with CP coating in 4 days after nanoirritants addition.

Computer morphometry was applied for detection of quantity level of intracellular alkaline phosphatase (ALP) activity. TNF-alpha and interleukins (IL-2, IL-4) concentrations were measured in cell culture supernatants.

Statistical analysis was made by means of variation statistics methods with the use of Mann-Whitney U-test.

III. Results

Chemical passivity of iron and composite nanoparticles with carbon covering was proved. ROS production caused by Fe(C) or FeSi(C) nanodispersions is insufficient to destroy cells and their microenvironment.

However, there was diverse heat flow rate of nanodispersions. Values were registered by microcalorimetric approach in a range of $11\times10^{-5}\pm2$ and $22\times10^{-5}\pm2$ Joule/s ($p<0,01$) for Fe(C) and FeSi(C) specimens, respectively. It testified the different levels of heart generation and surface free energy for chemically inert nanoparticles.

So, we can not exclude nanoparticles thermodynamic affect on HI as specific niches for stem and progenitor hemopoietic cells (Table 1).

TABLE 1

High amount (% of initial value) in 1 hour nanopowders exposition, X + m *) p<0.05 with negative toxic control; **) p<0.05 with Fe(C); #) p<0.05 with positive toxic control according to U-test; n – specimens number.

Groups, n=5	Stained HI	Unstained HI	Total number of HI
Negative toxic control	126.15±15.27	224.38±28.27	161.06±14.42
Fe(C)	137.35±22.35#	175.17±8.66	153.30±15.20#
FeSi(C)	72.48±9.08***	117.14±38,55	88.14±14,48***
Positive toxic control (H_2O_2)	69.03±16.21*	142.18±30.51	92.78±10.74*

Low doses (3 mg/l) of chemically inert nanopowders were capable to diminish morphofunctional status and humoral cooperation of SSC with HSC and CP coatings.

IV. Conclusions

We proposed thermodynamic functioning of interfaces between both different stem cells and CP surfaces.

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Carbon Nanomaterial Suspension Toxicity Assessment

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V. *Keywords* – carbon nanomaterials, biotests, toxicity assessment

I. Introduction

Nanomaterial is a material with at least one dimension in the size range from approximately 1 nm to 100 nm (https://cdb.iso.org/) with properties differing greatly from those of bulk substances. In recent years, development of new manufactured nanomaterials and their multiple applications have boosted toxicity research.

Carbon nanomaterials (CNM) have a low solubility in water, however, surface modification and organic substances, including natural organic matter, increase their solubility and affect CNM fate in environment [1]. Studies suggest that CNM can cause cell and organ toxicity and lethal effects by various routes of exposure [3]. The greatest susceptibility to CNM has been observed for crustaceans and algae with toxic endpoints at 0.25 mg L^{-1} for fullerene and 8.7 for multi-walled carbon nanotubes (MWCNT) [7].

Biotests with *Daphnia magna* (48h, freshwater, modified ISO standard) and *Artemia salina* (72h, 15 ppm saltwater) were applied to assess non-modified carbon nanomaterial acute toxicity in an aquatic environment.

II. Methods

Carbon black (CB) nanoparticles (Printex XE2 Evonik Degussa GmBH, average diameter of CB particle 30 nm, specific surface area 950 m^2/100g, dibutylphtalate absorption 380ml/100g) and multi-walled carbon nanotubes (Aldrich, outside diameter 40-60 nm, inside 5-10 nm, length 0.5-500 µm) were sonicated (with power 1W/ml) in 100 ml *A. salina* and *D. magna* test medium for 5 minutes to form a stock suspension with total CNM concentration of 10 mg L^{-1} and diluted for appropriate test concentrations.

Particle solubility changes in response to varying water salinity were measured, and particle sedimentation was assessed parallel to the test. Probit regression analysis was used to assess statistically correct results.

III. Results

Lethal effects for *A. salina* were lower at very high and very low concentrations and were not dose-dependant, reaching the highest mortality at 50% suspensions. In *A. salina* biotest, MWCNT induced more toxic effects than CB nanoparticles. *D. magna* (Figure I) showed to be more sensitive to CNM with all 48h LC_{50} observed at total concentrations lower than 2.5 mg L^{-1}. Particle sedimentation experiment (Figure 2) showed that most of suspended particles settled during the first 24h.

IV. Conclusions

I. Obtained experimental results show that CNM can exhibit toxicity by uptake and by causing physical damage for the test organisms at low concentrations, implying that also non-modified CNM water suspensions are potentially toxic in an aquatic environment.

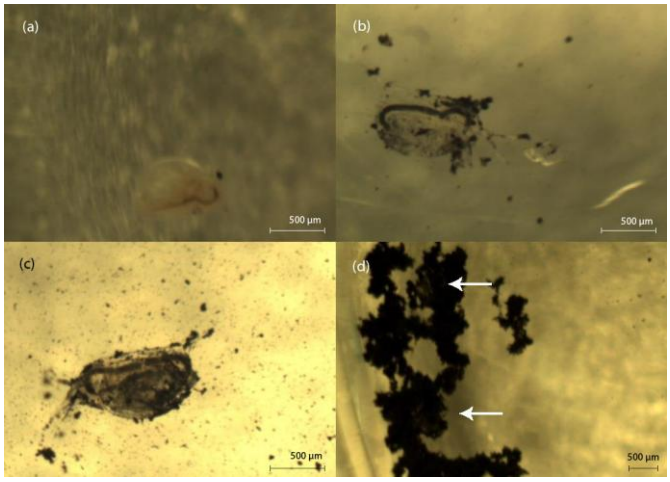

Figure 1.CB effects on *Daphnia magna* (48 h): (a) control with test medium, (b) CB uptake to gastro-intestinal tract and adherence to organism surface in 10% CB suspension, (c) an increased CB uptake and adherence in 17.5% CB suspension, (d) arrows show *D. magna* trapped in CB aggregate in 50 % CB stock suspension.

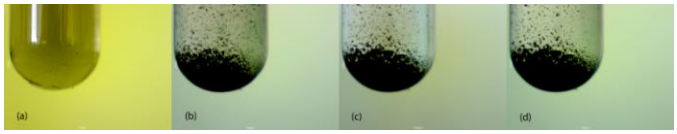

Figure 2.CB particle sedimentation in stock suspension: (a) 30 min, (b) 12 h, (c) 24 h, (d) 36 h after preparation.

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Volatile Organic Compounds Detection within Gaseous Mixtures

Gita Sakale, Elina Liepa and Maris Knite (*Riga Technical University, Institute of Technical Physics*)

Keywords **– nanostructured carbon composites, chemoresistive sensors**

I. Introduction

Volatile organic compounds (VOC) are markers that can indicate about spoilage of food and beverages, microorganism activity in foodstuff or other biological medium. Therefore selective sensor materials are elaborated and their capability to sense the presence of VOC evaluated. Detection of specific VOC in a gaseous mixture, which contains a mix of different VOC and has high relative humidity as well, is rather complicated. Usually gaseous mixture analyses are done by gas chromatography/mass spectroscopy. Here sensor materials based on polymer-nanostructured carbon composite (PNCC) are presented for in-situ registration of generated VOC.

II. Conception of Experiments

Sensor material is a composite film made of matrix and electroconductive filler. As matrix material is used polymer (polyisoprene as well as polyvinylacetate), but as filler – carbon nanoparticles or multiwall carbon nanotubes. PNCC sensor materials are prepared gradually increasing filler concentration till stable electroconductive grid within the matrix is formed. It means that the addition of filler changes the composite electrical properties and the composite from insulator become electroconductive. Besides that the composite conductivity is governed by tunneling currents in thin layer of matrix between carbon nanoparticles.

When the composite is exposed to VOC its electrical resistance increases noticeably. Electrical resistance increase is a result of VOC induced matrix swelling, distances between carbon particles increase and tunneling currents decrease.

III. Experimental

Polyvinylacetate-nanostructured carbon composite (PVAc-NCC) and polyisoprene-nanostructured carbon composite (Pi-NCC) production technology is described elsewhere [1]. Sensitivity to VOC is determined by exposing sensors for certain time to VOC and registering at the same time the electrical resistance of the sensor with Agilent 34970A acquisition switch unit.

IV. Results

Relative electrical resistance changes of both Pi-NCC and PVAc-NCC in time, when sensors are exposed to diverse VOC, are shown in Fig.1 and Fig.2. Diversity of VOC is controlled by VOC dielectrical constant (ε). As larger the value of ε, the more polar like the VOC is. Obtained results indicate that Pi-NCC has higher sensitivity to non-polar like VOC, but PVAc-NCC is more selective to polar VOC. For both composites the effect is reversible that means, when sensors are removed from VOC, electrical resistance decreases to the initial value. So the sensor materials can be used repeatedly.

VOC detection in gaseous mixture by PNCC also has been performed. As there is an interest for only specific VOC detection then the rest part of gaseous mixture is a background in form of relative humidity, mixture of other VOC and gases. Gaseous mixture background can considerably diminish or increase sensor material electrical response to specific VOC.

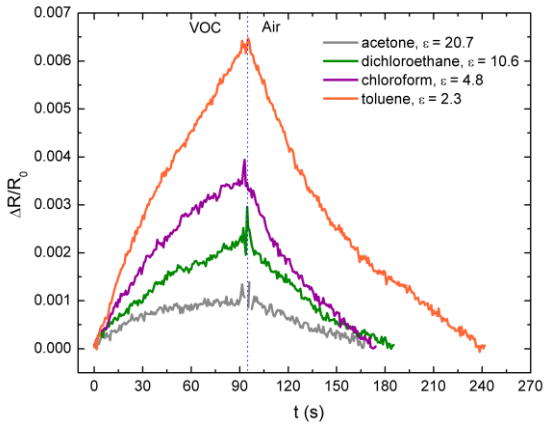

Fig. 1. Pi-NCC relative electrical resistance change versus time, when sensor material exposed to VOC (acetone and chloroform concentration 500ppm, toluene and dichloroethane - 200ppm).

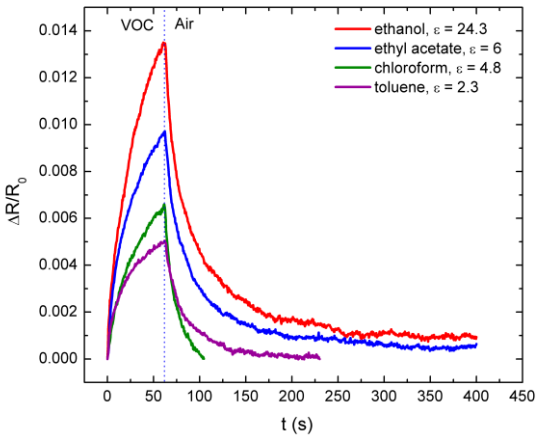

Fig. 2. PVAc-NCC relative electrical resistance change versus time, when sensor material exposed to VOC (VOC concentration 500ppm).

V. Conclusions

Elaborated and produced PNCC are selectively sensitive to the presence of VOC. Electrical resistance of the composite increases noticeably, when sensors are exposed to VOC. PNCC are perspective sensor materials to be applied for in-situ VOC detection in gaseous mixtures.

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MEMS Accelerometer-based Heart Monitoring System with Myocardial Fixation

Fjodors Tjulkins *(Hogskolen i Vestfold)*, Anh Tuan Thai Nguyen, Kristin Imenes and Mona Andersen.

Keywords **– encapsulation, heart monitoring, accelerometer, MEMS.**

I. Abstract

In the modern world, heart surgery, such as the coronary bypass grafting is an everyday occurrence, in large hospitals, multiple operations may be carried out daily. As with any surgery the patient needs to be monitored to see if the operation was a success. It has been reported that graft occlusion happens in 4% of patients in immediately after closure of the wound [1]. Established monitoring techniques have a number of drawbacks: electrocardigraphy (ECG) can be unspecific, echosonography and angiography are accurate but provide only intermitted monitoring. A sensitive, specific, reliable tool for continuous monitoring and detection of graft occlusion and ischemia in post-operative period is necessary.

An efficient heart monitoring system, based on a compact tri-axial accelerometer was developed by Hogskolen i Vestfold in cooperation with Intervention Centre at Oslo University Hospital [2]. The system demonstrated capability for rapid heart function change detection [3]. Despite excellent results obtained in clinical trials both on animal subjects and human beings the system is held back from clinical application by the relatively large size which means the patient's chest has to be open for implant removal. In order to make the clinical application of this system the sensor must be able to work in a closed chest setting and be extracted from the patient without additional surgical procedures, in a similar fashion to temporary epicardial pacing leads (heartwires). With the advance of MEMS accelerometers, highly compact tri-axial acceleration sensors like the CMA3000 (VTI, Finland) and BMA250 (Bosch, Germany), both just 2x2x0.95mm, are now available. These sensors can make a backbone of an implantable heart monitoring providing a suitable packaging solution is provided.

Previously, the sensor was sutured on top of the left ventricle, in the current project the implant is fixed inside the myocardium of the left ventricle, same way as temporary myocardial ECG probes. See Figure 1. In order to make this system possible, it is necessary to provide both electrical interconnection and biocompatible encapsulation. For the electrical interconnection a set of capacitors is necessary, as well as leads to connect the sensor to a data acquisition unit. The encapsulation must be biocompatible, provide a means of stabilisation for the implant.

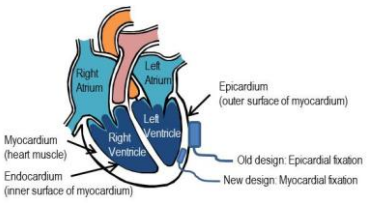

Fig. 1. Cross section of the heart showing the old and the new method of implant fixation.

To achieve those parameters the sensor was attached to a flex substrate that doubles up as a cable, it was overmoulded with medical grade silicone using a press form. Silicone moulding is a well-developed technique and allows control over the end devices parameters: the shape, the surface and mechanical properties.

From experiments conducted in the Intervention Centre at University of Oslo the maximum diameter of an object that could safely be inserted into the myocardium is 3mm. The encapsulation solution had to be made with this limitation in mind.

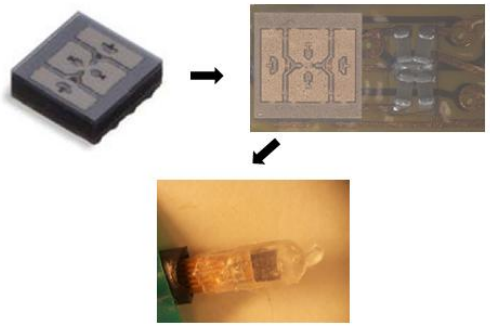

Fig. 2. CMA3000 sensor, CMA3000 mounted on a flex substrate with capacitors, an early prototype - sensor mounted and encapsulated with silicone.

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Source Localization based on Ictal Electroencephalographic Recordings

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Keywords **- Epilepsy, ICA, Spectral Coherence, EEG Source Localization.**

I. Introduction

A. In this work, we apply independent component analysis (ICA) to decompose the epileptic electroencephalographic (EEG) data into independent components. After computing the spectral coherence of IC, only components with high synchrony were retained while reconstructing the EEG. The reconstructed EEG was then used as an input for the source localization algorithm to determine the regions involved in seizure onset, spread and discharge.

II. Materials and Methods

A. Data and Independent Component Analysis

A 25-channel EEG data from one patient affected with severe seizure was used in the study. The ictal period was subjectively segmented by a neurophysiologist. Fig 1 in the full version (f.v) shows the ictal EEG signal. ICA was used to decompose the data into its independent components. The relationship between the observed EEG data and its components can be given as given by equation (1) in f.v. ICA algorithm aims at finding the de-mixing matrix. There are several separation algorithms based on ICA and in this work we have used the FastICA implementation [1].

B. Identification of seizure-related components and source localization

The spectral coherence for independent components at the frequency range of 3.5 - 10 Hz, which mainly corresponds to ictal EEG activity [2] was calculated using the formula given in equation (3) in f.v. Based on the spectral coherence matrix as shown in Fig 4 of f.v, only components with high synchronicity were retained to reconstruct the EEG. source localization was performed using dynamical statistical parametric mapping (dSPM) method implemented in Brainstorm toolbox [3]. An averaged boundary element (BEM) model was used for this purpose.

III. Results

The frequency-averaged spectral coherence matrix is shown in Fig 4. in f.v. It can be seen from the Fig 4 in f.v that there is a high level of synchronicity are seen between components 19 and 18, 23 and 13. Only retaining the columns corresponding to these components in mixing matrix, EEG data is reconstructed which is shown in Fig. 5 in f.v. It can be seen from Fig 5 in f.v. that the ictal patterns are more clearly evident when compared to the ictal EEG data in Fig 1 in f.v. The cortical origins of the seizure onset, its bilateral spread and finally a left discharge are shown in Fig. 6 in f.v. Based on the inputs by the neurophysiologist, three time points were selected pertaining to seizure onset, mid-ictal period (where bilateral spreading is seen) and left discharge, after which there was no further temporal evolution of the seizure.

IV. Conclusion

In this work we have demonstrated that by using ICA along with spectral coherence the components relevant to epileptic activity can be isolated. Further it was demonstrated that, by reconstructing the EEG using only the relevant independent components, cortical origins of seizure activity can be extracted by source localization. In future, we will explore the possibilities of applying similar measures on the estimated cortical current data from pre-ictal, ictal and post-ictal period to derive functional networks and their connectivity during these periods.

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Telemedicine in India – Impact on Health Care

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Keywords **– telemedicine, non-invasive, non-surgical, diagnosis, treatment.**

I. Introduction

India with its vast population, of which 70% are poor and often live in difficult to reach and inhospitable terrain, along with inadequate healthcare network faces a daunting challenge of providing quality healthcare to its citizens. Here, the average per capita spent on healthcare is one of the lowest in the world and various healthcare indicators are also lower than the global average. In order to provide quality and affordable healthcare to all, Telemedicine – the use of telecommunications to improve patient's health status by exchanging medical information from one site to another has provided an impetus to the government's vision of quality health for all by helping in delivering quality healthcare and in controlling the spiraling medical costs. The future for Telemedicine at the moment looks promising with governmental backing and private initiative. Telemedicine applications will play an increasingly important role in health care and provide tools that are indispensable for home health care, remote patient monitoring, and disease management, that encompasses not only rural health and battlefield care, but nursing home, assisted living facilities, and maritime and aviation applications.

II. Materials and Methods

Indian Space Research Organization's [ISRO] Telemedicine network has touched more than 30,000,000 people. Various state governments under National Rural Health Mission (NRHM) have begun implementing Telemedicine network. States such as Andhra Pradesh, Karnataka, Chattisgarh, Rajasthan and Kerala have all district covered under Telemedicine network. States such as Haryana, Madhya Pradesh, J&K and Punjab including North East states have taken to Telemedicine in big way. Under NRHM, government has allocated a budget of Rs.10 million per annum for each state to increase Telemedicine nodes at district level. Telemedicine network under the eHealth initiatives has been put to use to provide Continual Medical Education (CME) for doctors and nurses. Large companies such as ONGC have adopted Telemedicine for their remote operations

Players in the Telemedicine are:

- Ministry of Health, Government of India (GoI)
- Department of Information Technology, GoI
- State Government, which manages hospitals in district and remote places
- Satellite bandwidth provider – ISRO
- Medical Education provider – AIIMS, SGPGI, Medical Colleges across India
- Healthcare providers - Apollo Hospitals, AIIMS, Asian Heart Foundation, Narayana Hrudalya, Amrita Institute of Medical Sciences, District hospitals
- Telemedicine software provider – C-DAC, Televital, Apollo Telemedicine Networking Foundation
- Medical equipment providers – Wipro GE Healthcare, Siemens, Philips
- Telecommunications equipment providers – VTEL, Cisco, Erickson
- Videoconferencing equipment provider – Polycom, SONY.

III. Results and Discussion

12 th Five-Year plan allocates priority for providing accessible health care to rural population using existing fiber optic and satellite infrastructure , With the help of IT, satellite and fiber optic network, Telemedicine provides specialized healthcare to remote corners of country Telemedicine as a practice has been adopted by both – private and public sector healthcare providers. Telemedicine at present is mainly used for non-invasive and non-surgical diagnosis and treatment. Telemedicine is making healthcare financially viable to non-insured and poor people. Details will be discussed in the present communication.

On Usability of Gamma Criteria Distribution for Evaluation of field-in-field Treatment Plans in Conformal Radiotherapy

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A. Katashev *(Biomedical Engineering and Nanotechnology Institute, RTU, Riga, Latvia)*

***Keywords* – Field in field, gamma criterion, radiotherapy, verification, IMRT.**

I. Introduction

Hard, dynamic or virtual wedges are often used in conformal radiation therapy to reduce dose inhomogeneity within the target volume. There are restrictions exist in using such field modifiers for large fields due to technical peculiarities of the treatment machine. Field-in-field (FIF) manual segmentation, where one or more subfields are used to achieve dose homogeneity, could solve this problem, but such technique needs to be evaluated and verified first. FIF technique is based on intensity modulated radiation therapy (IMRT) principle, except that the intensity modulation is done manually using direct planning. The aim of this article is to determine whether the gamma criterion evaluation principle is suitable for FIF plans verification. [1,2]

II. Materials and methods

A. Detector and phantom set up

Measurements were made, using phantom, composed of the water equivalent 1cm thick PMMA slabs and IBA I'mRT Matrixx pixel ionization chambers detector array. 10 PMMA plates was paced on the array to form 10 cm thick build-up layer, while 5 plates was placed under detector to provide 5 cm thick backscattering layer.

B. Phantom CT data acquisition and treatment planning

Treatment plans were based on the anterior – posterior (AP) rectangular isocentric field. The size of the field was 17 x 12 cm. For this field 70 monitor units (MU) were prescribed. For each plan base field was copied and additional segmented field was added to the base field to create FIF plan. Segment fields were rectangular, AP aligned and isocentric, with a center aligned with the center of the base field, sized 5 x 12 cm, 6 x 8,5 cm and 3 x 4,3 cm were used (f.v.).

C. Field distortion modeling and measurements

To simulate patient misalignment / movement and model field distortion, segment fields was shifted in 1 mm steps in superior, inferior, lateral left and lateral right direction up to distance of 10 mm.

D. Data analysis

Measured dose distributions were compared with the reference, simulated by TPC, using gamma criteria. The dose differences, distances-to-agreement (DTA) and corresponding gamma distributions were evaluated using Omni PRO-I'mRT software. As the acceptance criteria for individual point, $\Delta DM=3\%$ dose-difference and $\Delta dM=3$ mm DTA were used [Fig.2]. For two dose distributions to be considered equal, 95% of all pixels should be within this criterion. [4] The chosen criteria are those routinely used in clinic for verification of the IMRT plans.

III. Results and discussion

The longitudinal shifts of the largest segment field in the direction of the field's longest side show steeper decrease in the number of "passed" pixels. Nevertheless, even as large shifts as 10 mm for the 6 x 8,5 cm and 3 x 4,3 cm segments do not lead to the percentage drop below 95% threshold. For the largest segment 5 x 12 cm, 8 mm shift required to decrease percentage of passed pixels below 95%, to the 94,66% and 94,42%. for superior and inferior shifts, correspondingly. The same shifts were analyzed using only DTA criterion, i.e. pixel form the reference distribution pass the criterion, if there is at least one pixel at the distance less then DTA. The DTA based evaluations of the number of passed pixels for lateral and longitudinal shifts are shown in Figure 5 and Figure 6, respectively. The results show that for FIF technique, the criteria, based on the distance discrepancy is more sensitive. The 95% threshold was reached for 5 x 12 cm and 6 x 8,5 cm at lateral and longitudinal shifts of 4 mm. Besides, for the small perimeter field, this method fail to detect discrepancies in the dose distributions for lateral shifts more then 10 mm and for superior – inferior shifts up to 8 mm. The reason of the poor performance of gamma criteria and DTA criteria seems to be entirely geometrical. FIF technique is characterized large areas of flat dose distributions. In such a case, both gamma and DTA criteria will indicate difference at the edges of segment field. For the segments of small perimeter, the number of pixels affected by shift may just be smaller, then 5%.

IV. Conclusions

For small area segments, even the large misalignment of the fields did not lead to significant changes of the percentage of failed pixels. Gamma criterion with dose difference 3%, and DTA 3mm showed poor sensitivity to the misalignment for field-in-field plan evaluations due to small segments perimeters and relatively small ratio between numbers of pixels in field versus number of pixels in shifted area. Even clinically significant shifts of 10 mm pass the 95% threshold level. 95% criteria should not be used at all for comparison of dose distribution in field in field conformal radiotherapy and other numerical criterion has to be developed.

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Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
The 1st Congress of World Engineers and Riga Polytechnical Institute / RTU Alumni

Determining the Threshold of Radiotherapy Delivery Error Detection Using Delta4

Peteris Eizentals (Biomedical Engineering and Nanotechnology Institute, Riga Technical University), Michael Thomas (Joint Department of Physics, Royal Marsden NHS)

Keywords **- Delta4, Radiotherapy, IMRT, VMAT, Verification**

I. Introduction

IMRT and VMAT have proven to be reliable radiotherapy treatment techniques, but due to their complex nature every clinical plan must be verified prior to applying on patient [1, 2]. Various systems are available for patient-specific verification, but due to the lack of official regulations related to them manufacturers do not give information about devices error detection abilities. Therefore before using these devices in clinical practice they must be checked by physicists. This study is dedicated to determining the threshold at which Delta4PT verification phantom can detect various radiotherapy delivery errors.

II. Materials and Methods

Delta4PT is a relatively new device designed for IMRT and VMAT plan verification, and, although there have been several researches [3, 4], its sensitivity to error detection is still largely unknown. Almost all possible motion errors and some dose delivery errors were tested - 3 types of MLC positioning errors, Jaws positioning error, monitor units (MU) error, collimator and gantry angle errors and missing control points (for VMAT only).

Delta4PT consists of two orthogonally orientated detector arrays that are crossed under specific degree with total of 1069 p-type silicon diodes and put in a cylindrical polymethylmethacrylate (PMMA) phantom. Detector arrays are distributed in two levels. Central level is 6 x 6 cm square with 0.5 cm spacing between diodes. Outer level is 20 x 20 cm square with 1 cm spacing between diodes. The phantom itself has a diameter of 22 cm and length of 40 cm. It is directly connected to accelerator and measures dose in relation to individual accelerator pulses using the trigger signal. It can also detect the gantry angle by using an inclinometer connected to the gantry head, which allows the device to identify and associate measured dose with separate VMAT control points. Prior to verification clinical RT plan is imported and recalculated in the phantom plan, which consists of a uniform PMMA equivalent cylinder [3].

To fasten the data acquisition process approximated method was used instead of an actual verification. Plans were modified manually outside TPs and then the recalculated plans were verified with Delta4PT software using slightly different method than standard verification. Instead of irradiating every modified plan to the verification system only un-modified plan was irradiated and the modified plans were used as reference data. such approach made it possible to obtain greater amount of data, but introduced some methodical errors, which were taken into account at data analysis.

Gamma index was used to compare and evaluate measurement with reference [5*]*. The error was considered as detected if the difference between gamma value for unmodified plan and plan with error exceeded 5%.

III. Results

Every modified field was compared to the original and the results were analyzed as described above. Average differences in gamma index are shown in tables 1 and 2 in the full version. As it can be seen random and systematic errors are hard to detect even if error size is 5 mm with acceptance criteria 2%/2mm. 2 mm shift error in IMRT plans can be detected with criteria 2%/2mm. As for VMAT, none of MLC positioning errors were detected with the tested error sizes. Dose errors are considerably easier to detect, 2 MU error can be detected with acceptance criteria 2%/3mm for both IMRT and VMAT. In IMRT plans 5 mm Jaws error can be detected with criteria 2%/2mm, but 10 mm error with criteria 3%/3mm. Surprisingly low impact Jaws error has on VMAT plans, only 100mm error can be detected with criteria 2%/3mm. Possible reason for that might be because esophagus plans have long segments and only few MLC leaves are left on sides to shield with jaws. Collimator error with the given error size was detected only for IMRT plans (2° error with 2%/2mm or 3° error with 2%/3mm criteria). Even less detectable appeared to be gantry error, with acceptance criteria 2%/2mm was mostly was detected only 3° error. As for control point errors, the first appeared to be easy detectable, even one missing control point would be usually detected with standard acceptance criteria 3%/3mm, probably because the overall dose change is easy to detect. The second was relatively harder to detect as the dose of the deleted control point smeared out around the PTV. Error starting with two missing control points was detected with criteria 2%/2mm or three control points with criteria 2%/3mm.

IV. Conclusions

Most of possible treatment machine errors were tested in this study to determine their detection threshold with Delta4PT verification phantom. A clear detection threshold for IMRT was detected for errors shift, MU, Jaws, collimator and gantry and for VMAT for errors MU and Jaws. No clear error detection threshold within tested error size range was found for the rest of the errors. Because the sensitivity of the used method due to some uncertainties is lower than normal patient specific verification, the results of this study can be considered as worst case scenario, i.e. if the error was detected in this study, it should be certainly detected in the actual verification. Delta^{4PT} phantom is a useful device for IMRT/VMAT plant pre-treatment verification.

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Dose Evaluation along the Ir -192 Brachytherapy Source Transportation Path to the Dwell Position Using 2D Film Dosimetry

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Keywords **– Brachytherapy, Ir-192 source, irradiation dose, film dosimetry.**

I. Introduction

2D film dosimetry is one of the methods for the recording of the dose distribution in the steep gradient fields, where the application of other methods is limited, as it is in the case of interstitial brachytherapy. The aim of this work was to discuss film calibration procedure in HDR brachytherapy, to establish film calibration curves for radiochromic (Gafchromic® EBT2) and radiographic (Kodak X-Omat V) films irradiated by Ir-192 source and to use obtained calibration curves for the evaluation of the doses along the brachytherapy source transportation path to the dwell position.

II. Instruments and Methods

Two types of films: radiochromic (Gafchromic® EBT2) and radiographic (Kodak X-OmatV) were used in this investigation. .he formatting rules for the digest are basically the same as for the full version of the paper. Series of both types of films were irradiated with gamma photons emitted from Ir-192 source ($E_\gamma \approx 370$keV) operated in two HDR brachytherapy units: GamaMed iX (Varian) and Microselectron V2 (Nucletron) increasing irradiation dose from 0 Gy to 2.5 Gy in 0.1Gy steps. Irradiation dose values were calculated using standard Ir-192 source activity conversion to dose algorithm.

Changes of the optical density and gray level pixel values of the irradiated film were used for the construction of dose calibration curves for each type of film.

III. Results and Discussions

Film calibration curves were almost linear for the Gafchromic films (Fig.1), however for radiographic films it was not a case (Fig.2).

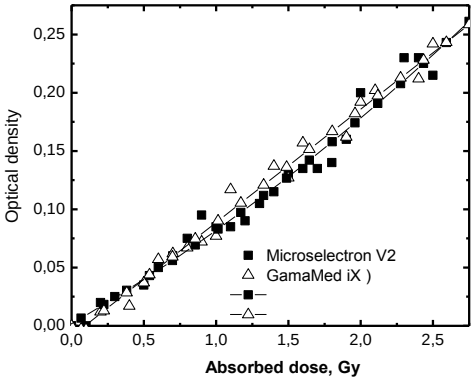

Fig.1. Film calibration curve of EBT2 (Gafchromic) film

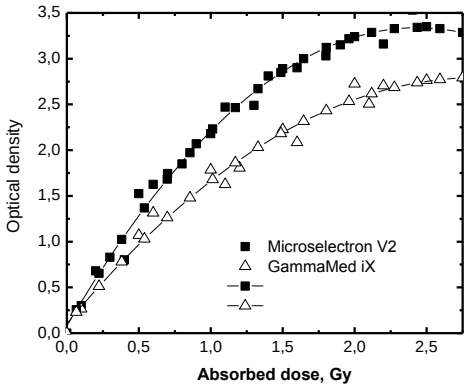

Fig.2. Film calibration curve of Kodak X-OmatV film

Film calibration curves were used for the evaluation of the doses along the Ir-192 brachytherapy source path. An example of images obtained in Gafchromic films irradiated to different doses are shown in Fig.3.

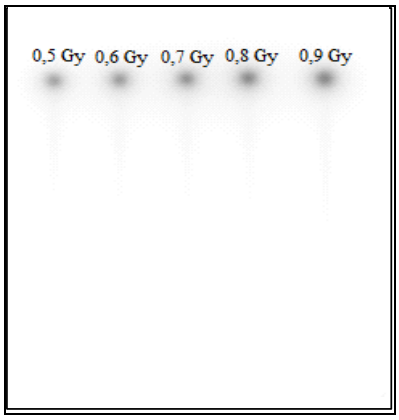

Fig.3. Image of Gafromic film irradiated to different doses with recorded source transportation tracks.

Using calibrated 2D film dosimetry system it was found that the "track" doses varied from 0.09 Gy to 0.12 Gy per one single track during irradiation procedure. Despite the evaluated dose values were attributed to the low dose category, these doses should be considered estimating doses to the surrounding tissues

Aknowledgement

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An application of Lévy metric to radiotherapy biological treatment plan optimization

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Keywords— **Lévy distance, Dose Volume Histogram, Tumor Control Probability.**

I. INTRODUCTION

Modern treatment planning allows the achievement of complex goals. Minimum and maximum doses cannot be considered as adequate figures of merit for the quality of a plan, and that is the reason why a complex set of parameters has to be evaluated when an irradiation plan is to be assessed. Particularly, radiobiological indices are useful tools for this evaluation, as they relate the plan to specific clinical goals. Therefore, when optimizing a treatment plan it is very useful to be able to characterize treatment plans, according to the closeness of their indices to a reference value (a goal or a previous result to should be improved). A measure of closeness to the objective dose distribution is needed, and it has to be related to the values of the index. In this work, we propose a type of distance between dose volume histograms that can be used to biologically optimize a treatment plan.

II. MATERIALS AND METHODS

Given a *DVH* curve, the function *F(z)=1-DVH* is a distribution function for some random variable (absorbed dose for random points inside the tumour in this case). The Lévy distance between the distribution functions *F* and *G* , $d_L(F,G)$ is:

$$d_L(F,G) = \inf\left\{\varepsilon \middle| \forall y : F(y-\varepsilon)-\varepsilon \le G(y) \le F(y+\varepsilon)+\varepsilon\right\} \quad (1)$$

If $F_0=1-DVH_0$ and R_0 is a bound for the Lévy distance around F_0, then, for *G* to be within this bound the following inequalities should hold.

$$\begin{aligned} \forall y : DVH_0\left(y - R_0\right) + R_0 &\ge DVH(y) \\ \forall y : DVH_0\left(y + R_0\right) - R_0 &\le DVH(y) \end{aligned} \quad (4)$$

The problem to be considered is whether or not two *DVHs* inside a given Lévy distance correspond to tumour control probabilities within a specified interval of values. And the inverse problem is to establish the maximum Lévy distance between two *DVHs* in order to fulfil a constraint on *TCP*. Using von Mises differentiability the following expression is obtained

$$T(G) - T\left(F_0\right) \cong \int g(y)\cdot d\left(G - F_0\right)(y) \le \le \int g(y)\cdot dF_0\left(y + R_0\right) - \int g(y)\cdot dF_0(y) \quad (11)$$

If *T* is an operator, and it is continuous, an upper and lower bound can be found on its values for distribution functions at a distance of R_0 from F_0. Moreover, if it is a linear operator, its derivative on *G* can be easily computed.

III. RESULTS

Using a simple linear-quadratic formula (3), and the mean value of number of clonogens given as datum,

$$TCP^* = \exp\left(-N\cdot\rho\cdot V\cdot\sum_i \exp\left(-\alpha\cdot D_i\right)\cdot DVH_d\left(D_i\right)\right) = \\ = \exp\left(-N\cdot\rho\cdot V\cdot\int \exp\left(-\alpha\cdot y\right)\cdot dG(y)\right) \quad (12)$$

In this formula $G(y)=1-DVH_c(y)$ and discrete functions have been considered as continuous.

Defining:

$$T(G) = \int \exp\left(-\alpha\cdot y\right)\cdot dG(y) \quad (13)$$

T(G) is a linear operator with $g(y)=exp(-\alpha y)>0$. Therefore, the bounds described in equations 11 and 12 are applicable. Moreover, bounds on the ratio TCP*(DVH)/TCP*(DVH_0) can be evaluated (equation 15 fv). Table 1 (f.v.) show results for this practical application.

For a minimum TCP goal a bound value can be obtained so that acceptance bands like the ones in Fig 2 can be built on the DVH graph, and therefore used for planning and optimization.

IV. DISCUSSION AND CONCLUSSIONS

Any functional on DVHs can be treated according to this newly devised theoretical framework, as long as it shows a minimum of good properties of continuity and differentiability, as it is typically the case with radiobiological indices.

The practical example (see f.v.) shows how the use of Lévy distance bounds can ensure that plans fulfilling the constraints will have TCP values in a predefined interval. This novel method allows a straightforward and elegant assessment of TCP variations, it makes possible to design constraints on DVHs ensuring limited variations on TCP.

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Physical measurement and dose tests on FUJIFILM Amulet

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Keywords **– Mammography, Glandular Dose, CNR, DQE, MTF, NNPS, Amulet.**

I. Introduction

In this work we report the acceptance tests results for the "Amulet" mammography system (FUJIFILM) that is based on a amorphous Selenium (a-Se) that uses a photo induced discharge instead the typical thin film transistor (TFT) readout for image acquisition. We focused our attention on the average glandular dose (AGD) and the Contrast to Noise Ratio (CNR) evaluation for different breast equivalent thickness and for the three automatic exposure calibration settings named W, L and H. Moreover we focused on the Detective Quantum Efficiency (DQE) measurement, performed using two standard IEC quality beam.. AGD and CNR measurement were comparing with the EUREF protocol limits. DQE analysis is made with two anode-filter combination belong the two principal directions of the detector and both with the antiscatter grid IN and OUT the beam propagation.

II. Methods

To perform the AGD measurement, we imaged a 20 mm to 60 mm thick set of Polymethylmethacrylate (PMMA) plates, putted on the detector carbon cover, with the compressor paddle at a distance as suggested in the guidelines of the EUREF protocol to obtain an equivalent breast thickness. We recorded the applied voltage, current and anode-filter-combination for each image performed with the three automatic exposure protocols H, L e W. than AGD evaluation is made from incident air Kerma (K_{in}) and Half Value Layer (HVL) estimated for all the radiological settings observed. For the most used WRh anode-filter combination, we directly measured the HVL for a set of applied voltage in the range from 26 kV to 32 kV. For others anode-filter combinations the HVL values used for the calculation are the expected values of the Table A5.3 of the EUREF protocol. Kerma measurement is performed taking into account the compression paddle attenuation and are correctly transferred to the AGD.

The CNR has been evaluated following the indication in the EUREF protocol imaging the same PMMA plates used for the AGD measurement with an aluminium object of 0.2 mm thickness putted on top.

The DQE has been performed using the beam quality RQA-M2 and W/Rh obtained, as explained in the IEC 62220 document, using the 28 kV applied voltage and 2 mm thick aluminium filter added on the beam output. The analysis has been conducted with the antiscatter grid putted both IN the beam path and OUT of it. We observed the DQE belong the two direction: the horizontal (H) corresponds to the patient Antero-Posterior and the vertical one (V) correspond to the patient Latero-Lateral. The Modulation Transfer Function (MTF) is measured using as a target a 1.5 mm thick Copper edge. The MTF and the Normalized Noise Power Spectra (NNPS) are obtained using the "COQ" ImageJ plugin developed by the Medical Imaging group of the Bologna University Physics Department.

III. Results

The AGD measurements are very surprising and they show how the Protocol "Auto L", normally used during the clinical activity, induce only the 58% of the achievable dose level expected by the EUREF protocol, for the 53 mm equivalent breast thickness.

The CNR analysis shows that the response curve is in the setting of the reference EUREF protocol.

DQE analysis is made to take a point zero measurement on the system image quality. The DQE, performed with the two anode-filter combination W-Rh (50 um) and Mo-Mo (30 um), shows a very high image quality performance of the system that in some case shows the 85% level. The measurement reveals an interesting detector asymmetry in the image reading belong the two principal directions. For the W-Rh anode-filter combination, without the antiscatter grid, we identified a cut-off spatial frequency, approximately equal to 5 lp/mm, so we obtained a better image quality in the range of frequencies higher than the cut-off frequency in the H direction and we obtained a better image quality in the range of frequencies lower than the cut-off frequency in the V direction. With the antiscatter grid introduction the cut-off frequency regressed approximately to 4 lp/mm value. For the Mo30Mo anode-filter combination we obtained similar results with the cut-off frequency observed without antiscatter grid approximately equal to 7 lp/mm and a same value of 4 lp/mm was observed for the cut-off frequency with the antiscatter grid on the beam propagation.

IV. Conclusions

The AGD is halved respect the limit achievable by the EUREF protocol and the CNR is according with the achievable setting.

The DQE analysis has been possible thanks to the very useful free downloadable tool the "COQ" ImageJ plugin produced by the Medical Imaging group of the Bologna University Physics Department. With this tool we had the possibility to manage easily the big DICOM output images of the mammography system, making all the processes necessary to obtain the DQE estimation. The very high measured DQE is an objective index of the detector quality performances and the measure can be used as point zero reference for futures quality check. The asymmetry noted, considering the DQE in the two principal directions H and V, confirm a cut-off frequency that make the image reading better for high frequencies details in the H direction and better for low frequencies details in the V direction. Taking into account also of the radiologist opinion, this asymmetry should be considered also in the clinical reading of the radiological image.

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Autologous Fibrin Mixed with Biphasic Calcium Phosphate Bioceramic Granules Activates Encapsulation in Soft Tissue Environment

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***Keywords* – fibrin scaffold, calcium phosphate bioceramic, in vivo experiments, autologous plasma.**

I. Introduction

The physical, chemical and biological properties of both biphasic calcium phosphate (BCP) bioceramics and fibrin scaffolds may be cumulated for preparing advanced bone substitutes. In our study autologous rabbit plasma was used as a raw material for fibrin scaffold fabrication. Aim of experimental study was to evaluate histological response on implantation of synthetic biphasic HAp/TCP bioceramic granules mixed with autologous plasma derived fibrin scaffold in subcutaneous tissue of rabbits.

II. Materials and Methods

A. Preparation of BCP ceramic granules

Calcium deficient hydroxyapatite (CDHAp) was synthesized by aqueous precipitation technique. The filtered precipitates was formed in to the granules, dried and sintered at 1150 ^{o}C for 2 hours. In this study the BCP ceramic granules with HAp/b-TCP ratio of 30/70 and in sizes from 0.5 to 1.0 mm were selected as appropriate.

B. Preparation of bioceramic and plasma derived fibrin scaffold composites

We slightly modified already existing method for plasma scaffold preparation [1]. For the preparation of the bioceramic and plasma scaffold composites, antifibrinolytic agent tranexamic acid is dissolved in the autologous rabbit plasma and then calcium gluconate and 0.5g BCP ceramic granules are added.

C. Implantation in vivo and evaluation of histological results

The Animal Ethics Committee of Latvian Food and Veterinary Administration approved the use of 6 New Zealand male rabbits for this morphofuncional study. 2 cm incision was made on the right side of lumbar area and 0.5 g Hap/TCP granules with fibrin scaffold were implanted subcutaneously. 0.5 g Hap/TCP granules without fibrin scaffold were implanted on the control side.

Blocks of soft tissue from experimental and control side were harvested and fixed in Stefanini solution. Then tissues were embedded into the paraffin, cut in 5 μm thick slides and prepared for detection of apoptosis using TUNEL. Routine histological method - staining with hematoxilin and eosin and evaluating with Leica BME microscopy was used for obtaining a review picture.

III. Results

Six weeks after the implantation of plasma derived fibrin scaffold with BCP bioceramic granules routine histological examination showed increased number of cells, mainly plasmatic and gigantic cells also lymphocytes and eosinophils and increased formation of fibrous tissue capsule compared with control side (Fig. 3). BCP bioceramics with autologous plasma derived fibrin scaffold initiate pronounced angiogenesis around the implant.

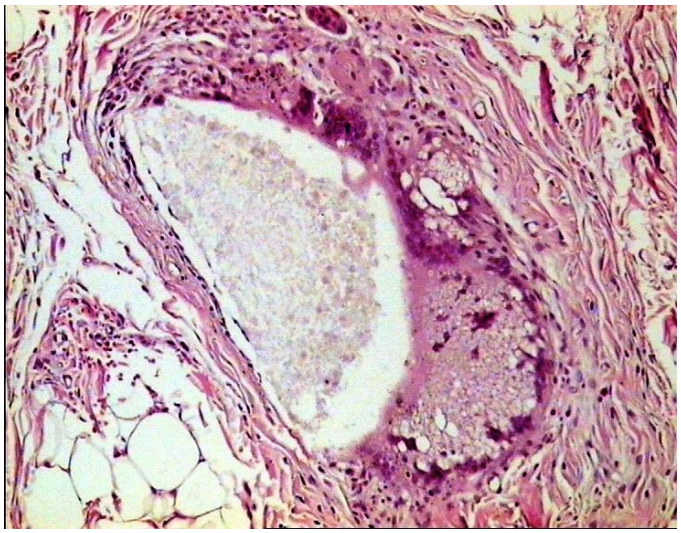

Fig. 3 Fibrous tissue capsule around BCP bioceramic granule with fibrin scaffold (h/eo, x 100)

IV. Discussion

Fibrin scaffold has double function in tissue engineering. First as scaffold for incorporation of cells, proteins, other biologic and pharmaceutical agents and second as immobilizier of different substances in other biomaterials to provide long time retention in site of clinical necessity and controlled release is in current evaluation.

V. Conclusions

From our results we can conclude that plasma derived fibrin scaffold activates encapsulation of BCP bioceramic in soft tissue environment. This phenomenon may serve as a possibility for biological retention of drugs, growth factors and/or cells.

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In Vitro Evaluation of Osteoblast Cells Behavior and Antimicrobial Properties of Biphasic Calcium Phosphate Ceramics

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Keywords **– biphasic calcium phosphate ceramics, bioceramics, hydroxyapatite, β-tricalcium phosphate.**

I. Introduction

The main advantages of synthetic calcium phosphates (CaP) are their osteoconductivity and biocompatibility [1, 2]. Mostly CaP bioceramics are used in forms of hydroxylapatite (HAp) β-tricalcium phosphate (TCP) or biphasic calcium phosphates (BCP), which is mixture of HAp and TCP [3]. The use of BCP bioactive ceramics is based on an optimum balance between more stable phase – hydroxyapatite and more soluble phase – β-tricalcium phosphate. Varying the ratio of HAp and TCP, bioactivity and resorbability of BCP can be controlled.

In current research, the adhesion and colonization of bacteria and osteoblast cell adhesion on pure TCP, pure HAp and TCP/HAp compositions obtained by two different methods was investigated and BCP preparation method impact on its properties evaluated.

II. Materials and Methods

The chemical synthesis of apatite and calcium-deficient apatites with different Ca/P ratios in range from 1.5 to 1.67 was carried out by wet precipitation method. The biphasic composition of ceramic was ensured using two methods: A) calcination and sintering of as-synthesised calcium-deficient apatites; and B) calcination and sintering of mechanical mixtures of as-synthesised powders with Ca/P ratio of 1.5 and 1.67. Before sintering (1150°C), powders were uniaxially pressed. Samples with following HAp/TCP ratio were obtained: 100/0, 90/10, 60/40, 50/50 and 0/100. For evaluation of antimicrobial properties reference cultures of *Ps. aeruginosa* ATCC 27853 and *S. epidermidis* ATCC 12228 were used. Bacteria suspensions were prepared from the microbiological cultures in 1 ml of TSB (Triptycase soy broth, Oxoid, UK) with the concentrations of 10, 10^2, 10^3 CFU/ml (colony forming units). Samples were cultivated at 37 ^{o}C for 2 h for the determination of bacteria adhesion. Bioceramic samples were incubated in 1 ml of TSB for 24 h, to evaluate the level of microorganism colonization. MG-63 cell line, human osteoblast, obtained from ATCC collection (CRL-1427) was used for evaluation of cell behavior on bioceramic sample surfaces. Crystal violet staining of alive cells on the surface of the samples was used for the determination of bioceramic citotoxicity**.**

III. Results and Discussion

Results showed that the open porosity of pure HAp is more than two times higher than that of pure TCP. At the same time the open porosity of biphasic HAp/TCP compositions is higher than that of pure components. We suggest that such effect occurred due to the differences in grain sizes and phase transition and sintering temperatures of HAp and TCP.

Microbiological investigation results showed that the use of pure HAp or BCP ceramics as implant materials can cause less inflammatory risks compare to the pure TCP ceramics. From the results obtained it can be concluded that the adhesion and colonization intensity of Ps. aeruginosa on the surface of the all samples was much higher than that of S. epidermidis. The intensity of adhesion in the 103 CFU/ml bacterial suspension for the Ps. aeruginosa was around 20 times higher than that for S. epidermidis.

The effect of HAp/β-TCP ratio as well as the impact of BCP preparation technique on osteoblast behaviour was evaluated. It was observed that BCP preparation technique significantly does not affect the cell behaviour on the surface of bioceramic samples. In all cases cells atached to the samples had morphologicaly normal shape and size correponding to MG63-GFP culture in control wells. Cell proliferation rate increases with increasing the β-TCP content in composites and reaches the maximum at HAp/β-TCP ratio 60/40. During the research it was found that more cells tend to attach the dense regions of the samples.

IV. Conclusions

The adhesion and colonization of bacteria as well as osteoblast cell behavior on the surface of the bioceramics is mostly dependent on the chemical and structural composition of the samples and only a small effect of preparation method can be observed. In vitro cell tests showed that bioceramic samples with HAp/β-TCP ratio 60/40 was most convenient for osteoblast attachment, indicating that the use of such composite as implant material could have an great advantage in bone tissue engineering.

V. Acknowledgment

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In vivo Tests of Cyanoacrylate Adhesives with Different Alkyl Chain Length

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***Keywords* – Cyanoacrylate adhesive, adhesion, *in vivo* test, hystology.**

I. INTRODUCTION

Cyanoacrylates polymerize in the presence of water. Skin has a high concentration of water, so cyanoacrylate adhesives can be used for surgical practice and wound closure. However, despite producing effective joining, the cyanoacrylate adhesives show too exothermic cure and the polymerised product is too stiff. One simple route to reduce the exothermic reaction and stiffness of the cyanoacrylate adhesives is to increase the length of the hydrocarbon chain backbone.

To the best of our knowledge there are a few scientific studies dealing with the physico-chemical characterization of cyanoacrylate adhesives. In this study, the properties of three cyanoacrylates are compared, paying particular attention to their performance for *in vivo* studies carried out with New Zealander albino rabbits.

II. MATERIALS & METHODS

Ethyl (ECN), butyl (BCN) and octyl (OCN) cyanoacrylate were used. Cyanoacrylate monomers were cured by adding water (1:1 vol.%).

18 New Zealand albino rabbits weighing 2 kg were used. Vital signs (weight, temperature) were recorded, blood tests, analytical determination of haematological parameters (with the Abacus team Junior Vet, CVM SL) and biochemical analyses (with the automatic analyzer VetScan Classic, CVM SL) were carried out for 0 up to 28 days after surgery.

For each rabbit, after shaving a dorsal and local disinfection with Ibitane ®, 2 superficial incisions with steel blade knife of about 2 cm in length in the skin were performed. The incisions were made in both longitudinal and transverse directions. The incisions were closed with the three cyanoacrylate adhesives.

For the histological study the animals were sacrificed after 3 to 28 days after adhesive application. After standard histological processing (dehydration with ethanol, Neo-Clear® solvent addition, embedding in paraffin), 10 to 15 µm thick sections were obtained with an automatic microtome Leica - RM-2065 and they were stained with hematoxylin-eosin for observation with transmitted light microscope Leica DMLS.

III. OBJECTS

The polymerization noticeably increased the temperature at which the cyanoacrylate degrades. In general, the temperature of decomposition increased by increasing the length of the alkyl chain in the cyanoacrylate. The ECN showed a unique decomposition at 199 ºC, both the n-butyl and the n-octyl cyanoacrylate showed two thermal decompositions corresponding to two different polymer structures.

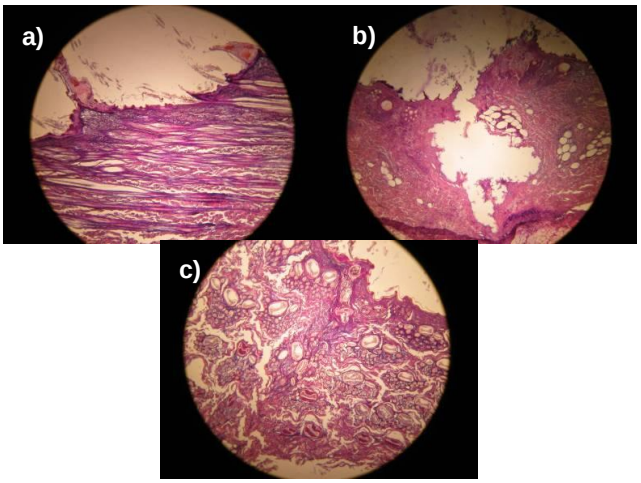

Fig. 1. Photomicrographs of histological sections of wounds closed after 7 days with different adhesives: a) ECN, b) BCN and c) OCN.

The BCN adhesive caused an excessive erosion on the rabbit skin likely due to excessive exothermic reaction. The results obtained with ECN and OCN were quite similar in wound closure.

Blood tests (hemogram and biochemistry) did not show significant alterations in the standard parameters in all joints.

Figure 1 shows for ECN and OCN that the wounds were closed with little inflammation, they did not have the edges separated, and the appearance of the tissues throughout the joint are nearby normal. However, a fibrous scar was more evident in the joint made with OCN (Fig. 1c) than with ECN (Fig. 1a). For the wound closed with BCN, the edges were open widely separated from the surface to the bottom, and an intense inflammation is shown. Structural and inflamatory alterations were induced in the skin tissues as a consecuence of the BCN stiffness (Fig. 1b).

IV. CONCLUSIONS

The use of ethyl and octyl cyanoacrylates was successful in closure of the skin incisions. However, the n-butyl cyanoacrylate was too agressive likely due to high stiffness and exothermic reaction.

Acknowledgements. Financial support from MINECO (MAT2010-19904 and PET2008-0264 projects), and Generalitat Valenciana (ACOMP2011/254 project) is acknowledged.

Absorption and degradation characteristics of collagen-based composites reinforced with magnesium and bioceramic powders

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***Keywords* – water absorption, enzymatic degradation collagen, magnesium powder, biocomposite,**

I. Introduction

Development of biocomposite materials for hard tissue repair or replacement has been an active research area in the recent years [1]. Water uptake of collagen based composite affects their property mechanical properties, degradability and dimensional stability. All of these defects have the potential of compromising the not only the function of the implant but also can affect the biocompatibility [2]. The exposure and uptake of water can reduce the life of a collagen based composite due to hydrolysis. Studies have shown that the equilibrium water content can affect cell adhesion. The degradation of the collagen matrix is very important in the production of biocomposites which are involved in bone tissue engineering.

II. Materials and Methods

The experimental biocomposites were prepared by freeze-drying for 48h of collagen gels having the different weight ratio (1%, 3% and 5% wt) of magnesium powder (coded: M1 (1%Mg), M2 (3%Mg), M3 (5%Mg)) and Mg+10%β-TCP (coded: MT1, MT2, MT3) and cross-linked with glutaraldehyde.

A. ***Water absorption.*** The water up-take was determined by a conventional gravimetric procedure, in which preweighed composite samples of 1 cm diameter, were allowed to swell in distilled water for a period of time (up to equilibrium swelling). Thereafter the samples were taken out from the water and gently pressed on a filter paper to remove the excess and weighed again using a sensitive balance.

B. ***Degradation.*** *E*nzymatic degradation of composites was investigated by monitoring the weight loss depending on exposure time to collagenase solution. Composites with 1 cm diameter were accurately weighed, placed in PBS solution and collagenase (1 μg/mL) and incubated at 37°C. At regular intervals the swollen composites were removed from degradation solution, blotted dry and weighed. The percent of composite degradation was determined by the following relation:

$$\% \text{ weight loss} = (Wi - Wt)/Wi * 100 \quad (1)$$

where W_i is the initial weight and W_t is the weight after time t.

C. ***Bioactivity – SBF medium.*** The in vivo bone bioactivity of an experimental biomaterial can be predicted from the apatite formation on its surface in SBF. The samples were immersed in SBF at 37°C and pH 7.4, and removed at 14, respectively 30 days. The evaluation of the apatite layer on the surface of the sample was evaluated by scanning electron microscopy.

III. Results and Discussions

IV. The water uptake curves of the composites are presented in Fig 1. As the collagen content was decreased, the water uptake decreased and the time to achieve equilibrium content decreased. This is primarily due to the presence of the amine and hydroxyl groups on the collagen, which is the most probable site accommodation of the additional water. Compared to the control sample the quantity of absorbed water of the composites is 2-3 times lower, achieving equilibrium after 24h.

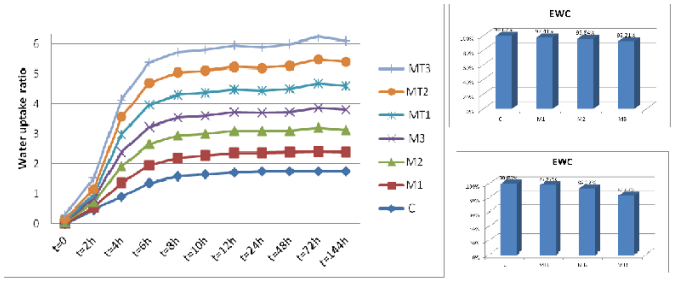

Fig. 1. Variation of water uptake and equilibrium water (EWC) of the experimental biocomposite (M1, M2, M3, MT1, MT2, MT3))

The enzymatic degradation has revealed that the experimental composites have a lower degradation rate comparative with the control sample (100% collagen - C). The degradation rate was influenced by the quantity of the filler (Mg, Mg+10%β-TCP). The degradation of the samples started after the 10th day after the immersion, time in which the samples presented water uptake instead of degradation.

Regarding the bioactivity of the samples, SEM micrographs of the biocomposites at 14 and 30 days after the immersion in SBF revealed a thin layer of apatite on the biocomposites surface. The biocomposites with 1% filler had degraded in the SBF medium after 10 days.

V. Conclusions

The aim of this research was to evaluate the absorption and degradation characteristics of some biodegradable collagen based composites reinforced with magnesium and (Mg+10%β-TCP) powder. The absorption and degradation characteristics have been influenced by the metallic filler, improving the degradation rate of the polymeric matrix of the composites. The composites with Mg+10%β-TCP present a better behavior than the ones with magnesium.

Considering the characteristics which have been studied in this paper, the experimental biocomposites appear to be suitable for medical applications.

VI. Acknowledgements

Authors recognize financial support from the European Social Fund through POSDRU/89/1.5/S/54785 project: "Postdoctoral Program for Advanced Research in the field of Nanomaterials"

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Synthesis and Electronic Structure of HAP-carbon Nanomaterial Composites

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Keywords **– calcium hydroxyapatite, carbon nanotubes, fullerene, shungite, composite.**

I. INTRODUCTION

Hydroxyapatite (HAP) has long been an attractive choice for bone replacement material. However, HAP has poor mechanical properties, such as brittleness and low tensile strength, thus its clinical application is limited.

One of the most common approaches to overcome these weaknesses is to produce composite materials based on apatite and various reinforcing additions. Very perspective materials for such HAP modification can be carbon nanomaterials – carbon nanotubes (CNTs) and fullerenes. Mineral shungite may also be interesting material from this point of view, as a source of natural fullerenes.

Thus, the purposes of this work was the synthesis of apatite composites with different modifying carbon nanomaterials (nanotubes, fullerenes, shungite), and investigation of mechanism and degree of interaction between particles of HAP and carbon nanomaterials by examining the composites electronic structure.

II. MATERIALS AND METHODS

The original calcium hydroxyapatite powder was synthesized by precipitation from an aqueous basic solution.

HAP modification by carbon nanomaterials was held in two ways - by mechanical mixing of HAP powder with carbon nanomaterials powder, and by ultrasonication mixing of these powders in aqueous suspension with pre-functionalization of carbon nanomaterials by boiling them in a mixture of sulfuric (H_2SO_4) and nitric (HNO_3) acids. The content of carbon nanomaterials in all obtained samples was 3 wt. %. X-ray photoelectron spectra (XPS) of samples core-levels were obtained by "JEOL" X-ray spectrometer. The working vacuum during the experiment was 10^{-7} Pa.

III. RESULTS

Analysis of the XPS spectra showed, that with the transition from pure HAP to composites HAP-carbon nanomaterials, electron density on the atoms of oxygen, phosphorus and calcium is decrease. It is observed the shift of core electrons binding energy of this atoms toward its increase in all composites: for HAP-fullerite - 0.6 - 0.9 eV; for the HAP-CNT - 0.3 - 0.6 eV; for the HAP-shungite - 0.1 - 0.2 eV (mechanical mixing) and 0.3 eV (mixing in aqueous suspension).

IV. DISCUSSION

The decrease of binding energy shift degree in the transition from fullerite (C_{60}) to CNT modifying material could mean less interaction degree of CNTs with HAP particles in comparison with the interaction degree of fullerenes with HAP, which can be due to the size effect: the fullerenes C_{60} molecules are much smaller than the CNTs molecules, and they can interact with greater number of HAP particles, compared with carbon nanotubes.

An even greater decrease of binding energy shift in transition to shungite can be explained by the reduced concentration of fullerenes in this mineral composition.

Thus, the core level energy value of Ca, P and O in the transition from pure HAP to the composites with carbon nanomaterials increased, which indicates a decrease in electron density on these atoms by such modifications, what suggests the increase of covalent component proportion in the overall balance of chemical bond.

As fullerenes and carbon nanotubes carbon atoms are linked by covalent bonds, it can be assumed that the increase of covalent component proportion in the overall balance of chemical bond indicates the formation of molecular complexes and the structure ordering.

V. CONCLUSIONS

A series of HAP-carbon nanomaterials composites was synthesised and their electronic structures were investigated by XPS method. It was established that the core level energy value of Ca, P and O in the transition from pure HAP to the composites with carbon nanomaterials increases, which indicates a decrease in electron density on these atoms by such modifications and the increase of covalent component proportion in the overall balance of chemical bond. Different degree of binding energies increase in different composites can be due to the size effect. The introduction of carbon nanomaterials in calcium hydroxyapatite leads to the formation of molecular complexes and to the structure ordering.

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Influence of the Hydroxyproline Content on the Denaturation Temperature of Fish Skin Collagen and Bovine Achilles Tendon Collagen

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I. Introduction

Collagen is the one of the most important component of human organism. It is the basic structural protein of connective tissue which constituent bones, cartilages, muscles, skin. The macromolecule of collagen is a complex molecule made of three polypeptide chains, which form the left-turn super helix and prion transmission associated diseases. Until the discovery of prions only bovine collagen had been used. Bovine collagen has long been recognized as a safe and highly biocompatible material to perform dermal implants. The observed transmission of BSE to humans resulted in the development of new sources of collagen. Therefore, collagen hydrolysate obtained from fish skin, as a prion free material, has generated some considerable interest in medicine and science in recent years. Collagen isolated from fish skin by hydration seems to maintain its native structure.materials

The material used in the experiment was fish skin collagen (FS – fish skin; *family: Cyprinidae*) obtained by means of acid hydration process and collagen type I derived from bovine Achilles tendon (BAT) collagen /SIGMA/, which was used as the control material.

II. Results and Discussion

The amino acid sequence is commonly glycine, proline and hydroxyproline [1,2]. In the triple helix the glycines are close to the central axis. The amino acid cystine is absent in collagen. FS collagen contains a lot of proline (13.55g/100g), similarly to BAT collagen (13.92g/100g). The content of the methionine is three times larger in case of FS collagen compared to BAT collagen. Both FS collagen and BAT collagen reveal high content of glycine and proline. The lower value of the FS collagen denaturation temperature is connected with the lower content of the hydroxyproline. Differences in the content of the hydroxyproline for FS collagen and BAT collagen are statistically significant ($p = 0.0063$). Achieved results demonstrate the dependence of the denaturation temperature on the hydroxyproline content.

III. Conclusion

The higher denaturation temperature (T_D) for BAT collagen, indicated its higher thermal stability than the thermal stability of FS collagen [3]. Although T_D of the FS collagen indicated its lower, but still it is sufficient to replace the BAT collagen.

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Biogenic Nanosized Hydroxyapatite as Novel Material for Tissue Engineering Applications

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Keywords **– eggshell, hydroxapatite, nanostructure, in vivo**

I. INTRODUCTION

One of perspective, non-expensive and environmental friendly material for hydroxyapatite (HAp) preparation is the recycled eggshell. The eggshell is composed of 94% calcium carbonate, 1% calcium phosphate, 4% organic matter 1% and magnesium carbonate and other trace elements [1]. Hydroxyapatite as resorbable porous bioceramics have been widely used as bone defect filling materials due to its remarkable biocompatibility and close chemical similarity to biological apatite present in bone tissues [2]. The aim of this work is to propose a simply method for producing HAp by mechanochemical activation from eggshells and study the bone regeneration of HAp successfully applied as material for tissue engineering applications.

II. MATERIALS AND METHODS

The eggshells were collected and cleaned. The raw eggshells were calcinated at 900 °C in air. The 3 hours thermal treatment resulted in calcium oxide formation from eggshells. To synthesize calcium phosphate powders, the shells were crushed and milled by high efficient attritor mill (Union Process 01 HDDM) at 4000 rpm for 5 h. The shell : H_3PO_4 ration was 50:50 wt% [3]. After milling, a small amount of HAp powder was heat treated at 900°C for 2 h in air atmosphere. The structure of HAp was characterized by scanning electron microscope (SEM, Jeol Inc., Toyko Japan) and transmission electron microscope (TEM, Philips CM-20). For in vivo tests, general anesthesia of mouse was induced by intramuscular injection of a combination of 0.05ml of rompun and 0.05ml of zoletil. A dental-trephine bur was used under copious saline irrigation to create a one full-thickness calvarial defect with 3mm in diameter. The graft – HAp was placed into calvarial defects. Postoperatively, the mouse received gentamicin 1mg/kg intramuscularly once daily for 3 days. They underwent a micro-computed tomogram 4 weeks later. The anesthetized state of the mouse underwent micro CT using an Explored Locus SP micro CT scanner (GE Medical Systems, London, Ontario, Canada).

III. RESULTS

The HAp powder after milling showed bimodal structure. The average size of finer structure was ~ 10 nm and the globular particles were ~ 200 nm (Fig. 1). The bioactivity of nanosized HAp was evaluated in mouse models. After bilateral parietal bony defects formation, the nanosized HAp was grafted. The control was the unfilled defect.

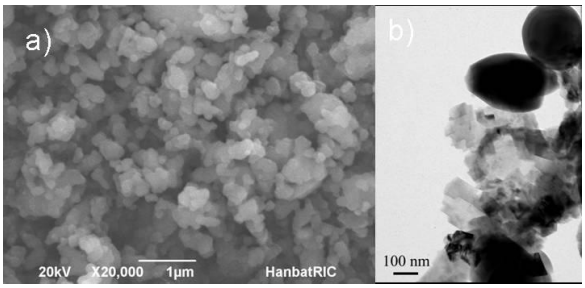

Fig. 1. Structural investigation of HAp. a) SEM and b) TEM image.

Results of bone regeneration evaluated by micro-computerized tomograms at 4 weeks are shown in Fig. 2. HAp showed much more bone formation compared to control group in micro-tomographic analysis.

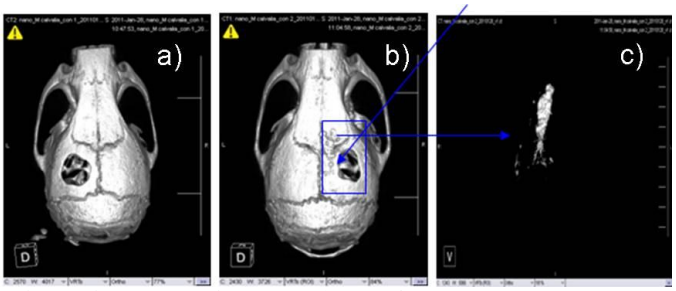

Fig. 2. Micro Computed tomogram (μ-CT) of mouse in vivo experiment. a) control, b) experiment, c) new bone after 4 weeks.

IV. CONCLUSIONS

Nanosized hydroxyapatite was successfully produced from recycled eggshells and phosphoric acid by attritor milling. The eggshell is easily available and cheap material. Our results demonstrate that nanosized HAp prepared from the eggshell can be good calcium source in bone formation.

V. ACKNOWLEDGEMENTS

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Profilometry on Refined Hydroxyapatite Coatings Supports the Design of Orthopaedic Implants

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Keywords **– coatings, hydroxyapatite, implants, topography, surface characterization.**

I. Introduction

The implant surface provides the first interaction with the biological environment and hence is essential to a) optimize for insertion into bone and then b) providing the right signals for cell expression. Hydroxyapatite is modified during dissolution and so the microstructure plays an important role at the nanometer level [1]. The manufacturing process affects the roughness at the micro and the nano level. Little attention has been directed to the topography of thermal spray hydroxyapatite coatings since it typically consists of partially molten particles, fragmented particle cores, splashed droplet and well formed flattened droplets [2]. Recent developments have provided a coating that consists solely of flattened solidified droplets. This has generated a new requirement to accurately describe the surface of hydroxyapatite coatings for the design of optimized implant surfaces.

Roughness and topography exists at the splat surface and also the surface consisting of a random arrangement of splats. The aim of this investigation is to determine the profile characteristics that can be obtained using the contact method.

II. Materials and Methods

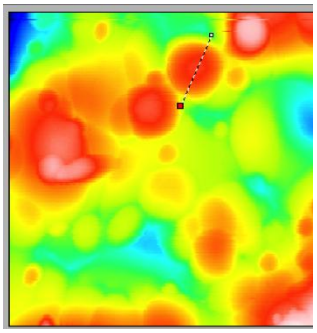
A refined hydroxyapatite (HAp) coating was produced by ensuring that HAp particles were totally molten and deposited while in a molten state. This was achieved by using a narrow particle size range so that the particles would all melt to the same degree. Coatings were produced by flame spraying 20-40 μm powders in an oxygen acetylene flame.

Profilometry was performed with a Taylor Hobson Form Talysurf Intra 50 contact profilometer with a 2 micron spherical end and an included angle of 90 degrees. A map was produced by using the TalyMap Expert software. Dimensions of measurement areas for both x and y axes– 200 μm × 200 μm or 400×400 data points. The topography was plotted in a 2D view with the corresponding profile of the line of interest.

III. Results and Discussion

A refined hydroxyapatite (HAp) coating was composed of rounded splats without splashing. The splat size was determined using the profile extraction tool. Adotted line was drawn across a splat in 6 different orientations to produce a splat size of about 45 μm, Fig 1. The corresponding profile provided the height of the splat, Fig 2. A closely positioned neighboring splat prevents the measurement of the splat height and the base will appear much higher.

The splat height of 10 μm also prevents the determination of the true edge profile. The large included angle of the diamond probe (90°), will lead to the sliding of the diamond tip on the side of the splat transform a rounded splat edge to a tapered splat edge, Fig 3. Use of a smaller included angle diamond tip is expected to lead to a steeper taper, but still not provide a true representation of the splat edge. Atomic force microscopy is needed for an accurate shape of the splat edge.



splat profile

Figure 1. A map of the coating surface indicating a line drawn to measure the

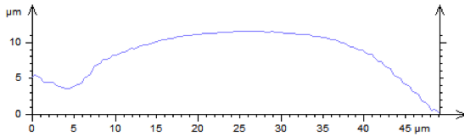


Figure 2. The profile of the splat, showing interference from an adjoining splat to the left.

Only the splats from molten particles close to 20 μm appear to populate the surface. Larger splats are 3 to 4 times larger and blend into the background. The rounded splats will provide less abrasion and facilitate easier implant insertion into bone, compared to coating that also consist of partially molten particle and fragmented particle cores.

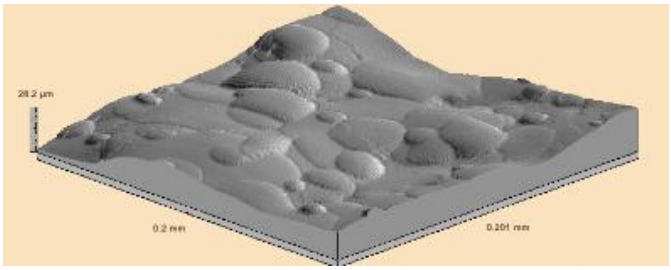


Figure 1. Photo-simulation of the hydroxyapatite coating surface.

Roughness of the splat surface could be determined, but the diamond tip with a 2 μm diameter would not provide the required precision. An AFM tip is expected to give better results on the splat surface roughness.

Further work is required to compare the topography with noncontact profilometry and atomic force microscopy. Another important aspect will be to determine the angle of the deposited droplets.

IV. Conclusions

This study has shown the ability to report on thermal spray coatings at the splat level, providing the splat diameter and height, and a photo-simulation of the surface.

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Physical-mechanical properties and biomedical performances of titanium oxynitride films deposited by reactive magnetron sputtering

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***Keywords* – magnetron reactive sputtering, titanium oxide and oxinitride coatings, hemocompatibility.**

I. Introduction

Hemocompatibility is a key property of biomaterials used in cardiac surgery and modification of the implant surface has a great importance for improving this property of medical grafts. Titanium oxides and oxinitride films are very promising for application as coronary stents coatings. The film must possess the following general properties: to be biocompatible, continuitibles, without crack and defects with a thickness no more then 1μм. Also the films must have high density, high adhesion and mechanical characteristics.

The object of this work was the analysis of physical-mechanical properties of Ti-O/Ti-O-N films and its blood compatibility *in vitro* and *in vivo.*

Plates of 316L stainless steel were used as substrates. Ti-O/Ti-O-N thin films were synthesized by pulsed magnetron reactive sputtering deposition technique. Pulsed dc magnetron reactive sputtering of dielectrics provides a deposition process without arcing. The deposition process was carried out with pulsing frequencies 60 kHz and duty cycles in the range 50–90%. The operating conditions were optimized empirically and were critically dependent on the properties of the pulsed plasma in the immediate vicinity of the magnetron. The chemical composition of the plasma was investigated by optical emission spectroscopy. The thin coatings were characterized by EDX, ESEM, XRD, IR spectroscopy, and pull off test. The semiconducting behavior of the films was investigated using electro conductivity measurements.

The blood plasma enriched by platelets of a healthy volunteer was separated out in biological part of the experiments. In the test tubes with tested samples 1 ml blood plasma was added and incubated 1 hour at 37°C according to ISO 10993-5. Structural - functional characteristics of primary platelet hemostasis were determined in an hour. The probes with steel samples without coating were used as control.

II. Results and discussion

The surface of magnetron deposited coatings is homogeneous, dense, and no cracks were observed. The chemical, and phase composition as well as thickness and structure can be varied by set of deposition parameters: chemical composition of plasma, the power of discharge etc. The results show that deposited coating has character of nanocomposite with two-phase amorphous-crystalline structure with high part of interphase boundary.

The adhesion strength of the coatings was in order to 40 MPa. X-ray diffraction patterns demonstrate that for TiO_2 coatings the main components of the film are anatase (69.8%) and rutile (8.1%). The film has nanocrystalline structure with average grain size that equals 13.83 nm. Experimental research of mechanical characteristics done by the method of dynamical nanoindentation demonstrated that the coating has high nanohardness and high density. High enough Young's modulus value (11 GPa) is an evidence of a high mechanical strength and good elastic properties of coatings. On the other hand relatively low value of elastic recovery (up to 82%) means that coating is plastic. The character of deformation is plasto-elastic. Increase of elastic recovery with thickness of coating testify increase of it elasticity and ability to restore the shape after unloading. This indicates also that the probability of crack formation in the coating decreases. Nanohardness of the coating is greater than that of substrate and increases with the increase of film's thickness in the interval 0.35 μm to 2 μm. On the contrary, contact stiffness decreases. Cell contact with steel substrata led to increasing of practically all parameters of platelets' functional activities with respect to the control. Deposition of the coatings on the steel substrates led to decreasing of platelets' functional activities. The development of platelets' aggregation decelerated (lag period increased) under the stimulation of processes by adenosine diphosphoric acid or collagen. The concentration of cells and hematocrit in liquid part increased. Titanium oxide and oxinitride films on the steel substrate blocked the platelets' adhesion to the artificial surface and consequently thrombosis. *In vivo* implantation of the samples into dog femoral artery showed no thrombus formation on the surfaces of the Ti–O coated samples although serious coagulation occurred on the surfaces of unmodified samples over a period of 3 months under conditions with no anticoagulant therapy.

III. Conclusions

The structure of the surface of magnetron deposited TiO_2 coatings was homogeneous, dense, and no cracks were observed. The deposited coating is biphase with amorphous and nanocrystalline structure. Deposited coatings belong to the class of nanocomposite materials with high physical-mechanical properties (H > 10 GPa), elastic recovery (R > 70 %). Obtained TiO_2 film possesses the properties which allow using them as coatings for medical grafts applied in implantology.

Nanostructured titanium produced by severe plastic deformation: structure, properties, medical applications

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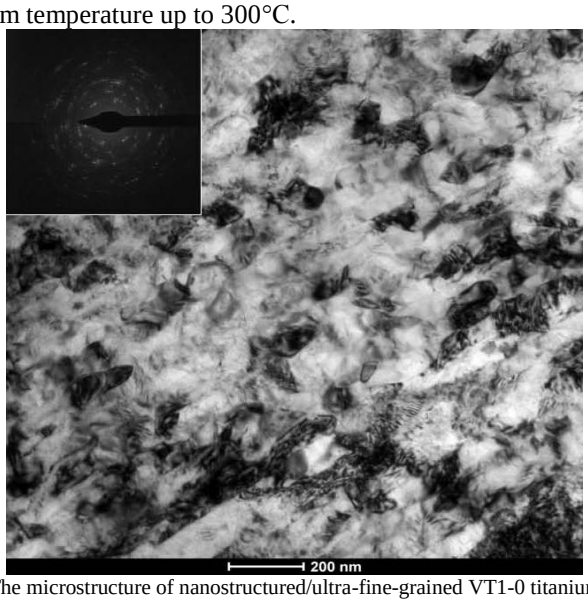
Keywords **– nanostructured titanium, structure, properties. medical applications.**

One of the ways to increase mechanical properties of metals is a formation of ultrafine-grained or nanostructured state in the bulk with severe plastic deformation. At present the different severe plastic deformation methods have been developed. There are many experimental data illustrating a improvement of mechanical properties, such as limit strength, yield strength, fatigue strength, wear resistance, microhardness and so on as a result of the ultrafine-grained or nanostructured state formation with the severe plastic deformation.

Today, a combined method of severe plastic deformation, comprising abc-pressing in a press-mold and multiple rolling, to produce the technically pure titanium VT1-0 rods in nanostructured / ultrafine-grained state, is used in ISPMS of SB RAS. This method represents multiple uniaxial pressing of coarse-grained titanium billets in a press-mold with the change in deformation axis before the each cycle of deformation and at a successive step-by-step decrease of temperature from 700°C to 400°C, then - multiple rolling in the grooved rollers and prerecrystalline annealing at the temperature of 300-350°C.

The method allows us to produce titanium rods in nanostructured / ultrafine-grained state (fig. 1) with a homogenous structure in the bulk with the average size of the elements of the grain-subgrain structure (grains, subgrains, fragments) of 100 nm and less (fig. 2). Mechanical properties (yield point, ultimate stress, hardness and fatigue strength) of the nanostructured titanium, produced by the method, compared with those of medium-strength titanium alloys, i.e. Ti-6Al-4V. The nanostructured titanium remains the stable microstructure and properties in the temperature interval from a room temperature up to 300°C.



The microstructure of nanostructured/ultra-fine-grained VT1-0 titanium

The modern constructions of intraosseal screw dental implants of different modifications from the VT1-0 nanostructured / ultrafine-grained titanium (they are characterized by the increased osseointegration) have been developed (fig. 3). Instruments and implements necessary to perform surgical and orthopedic procedures with dental implants have been developed.

The clinical tests of nanostructured titanium dental implants have been completed. They have confirmed that the implant constructions correspond to the modern state of implantology.

Fif. 2. Long-length rods of nanostructured / ultrafine-grained VT1-0 titanium

Fig. 3. A set of dental screw intraosseous implants with instruments and implements

DLC Thin Films for Cardiovascular Stents

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***Keywords* – Diamond-like carbon, nanocomposite DLC, RPP.**

I. INTRODUCTION

Diamond-like carbon (DLC) films have found widespread application in biological coatings for implantable medical devices, as a result of their good chemical resistance, temperature stability and biocompatibility. The biological behavior of an implant can be tuned by modifying the element composition. DLC can be easily alloyed with other biocompatible materials such as titanium as well as toxic materials such as silver, copper and vanadium by normal co-deposition methods [1]. Nanocrystalline diamond-coated medical steel has shown a high level resistance to blood platelet adhesion and thrombi formation [2]. Diamond and DLC coatings have successfully been proposed for applications as artificial heart valves, prosthetic devices, joint replacements, catheters and stents, orthopedic pins, roots of false teeth, surgical scalpels and dental instruments [3].

II. EXPERIMENTAL

In this paper we present the results of the microstructural control of Ti/DLC nanocomposite coatings with pulsed direct current (DC) magnetron sputtering. The sputtering system was configured of Ti target (99.7%), and graphite target (99.99%). Deposition rate of 3.5 μm/h is obtained by using the sputtering current of 30 A. Ti/DLC films were deposited on non-annealed and annealed 316L stainless steel. Annealing was performed according the technology sequence for stents-electropolishing and high temperature annealing for grain enlargement and improving of the stents elasticity. A number of analytic methods were applied SEM, AFM and EDX. The high temperature annealed stainless steel morphological analyses demonstrated the essential grain enlargement 10 to 60 μm, which is necessary for the required elasticity of the arterial stents. The grain structure can influence the structure of the deposited biocompatible nanolayers, which is demonstrated further for deposited at high temperatures layers on stainless steel substrates.

The investigated Ti/DLC nanocomposite films have been deposited onto the coronary stainless steel stent with the following dimensions: diameter 3mm, length 13mm fabricated by Company ISMA Ltd Sofia, Bulgaria.

The thermal annealing of the stainless steel substrate during deposition at high temperatures do not change essential the elemental content of the substrate. Only a small oxidation is observed. But the surface and the structure of the deposited carbon layers is not smooth, as it is for layers deposited on the glass and these temperatures are not applicable for the stents technology.

AFM study images of the DLC layers deposited on stainless steel at 250°C, RPP 400°C are presented in Fig. 1.

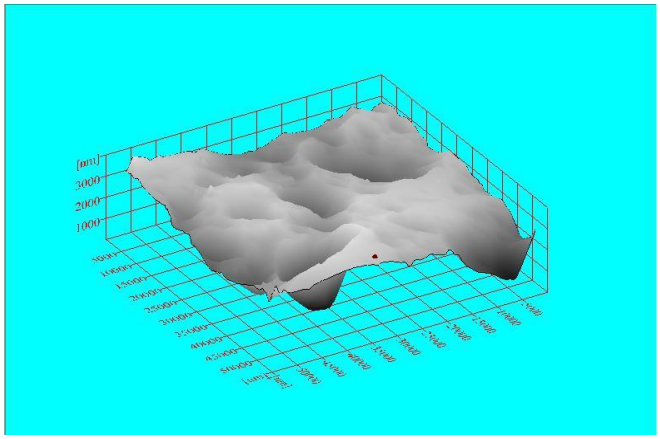

Fig. 1 AFM image of layer deposited at 250°C on non-annealed stainless steel 316L

The AFM study of DLC layers deposited at high temperatures on non-annealed and annealed stainless steel showed that the roughness of the layers is up to 300 nm on non-annealed substrates and up to 3500 nm on annealed substrates. The roughness on non-annealed samples was due to the non-polished surface, wile on the annealed substrates-to the much larger grain size after annealing.

The Rapid photothermal processing was performed at 300°C - 700°C in vacuum and N2. The RPP at 300°C and the furnace annealing at 400°C up to 3 min do not essentially change the carbon content, but RPP at higher temperature 350°C-450°C even up to 1 min essentially changed/reduced the carbon content.

Auger analyses of DLC layers showed the existence of relative thick carbon layer, thin transition C/Ti layer and thin Ti layer.

III. CONCLUSIONS

The reliable technology for magnetron deposition of biocompatible Ti/DLC nanolayers for coating of implantable medical devices has been established. RPP at 400°C improved the microstructure and properties of deposited coatings, which strongly depend on the intensity of the concurrent ion impingement on the growing interface.

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Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
The 1st Congress of World Engineers and Riga Polytechnical Institute / RTU Alumni

Laser-induced Hydrodynamics for Tissue Regeneration

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Keywords **– laser, hydrodynamics microbubbles, tissue, regeneration.**

I. Introduction

Modern laser medical technologies widely employ delivery of laser light to irradiated tissues via optical fibers. Optical fiber easily penetrates through needle and endoscopic channels, and laser light can be delivered through a fiber for puncture and endoscopic operations. Several laser medical technologies are based on effective hydrodynamic processes in water-saturated biotissues. Laser irradiation of water and water-saturated biotissues causes formation of micro-bubbles and their streams, circulated flows of liquid and even filaments. These hydrodynamic processes trigger cellular response and regenerative effects through the specific mechanisms of mechano-biology. They can stimulate sanitization of degenerated tissue cavities and proliferation of cells. We consider here different kinds of effects stimulated by a medium power laser-induced hydrodynamics in the vicinity of a fiber tip surface, in particular, generation of vapor-gas bubbles, fiber tip degradation, and generation of intense acoustic waves.

II. Results

We have performed the measurements in bulk liquid and in the glass capillary that simulates the laser channel. A developed threshold character of the dynamics of liquid is demonstrated. At a relatively low laser power (about 1 W), we observe the slow formation of air–vapor bubbles with sizes of hundreds of microns on the end surface of the optical fiber. When the laser power increases, we observe the hydrodynamic processes related to the explosive boiling in the vicinity of the hot end surface. The resulting bubbles with size ranging from a few microns to several tens of microns provide motion of liquid. The estimations give a velocity of up to 100 mm/s for the bubbles in the vicinity of the end surface. The generation of bubbles in the capillary leads to the circulating liquid flows with periods ranging from 0.2 to 1 s. For the laser radiation with a wavelength of 0.97 μm, we observe such effects only for the blackened end surface of the silica fiber, which serves as a point heat source.

Hydrodynamics caused by laser heating in the free liquid volume can lead to the degradation of the fiber end surface over several minutes even at relatively low laser intensities (10^3–10^4 W/cm^2). The hydrodynamic processes in the regime of the channel formation result in more significant modifications over shorter times. In this regime, a channel is burnt by the laser-heated fiber end surface in the presence of water in a wooden bar that mimics the biotissue. Holes and cracks appear on the fused working surface, and the structure of the silica fiber in the vicinity of the end surface appears damaged. Even at moderate laser powers and intensities of about 10^4 W/cm^2, the temperature in the vicinity of the end surface of delivery fiber can reach several thousand degrees. High temperatures and pressures resulting from the collapse of the cavitation microbubbles allow growing of a new phase (nanosized diamonds) and the formation of the supercritical water, which also facilitates the degradation of fiber. The observed significant degradation of the delivery fiber due to multiple irregularities of different scales causes substantial modification of the irradiation of biotissues.

The collapse of the cavitation bubble leads to the generation of the high-pressure pulse, whose amplitude can be greater than 10^6 MPa at relatively low gas content, and causes the heating of the internal gas, so that the gas temperature rapidly increases to, at least, 10^4 K. At such temperatures and pressures, we obtain the supercritical water (the critical pressure and temperature for water are *P*cr = 22.1 MPa and *T*cr = 374°C, respectively), which effectively dissolves the silica glass. Indeed, the modification of the fiber end surface is similar to the modification of silica fiber after etching in the supercritical water.

Fig.1 shows that spectra*3–5*, which correspond to different fragments of the fiber end surface, exhibit two broad peaks, whose positions are close to the positions of the graphite Raman bands (curve *1*). However, as distinct from the spectrum of graphite, the peak amplitude in the interval 1300–1400 cm^{-1} is approximately equal to (curve *5*) or greater than (curves *3* and *4*) the peak amplitude in the interval 1540–1640 cm^{-1}. This can be due to the presence of the diamond crystals on the fiber end surface.

The fact that the low-frequency bands in spectra *3–5* are wider than the Raman band of diamond peaked at 1330 cm^{-1} (curve *2*) can be due to the presence of the nanosized diamond particles.

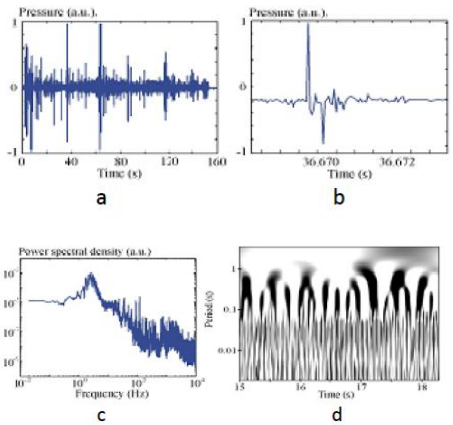

Fig. 1. Acoustic signal in the course of laser induced hydrodynamics.
a – signal; b –fragment of signal; c–spectral density of signal power;
d– wavelet transformation of acoustic signal fragment (Fig.5a) with a well pronounced cascade process.

III. Conclusions

Laser induced hydrodynamics allows:
- Triggering biotissue regeneration;
- Sanitization of biotissue cavities;
- Bloodless and precise cutting of biotissue;
- Stimulate cell membranes permeability and drug delivery.

IV. Acknowledgements

This work was supported by Russian Foundation for Basic Research (grants 10-02-01472, 12-02-00392, 12-02-00914).

Ultrastructural Characteristics of Tissue Response After Implantation of Calcium Phosphate Ceramics in the Mandible of Rabbit

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***Keywords* – β-tricalcium phosphate, hydroxyapatite, ceramics, tissue, porous structure, cell, microstructure**

I. Introduction

Inflammation, trauma, congenital malformations and tumors can cause bone defects. The most popular implant material for bone regeneration is calcium phosphate (CaP) ceramics, especially hydroxyapatite (HAp) and β-tricalcium phosphate (β-TCP) ceramics due to chemical similarity and crystallinity with mineral phase of natural bone. To reach better bioactivity, resorption and even drug release kinetics many scientific publications report, that mixture of both CaP shows better results comparing to single phase [1]. Studies over implants show that not only the structure of biomaterial, but also the character of surface affects the local tissue reaction. This study was designed to detail the structural and ultrastructural features of the interfaces between pure HAp or biphasic calcium phosphates ceramics implants and their surrounding tissues.

II. Materials and Methods

A. Preparation of porous samples

Three powders (1st group – 100% HAp, 2nd group – 95% HAp/5% β-TCP, 3rd group – 80 HAp/20% β-TCP) with different Ca and P ratio were obtained by realizing wet precipitation reaction between $Ca(OH)_2$ suspension and H_3PO_4 solution. Obtained powders were mixed with glycerol, distilled water and ammonium bicarbonate NH_4HCO_3. Samples were dried in 120°C to promote foaming process and to gain porous structure. Samples were thermally treated in 1150°C.

B. Examination of porous samples

The obtained CaP porous samples were analyzed by X-ray diffraction (XRD) and Fourier transformation infrared spectrometry (FT-IR) to evaluate phase and chemical purity. The field emission scanning electron microscopy (FE-SEM) was used to study the microstructure after sintering. Porosity was determined by Archimedes method.

C. Morphologic examination

The tissue response was evaluated 6 months after implantation of ceramics in the mandible of rabbits. Tissue samples were fixed in 2.5% glutaraldehyde. For transmission electron microscopy (TEM), the samples were post-fixed in 1% osmium tetroxide, dehydrated through a graded ethanol series, and embedded in Epon epoxy resin. 60 nm-thick fine sections were cut, collected on 200-mesh formvar coated cooper grids, double stained with uranyl acetate and lead citrate. 1 μm- thich sections were stained with toluidine blue and viewed using light microscope.

For scanning electron microscopy (SEM), tissue dehydration was performed using increasingly concentrated solutions of acetone, dried by the critical point method using liquid CO_2, and coated with a thin layer of gold.

III. Results and Discussion

According to XRD data, obtained CaP products after synthesis are well crystalline phase composition are: 1st group – 100% HAp, 2nd group - 95% HAp and 5% β-TCP and 3rd group – 80% HAp and 20% β-TCP. FTIR analyze approves, that used additives for production of porous samples do not affect chemical composition of resulting products.

Pores of examined samples are without a specific form. The size of macropores ranges between 30 and 400 μm. According to literature [2], it is promising for cell penetration and tissue forming. The surface of pore walls is rough and grains have dense packing after sintering. There are partly connected micropores (< 10 μm) in the fracture of pore wall.

The outer layer of all implanted tablets was constituted by collagen fibers arranged in bundles and connective tissue cells presented mostly by differentiated fibrocytes. Near the implant surface the collagen fibers ran parallel to biomaterial surface, and fat tissue was rather abundant, particularly, in the 2nd group. SEM examination revealed an intimate adhesion and spread of cells immediately at the HAp tablet surface. These were much more less numerous at the samples obtained from the 3rd group, whereas, the samples of the 1st group displayed a remarkable tendency for cell clustering and aggregation seen in SEM studies. A vascular supply was well established. Osteoblasts attached to the surface of bioceramics were regularly appearing.

IV. Conclusions

The results 6th months after implantation showed, a thick fibrous collagenous capsule formed around the pure HAp and presented by densely packed and flattened fibrocytes, while addition of β-TCP evidenced highly vascularized adipose tissue. Calcium phosphate porous ceramics obtained by gas-generating method is promising for bone tissue regeneration as showed histological studies. It has to be taken into account microstructure and phase composition of prepared ceramics to provide better new bone formation and resorption of implant material.

Acknowledgement

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Bone Marrow Multipotent Mesenchymal Stromal Cells Transplantation Effects after Experimental Polytrauma in Rats

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Irina Paegle, Oleg Suhorukov (*Riga Hospital of Traumatology and Orthopedics*),
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Keywords **- Bone marrow multipotent mesenchymal stromal cells, polytrauma**

I. Introduction

Military operations, terror acts and natural disasters in the last years have increased the number of polytrauma victims. Polytrauma is characterized not only by damage to certain parts of the body, but also by serious systemic changes which require complex treatment [3]. During the last decade regenerative medicine in treatment of tissue and organ injury has lead to more wide-spread use of cell technology [6]. Bone marrow multipotent mesenchymal stromal cells (BM MMSCs) are being used more frequently. Their therapeutic efficacy is provided not only by capability to differentiate within its mesenchymal lineage, but also by its potency to transdifferentiate into an ectodermal cell lineage, as well as immunomodulation and paracrine effects. The aim of our study is to investigate the effects of BM MMSCs transplantation on bone fracture repair in rats exposed to experimental polytrauma.

II. Materials and Methods

Male Wistar-Kyoto rats (190±11g) were divided into 3 groups (n=9): A – intact animals - control, B – polytrauma, C – polytrauma and syngeneic BM MMSCs transplantation.

Polytrauma was induced by causing 3 bone fractures and hemorrhagic shock. 36 hours and 9 days after surgery rats of group C received BM MMSCs ($1x10^6$ cells/kg) i/v.

The weight and rectal temperature of the rats were measured regularly. The blood analyses were performed periodically. The rats' locomotive behavior was assessed in an open field test. Animals were euthanized 30 days after surgery and the lower extremities were taken for muscle and callus macroscopic examination as well as for histological observation.

III. Results and Discussion

A body weight decrease was observed 24h after surgery; thereafter it increased (f.v. Fig. 1). That indicated that the studied animals had no irreversible stress. At the end of the experiment rats' weight gain in group C was greater than in group B. This may mean that rats' treatment with BM MMSC transplantation leads to faster recovery after trauma and better rehabilitation process outcomes.

Animals treated with BM MMSCs transplantation regained functional capacities of their extremities earlier than the untreated group (f.v. Fig. 2). Macroscopic observations showed that rats from group C had larger sizes of callus that could ensure stability and functionality of broken extremities.

Transplantation of BM MMSCs enhanced osteoblast activity and their function (bone matrix development and mineralization) and accelerated trabeculae formation and maturation (f.v. Fig. 3).

10 days after surgery the lowest blood glucose level was observed in group C, but lactate concentration was the same as in group A while in group B it had decreased. These differences could be explained by differences in the animals' physical activity level: rats in group C were more mobile.

Blood acid/base balance and gas parameters after surgery indicated hypoventilation and respiratory acidosis with metabolic compensation (f.v. Table 3). There were no statistically significant differences between group B and C indicating that BM MMSCs transplantation did not have any impact on this part of the polytrauma pathophysiological process.

Production of new red blood cells after acute anemia in animals who received BM MMSCs transplantation was impaired as indicated by RBC count as well as the HGB and HCT levels (f.v. Table 4). The reasons for this are unclear.

Rats that underwent surgery had decrease in the leukocyte count that was caused by blood loss however at day 10 it was elevated by 30% above the normal level (f.v. Fig. 4), which evidently shows inflammation caused by polytrauma. At the end of the experiment the WBC number in BM MMSCs treated rats was 16% less than in control. This phenomenon may be explained by MSCs-mediated inhibition of lymphocyte proliferation.

IV. Conclusions

BM MMSCs transplantation improved rat rehabilitation scores after experimental poly-trauma and stimulated bone fracture healing, but at the same time caused delayed recovery after hemorrhage.

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Transmyocardial Laser Revascularization - single Institution Experience

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***Keywords* – transmyocardial laser revascularization, coronary artery disease, coronary artery bypass graft surgery, Canadian cardiovascular society angina class.**

I. INTRODUCTION

The standard revascularisation methods have not proved effective enough in situations of very diffuse coronary artery disease (CAD)[1-2]. One of the methods to solve this situation is transmyocardial laser revascularization (TMLR)[1-3].

II. METHODS AND RESULTS

35 patients have undergone surgical treatment since November 2003. All operations had done TMLR as an adjunct to coronary artery bypass graft surgery (CABG). All patients had 3 vessels disease. At a median follow up 6 months after operation 78 % of patients were free of angina pectoris. All patients before operation were in III and IV Canadian Cardiovascular Society (CCVS) angina class, after operation at follow up time were in class 0 – II CCVS. Myocardial perfusion scintigraphy shows significant improvement of myocardial perfusion. Control group included 50 patients with three vessels disease; all of the patients underwent isolated CABG surgery on pump. No statistical significant differences were found in Troponin I level, postoperative bleeding compared with isolated CABG.

III. CONCLUSIONS

TMLR is minimally traumatic and effective treating method in combination with CABG.

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Sources of Radiotoxicity in Spent Nuclear Fuel

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Keywords **– Spent nuclear fuel, fission products, actinides, code APOLLO, code PEPIN, radiotoxicity.**

I. INTRODUCTION

About one third of all the electricity produced in the European Union is nuclear–generated. The future of nuclear energy in Europe depends to a great extent on public and political acceptance [1].

Ignalina Nuclear Power Plant (Ignalina NPP) in Lithuania was the most important energy supplier not only for Lithuania, but also for neighbouring countries. Two RBMK-1500 reactors were design at the Ignalina NPP with a capacity of 1500 MWe each. The first reactor was commissioned late in December 1983, the second one in August 1987. Their design lifetime was projected out to 2013 – 2017. [2]. One of the key conditions due to Lithuania's accession to European Union was a requirement that the first RBMK-1500 reactor must be closed at the end of 2004 and second one – at the end of 2009. It was fulfilled at 31st December, 2009, 20:54 (UTC). Next to the current Ignalina nuclear power plant the regional Visaginas nuclear power plant will be constructed [3].

II. RADIOTOXICITY

The concept of radiotoxic inventory and the term of potential radiotoxicity are used for evaluation of the harmful potential of a certain quantity of radioactive material. The radiotoxicity (in sievert, Sv) resulting from intake of a particular nuclide is the product of the effective dose coefficient (units Sv/Bq) and the activity (in Bq) of that nuclide:

$$Radiotoxicity = Activity \cdot e(50)$$

Effective dose coefficient corresponds to the dose resulting from the intake of 1 Bq of a specific radionuclide. It takes into the account the metabolism of radionuclides in the organism once ingested or inhaled, the energy and type of the emitted radiation as well as the effect of radiation upon the specific tissue or organ and the integration time in years following intake. For adults, the integration time is 50 years [4].

A dose factor table is regularly updated by the International Commission on Radiological Protection (ICRP).

III. RESULTS AND DISCUSSION

Radiotoxicity of spent nuclear fuel consists from radiotoxicity of actinides and radiotoxicity of fission products. For the same level of radioactivity, actinides have a greater impact than fission products [5].

Uranium ^{238}U is the main naturally-occurring fertile isotope, and uranium ^{235}U is fissile isotope. Other heavy nuclei that are fissile are ^{239}Pu and ^{241}Pu. Each of these plutonium isotopes is produced artificially in a nuclear reactor, from the fertile nuclei ^{238}U and ^{240}Pu respectively. Uranium and plutonium are termed the major actinides. Other actinide elements in spent nuclear fuel are named as minor actinides. The minor actinides include americium, neptunium and curium. Plutonium and the minor actinides are responsible for the majority of the radiotoxicity in the spent nuclear fuel. The most important nuclides are ^{237}Np, ^{241}Am, ^{243}Am, $^{242\text{-}244}$Cm. The accumulation of major and minor actinides in dependence on fuel burnup was calculated by means of code APOLLO1 [6] for RBMK-1500 reactor.

Another component of radiotoxicity in spent nuclear fuel is fission products. Binary fission, which is most probable, creates two nuclei with different masses. There are 699 fission products in the radiated nuclear fuel analyzed with the depletion code Pepin [7], with mass numbers ranging between 60 and 170 and from copper (Cu) to ytterbium (Yb).

Table 1. Importance of radionuclides according activity in spent nuclear fuel

Cooling time	Nuclides
1 y	^{85}Kr, *^{89}Sr*, *^{90}Sr* ^{90}*Y*, *^{91}Y*, *^{95}Zr*, **^{95}Nb**, ^{103}Ru, ^{103m}Rh, **^{106}Ru,** **^{106}Rh**, ^{123}Sn, ^{125m}Te, ^{127m}Te, ^{127}Te, ^{129m}Te, ^{129}Te, ^{134}Cs, *^{137}Cs*, ^{137m}Ba, ^{141}Ce, **^{144}Ce**, **^{144}Pr**, *^{147}Pm*, ^{155}Eu.
10 y	*^{85}Kr*, **^{90}Sr**, **^{90}Y**, ^{106}Ru, ^{106}Rh, ^{121m}Sn, ^{121}Sn, ^{125}Sb, ^{125m}Te, ^{134}Cs, **^{137}Cs**, **^{137m}Ba**, ^{144}Ce, ^{144}Pr, *^{147}Pm*, ^{151}Sm, ^{155}Eu.
50 y	^{85}Kr, **^{90}Sr**, **^{90}Y**, ^{99}Tc, ^{121m}Sn, ^{121}Sn, **^{137}Cs**, **^{137m}Ba**, *^{151}Sm*, ^{155}Eu.
100 y	^{85}Kr, **^{90}Sr**, **^{90}Y**, 99Tc, ^{121m}Sn, ^{121}Sn, **^{137}Cs**, **^{137m}Ba**, *^{151}Sm*.

The Table 1 shows radionuclides with activity more than 0,01 % of total activity. The results were defined with code PEPIN1. Cursive script is used to show the radionuclides with contribution more than 1 %, and boldfaced script is used to show the radionuclides with more than 10 % of total activity. After 1 year cooling there were ^{95}Nb, ^{106}Ru, ^{106}Rh, ^{144}Ce, ^{144}Pr in RBMK-1500 reactor spent nuclear fuel with burnup of 18 MWd/kg. After 10 to 100 years cooling ^{90}Sr, ^{90}Y, ^{137}Cs, ^{137m}Ba are most important radionuclides according to the activity.

According Table 1, after 50 years cooling most important nuclides are ^{85}Kr, ^{90}Sr, ^{90}Y, ^{99}Tc, ^{121m}Sn, ^{121}Sn, ^{137}Cs, ^{137m}Ba, ^{151}Sm, ^{155}Eu.

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On Criteria for Wide-angle Lens Distortion Correction for Photogrammetric Applications

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Keywords **– photogrammetry, camera calibration, image distortion, wide-angle lens, correction.**

I. Introduction

Photogrammetry is intensively used both in industrial applications and medicine. Extraction of various anthropometrical data, such as height, shoulder inclination or Kobb angle form single photograph could be implemented in mobile devices, used for health screening. To be able to get photo of standing individual when the space for observations is restricted, wide – angle lens has to be used. Unfortunately, such lenses demonstrate highly expressed radial distortion, thus image has to be corrected before it could be used for estimation the subject's dimensions. There are number of methods, proposed to correct lens radial distortion. Most of them use deviation of the imaged straight line from the real straight line as a criterion for image correction. Correction parameters are adjusted to minimize the deviation. This paper demonstrates, that such criterion does not guarantee that error of dimensions measurements will be minimal as well. In the present work, various radial distortion correction methods, including one, introduced by authors, were evaluated, using both straight line deviation and dimension measurement error. Obtained results allowed formulate recommendation for improvement of existing image correction methodology.

II. Materials and Methods

Usually a set of calibration images, taken from different angles, is used to account for different perspective distortion, but in the present work the calibration phantom object was maximally accurately positioned in front of the camera to reduce perspective distortion to the negligible value.

The study was carried out, using phantom object - pattern of 2 × 2 mm black points, placed in the nodes of rectangular net with cell size 10 × 10 mm. Alongside, a stand with reference points was constructed to perform evaluation of the measurement accuracy from a longer distance (distance from pattern was 10 cm, but from stand – 110 cm). The stand's width and height approximately corresponds to the more than medium human sizes.

Within this work 10 different parametric distortion functions were summarized and evaluated, because still any universal for all lenses model have not been established. In addition we have introduced a function (1), which resulted from an attempt to combine commonly used polynomial function with some other trigonometric models:

$$r_u = \arctan\left(\frac{1+K_1\times r_d^2+K_2\times r_d^3}{1+K_2\times r_d^3}\right)\times r_d\,. \qquad (1)$$

For corrected image, the coordinates of the calibration pattern points were extracted using center of mass estimation method which provided sub-pixel resolution in evaluation of the point position. Totally 294 points, grouped in 14 horizontal and 21 vertical lines, were extracted. Then, two target values were calculated. The first one was the parameter of straightness $\sum(\chi^2/l)$ [2]. The second parameter, which we are introducing, was just the standard deviation *S* of the measured distance between two adjacent points, calculated over all available pairs.

The distortion correction function's parameters were iterated to minimize either first or the second parameter. Obtained parameters were used to correct the image of the stand. Then maximal deviation from known distances between stand marker sizes (V = 40 cm, H = 20 cm) was determined and used as parameter of the measurement accuracy.

III. Results and Discussion

For the group of functions with different measurement errors Δ parameter $\sum(\chi^2/l)$ appeared to be the same that have demonstrated poor usability of this criterion for the selection of the best method. Moreover, the parameter $\sum(\chi^2/l)$ is noticeably higher for cases of low measurement errors.

The proposed distortion correction approach also directly includes determination of the center of distortion.

The last question of interest for the present work was distribution of the distance measurement error over the image plane. For all methods, the distribution of the errors over the image was the same – overestimation of the distances in the bottom – right corner and underestimation in the upper – left corner of the image.

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In the present work, one has demonstrated that widely used criteria of the line straightness do not perform well for the wide–angle lens radial distortion correction. Alternative criteria, based on the minimization of the error of the distance measurement Δ, could be more useful for photogrammetry purposes.

New, Trigonometric-Polynomial radial distortion correction function was introduced. This function demonstrates good characteristics and it have reached highest measurement accuracy for the lens – camera combination, used in the present work.

For the used camera (DMK 31BU03), method allowed to achieve distance measurement precision of about 2%. This result is sufficient for anthropometrics measurements. Besides, only central part of the camera field of view has to be used, since at the image periphery relative error increases up to 15%

Although proposed optimization parameter and correction method has shown good results for the used lens – camera combination, further research in needed to evaluate method's performance for other lenses.

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Required Lokomotor Robot Habilitation and Rehabilitation for Children with Cerebral Palsy During Sleep

Evgueni Dukendjiev (*Atypical Prosthetic Laboratory)*

***Keywords* – sleep, habilitation, rehabilitation, locomotor robot.**

I. INTRODUCTION

Patients with paediatric cerebral palsy (PCP) aged between 1.5 and 6 years lack muscular and controlling activity and movement stereotypes. The process of habilitation becomes possible only if the imperative acceleration of a child's locomotor activity is applied through exposure to external energy. Application of the locomotor robot makes it possible to ensure controlled external energy and information flows. Sleep makes the child available for corrective intervention. The subject of the research is habilitation during slow sleep phase (SSP) ensured by a biotechnical system „child – locomotor robot".

II. METHOD RESULTS

The child was cast into SSP by exposure to monotonous action of the locomotor robot thus creating movement stereotypes during recurrent day sessions.

For application of the method a locomotor robot was used [1], which consisted of the reciprocal orthotic system that was put on the whole of the child's body; the system with the child placed inside is fastened to a verticalization device, which was mounted on the side frame of the treadmill. The patient's feet that rest upon the treadmill's lane were forced to move with the help of the active reciprocal mechanism. After the robot was switched on, forced to alternate the movement of the left and right legs thus ensuring the locomotive action. The trunk, arms and head were also forced to perform the balancing movements that accompany bipedal walking.

The first stage of SSP (hypnoidal state, drowsiness) quickly passed into the second and third stages that are characterised by development of a slow rhythm in delta range of the encephalogram with the frequency of up to 2 per 1 second. Duration of an individual sleep cycle was 1.5-2 hours on the average, which fully coincided with the duration of the locomotor session (up to 2 hours). To ensure initial resonance processes it is necessary to determine the length (pace) and frequency of step.

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Tests showed that during the sleep phase kids demonstrated appearance of motor reflexes, while brain kept functioning at the level consistent with a lower stage of ontogenesis. More significant changes in the sleep components were observed in children under 6 years old.

Cerebral conditions cause long-term sleep disorders – hypersomnia, and are mainly manifested by fits of day sleep (catalepsy). Idiopathic hypersomnia is characterised by diurnal drowsiness, which is quite frequently accompanied by the "sleep drunkenness" syndrome. These pathologic processes have also been taken into account and used in the clinical picture of the discussed method.

During "locomotor" sleep the brainstem-induced active inhibition is registered. These changes caused by pre-synaptic and post-synaptic inhibition of the activity of Gamma and Alpha motor neurons lead to hypomyotonia during SSP and sharp muscle suppression during the fast sleep phase (FSP).

Due to monotonous action on the vestibular apparatus the thresholds of vestibulospinal reflexes of inhibition of sensorial and vegetative processes are reduced.

IV. CONCLUSIONS

Application of monotonous forced mechanical movement of all body parts triggered the process that does not require rebuilding of the central nervous system (CNS) but merely marked a transition from the forced conditioned reflex to unconditioned reflex activity. The basis for such transition is shaped at the level of microstructure responsible for locomotion control – at the (active or forced) muscle excitatory stage, locomotion centres are released from inhibitory influence and become available for corrective intervention. Due to the links among motor neurons of various muscles and groups, spinal interaction is launched in the motor neuron pools of the spinal cord, which creates rhythmical movement of the step motion pattern.

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Metods for Evaluation of Root Canal Curvatures

A.M. Pangica, C. Biclesanu and A. Florescu (*Faculty of Dentistry/Odontotherapy Department, Titu Maiorescu University*),

Keywords **– root canal curvature, Schneider´method, X-ray, curvature radius, angle of curvature.**

I. INTRODUCTION

Endodontic treatment involves cleaning and shaping of the root canal and three-dimensional (3D) sealing of the canal space. For successful root canal treatment, the canal must be cleaned well, prepared, and filled completely. Some of the most important factors that affect quality of root canal treatment are the anatomy of the canal, the presence of extra canals, and curve in the canal pathway.

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We assumed that using geometric corrections, within Schneider's method, some improvements in the accuracy of the root curvature measurement can be achieved

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13% showed angles between 27 and 35 degrees with radius <15 mm, and 9% of all canals showed angles >35 degrees with radius <13 mm. Most angulation was 72 degree with a radius of curvature of 2mm.

In order to be mathematically defined the canal curvature, angle, radius, and length of the curve must be in a mathematical relationship.

Special question is how to destroy the cell membrane. In the modeling experiments it is realized by taking out separate elements step by step. Another way is by increasing the pressure inside the cell that will initiate the cells decay in separate elements. In modeling experiments it is possible to make the two layers model as well as onion type one.

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The carbon film investigation is just in starting position and every day there are some new surprising physical results. We concentrate on some interesting processes that could take part in biomembranes. The structure of carbon sheet as well as C60 is made by atoms. In biomembranes we have molecular complexies. In the modelling experiments we used macro dipoles. It looks that there is a physical analogy which is not influenced in the dimension scale. The modelling experiments with magnetic dipoles allow extending the results also to systems with electrical dipoles. There are enormous experimental and theoretical materials in cells membranes science and discussed results could only serve as ideas that will stimulate future investigations.

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The root canal is three-dimensional and the curve and its location vs the apical foramen is usually determined using an X-ray film in two dimensions. Distomesial approach has been used for gathering information on root canal curvatures, which may not usually be obtained using radiographs taken in bucco-lingual incidence. These unseen curves play a significant role in the process of cleaning and shaping, as they may lead to loss of working length during instrumentation or to the extension of a proximal curvature channel thus eventually leading to severe channel thinning or even its perforation.

The results of this study can enhance endodontic therapy predictability and minimize errors during root canal obturation. Proposed method may be valid for planning of endodontic treatment.

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Sole Hardness Effect on Typical Badminton Movement

J.B. Ma, W.W.Shen and Q. Hao (*Faculty of Sports Science, Ningbo University*)

***Keywords* – Badminton shoes, sole hardness, heel landing .**

I. Introduction

Badminton is very popular among people of various ages and its popularity is still in increasing trend [1]. In order to further improve athletic training level of badminton, prevention sports trauma to ensure that the continuous movement of good development, sports biomechanics research is necessary to discuss the inherent theory and applied to daily training guidance [2].

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III. ResultS

Results of the ground maximum vertical force which found when wearing the soft soled shoes was slower than when wearing the harder soled shoes.

IV. Conclusions

This study found that the heel of the maximum ground vertical forces and the time of maximum ground vertical forces will change with various hardness badminton shoes in the action of Right-court lunge step to catch net ball. The greater the hardness of the shoe sole, the ground vertical forces that the heel suffered will be larger, but in this study it showed no significant difference, the result was same as previous research. After the test for the ground vertical forces when the subjects in walking state with hard and soft shoes, Tsai et al [3] found that the ground vertical forces what the hard shoe suffered is greater than the soft one , but it didn't show the significant difference. Miiani et al [4] also found the same results when he studied the relationship between different sole hardness and sense organs.

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On Criteria for Wide-angle Lens Distortion Correction for Photogrammetric Applications

Dmitrijs Celinskis (*Riga Technical University*) and Alexei Katashev

Keywords **– photogrammetry, camera calibration, image distortion, wide-angle lens, correction.**

I. Introduction

Photogrammetry is intensively used both in industrial applications and medicine. Extraction of various anthropometrical data, such as height, shoulder inclination or Kobb angle form single photograph could be implemented in mobile devices, used for health screening. To be able to get photo of standing individual when the space for observations is restricted, wide – angle lens has to be used. Unfortunately, such lenses demonstrate highly expressed radial distortion, thus image has to be corrected before it could be used for estimation the subject's dimensions. There are number of methods, proposed to correct lens radial distortion. Most of them use deviation of the imaged straight line from the real straight line as a criterion for image correction. Correction parameters are adjusted to minimize the deviation. This paper demonstrates, that such criterion does not guarantee that error of dimensions measurements will be minimal as well. In the present work, various radial distortion correction methods, including one, introduced by authors, were evaluated, using both straight line deviation and dimension measurement error. Obtained results allowed formulate recommendation for improvement of existing image correction methodology.

II. Materials and Methods

Usually a set of calibration images, taken from different angles, is used to account for different perspective distortion, but in the present work the calibration phantom object was maximally accurately positioned in front of the camera to reduce perspective distortion to the negligible value.

The study was carried out, using phantom object - pattern of 2 × 2 mm black points, placed in the nodes of rectangular net with cell size 10 × 10 mm. Alongside, a stand with reference points was constructed to perform evaluation of the measurement accuracy from a longer distance (distance from pattern was 10 cm, but from stand – 110 cm). The stand's width and height approximately corresponds to the more than medium human sizes.

Within this work 10 different parametric distortion functions were summarized and evaluated, because still any universal for all lenses model have not been established. In addition we have introduced a function (1), which resulted from an attempt to combine commonly used polynomial function with some other trigonometric models:

$$r_u = \arctan\left(\frac{1+K_1\times r_d^2+K_2\times r_d^3}{1+K_2\times r_d^3}\right)\times r_d\,. \qquad (1)$$

For corrected image, the coordinates of the calibration pattern points were extracted using center of mass estimation method which provided sub-pixel resolution in evaluation of the point position. Totally 294 points, grouped in 14 horizontal and 21 vertical lines, were extracted. Then, two target values were calculated. The first one was the parameter of straightness $\sum(\chi^2/l)$ [2]. The second parameter, which we are introducing, was just the standard deviation *S* of the measured distance between two adjacent points, calculated over all available pairs.

The distortion correction function's parameters were iterated to minimize either first or the second parameter. Obtained parameters were used to correct the image of the stand. Then maximal deviation from known distances between stand marker sizes (V = 40 cm, H = 20 cm) was determined and used as parameter of the measurement accuracy.

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For the group of functions with different measurement errors Δ parameter $\sum(\chi^2/l)$ appeared to be the same that have demonstrated poor usability of this criterion for the selection of the best method. Moreover, the parameter $\sum(\chi^2/l)$ is noticeably higher for cases of low measurement errors.

The proposed distortion correction approach also directly includes determination of the center of distortion.

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In the present work, one has demonstrated that widely used criteria of the line straightness do not perform well for the wide–angle lens radial distortion correction. Alternative criteria, based on the minimization of the error of the distance measurement Δ, could be more useful for photogrammetry purposes.

New, Trigonometric-Polynomial radial distortion correction function was introduced. This function demonstrates good characteristics and it have reached highest measurement accuracy for the lens – camera combination, used in the present work.

For the used camera (DMK 31BU03), method allowed to achieve distance measurement precision of about 2%. This result is sufficient for anthropometrics measurements. Besides, only central part of the camera field of view has to be used, since at the image periphery relative error increases up to 15%

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II. METHOD RESULTS

The child was cast into SSP by exposure to monotonous action of the locomotor robot thus creating movement stereotypes during recurrent day sessions.

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J.B. Ma, W.W.Shen and Q. Hao (*Faculty of Sports Science, Ningbo University*)

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Sequential and Structural Biophysical Aspects of Combinatorial Oligo FISH in Her2/neu Breast Cancer Diagnostics

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***Keywords* – Human genome, sequence analysis, triplex forming oligonucleotide, molecular dynamics simulation, nuclear architecture.**

I. Introduction

Fluorescence in situ Hybridization (FISH) is an important tool in medical diagnostics to determine the genetic status to monitor tumor progression in breast cancer. The newly developed method of COMBO-FISH [1] allows a more refined diagnosis by using a set of short oligonucleotides which cluster at the Her2/neu gene and indicate the multiplicity of amplification. A careful image analysis of the fluorescence microscopic image also provides insights in the nanolocal nuclear architecture. Designing a set of short oligonucleotides which can form triple helical structures with double stranded DNA and cluster exclusively at the Her2/neu gene locus is based on the analysis of the sequence of the whole human genome, while understanding the properties of the hybridization process, namely its kinetics and energetics, depends on the detailed knowledge of the dynamics of the molecular interactions which are exemplified by molecular dynamics simulations of triplex forming oligonucleotides.

Here, we describe the triplex forming COMBO-FISH set which has been developed for the special application to Her2/neu breast cancer diagnostics and therapy control. We will put special emphasis on the combinatorial methods [2] used for the design of the COMBO-FISH probe set and on the biophysical structural problems associated with the hybridization process.

II. COMBO-FISH probe set design for Her2/neu

To design a triplex forming COMB-FISH probe set, several short oligonucleotides are selected which have the capability to form triplex structures (TFOs) with double stranded DNA, that is, the oligo strand intercalates into the major groove of double stranded DNA. This imposes manifold restrictions on the single oligo chosen. It has to be of a length between 15 and 30 bases, and, for classical Hoogsteen pairing, the sequence has to consist either of T's and C's solely or of A's and G's exclusively. We want the probe set to be uniquely identifying the desired genetic region, here the Her2/neu gene. Therefore, the oligo strands, which bind to a lot of genomic locations due to the mere combinatorics of the vast human genome (3.7 Gb), are not allowed to form clusters of more than 6 oligo strands within 250 kb chromosomal length elsewhere in the genome.

III. Sequential features of Her2/neu gene locus

The genomic locus of the Her2/neu gene extends from base 3118545 to base 3159067 in positive strand direction on contig 5 of chromosome 17 as deposited in the 2011 read of the reference human genome of NCBI. With a length of 40523 bases, it consists of the join of 30 exons which are expressed in different mRNA variants. The locus of Her2/neu contains 35 sequences consisting of T's and C's exclusively with a minimum length of 15 bases, the longest being a sequence of 35 A's and one G. Having determined all binding locations of these probe candidates, a cluster analysis is performed and subsequently probes are removed from the set, until no clusters with more than 6 oligo strands within 250 kb are remaining. This final set consists of 13 strands on the Her2/neu gene and 7 strands in the region up to 6520 bases upstream.

IV. Structural features of Her2/neu gene locus

In order to understand the hybridization behaviour, we have performed molecular dynamics simulations for short oligonucleotides bound to double stranded DNA. Such simulations impose statistical molecular forces on a starting configuration, here in water solution, to model the dynamical behaviour in such an environment. As a starting structure, we chose a crystal structure of a TFO of six bases intercalating into the major groove of the corresponding double stranded DNA well extending beyond the binding region. The TFO sequence was CTCTCT, a motive which is contained in three of the 20 COMBO-FISH probes designed for Her2/neu.

Depending on the statistical fluctuations, the triplex forming oligonucleotide will stay within its binding groove, or it will lose its binding contacts and drift away. This indicates that six oligonucleotides may be a critical length for the stability of the alternating CT repeated sequence.

V. Discussion and Conclusion

Fluorescence in situ Hybridization (FISH) has become an important tool in medical diagnostics. In our example here, tumor progression in breast cancer is monitored by the observation of the status of the Her2/neu gene. Indicators for the patients' state of health are numbers like the amplification or translocation of the gene. Though commercial kits for labeling Her2/neu are widely used in clinics and laboratories nowadays, a more detailed analysis of the Her2/neu chromosomal status by COMBO-FISH [3] could improve the results.

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Magnetic Properties of Lewis Lung Carcinoma and Antitumor Magneto-Sensitive Complex

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Keywords **– Lewis lung carcinoma, doxorubicin, magnetic nanoparticles, magnetic properties.**

I. Introduction

Iron is a central element in the metabolism of normal and malignant cells. The formation rate of ferrimagnetic magnetite and/or maghemite appears to be higher in the tumor tissue. It is known that the ferric oxide content, which is a ferromagnetic, can be stored in Lewis lung carcinoma [1]. Magnetic nanoparticles offer some attractive possibilities in biomedicine [3].

In this study we have examined endogenous magnetic characteristics of Lewis lung carcinoma (3LL), mechano-magneto-chemically synthesized MC and mechano-magneto-chemically treated anthracycline antitumor antibiotic doxorubicin (DR).

II. Materials and Methods

In the study 10 C57BL/6 male mice weighing 19 ± 1 g were used. We have studied the lyophilized Lewis lung carcinoma and environment of the tumor tissue of C57Bl/6 mouse on 14 day after inoculation.

MC consisted of the nanoparticles Fe_3O_4 (International Center for Electron Beam Technologies of E.O. Paton Electric Welding Institute, Ukraine) with diameters in the range 20–40 nm, KCl and DR (Pfizer, Italy) were processed in high-precision mechano-magneto-reactor (NCI, Ukraine) [2].

The magnetic properties were studied by "Vibrating Magnetometer 7404 VSM" ("Lake Shore Cryotronics Inc.", USA) with magnetic fields up to 13 kOe.

The registration of electron spin resonance (ESR) spectra and the assessment of paramagnetic centers' concentration in the samples were performed using an updated computer-controlled electron spin resonance spectrometer RE-1307.

III. Results and Discussion

Hysteresis loop of Lewis lung carcinoma is represented at Fig. 1. Lewis lung carcinoma had properties of soft ferromagnetic with saturation magnetic moment m_s = + 0.187 emu/g in contrast to diamagnetic environment tissues (m = – 0.002 emu/g).

MC of Fe_3O_4 nanoparticles and DR was soft ferromagnetic (m_s = 11.781 emu/g).Conventional DR was the diamagnetic (m = – 0.200 emu/g). Mechano-magneto-chemical treatment increased magnetic moment DR (m = + 0.068 emu/g at H = 3000 Oe) and it turned into paramagnetic.

ESR spectra of Lewis lung carcinoma and environment tissue are shown in Fig. 3. Lewis lung carcinoma had higher concentration of paramagnetic centers (10^{15} mg^{-1}) compared to environment tissue ($3\cdot10^{14}$ mg^{-1}). Maximal concentration of paramagnetic centers was observed in MC samples (10^{18} mg^{-1}). The g-factor for MC increased up to 2.64.Qualitative change in ESR spectrum for DR samples was not observed. The data suggest that the concentration of paramagnetic centers with g = 2.003 in DR, which acquired

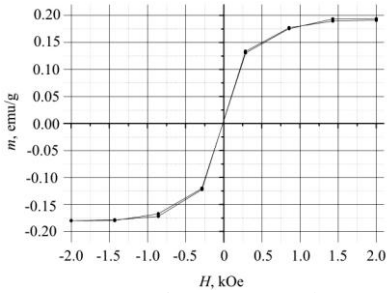

Fig. 1. Hysteresis loop of Lewis lung carcinoma at 300 K, H – magnetic field.

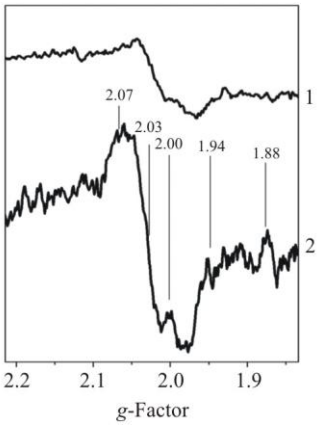

Fig. 3. ESR spectra of lyophilized tissue: environment tissue of Lewis lung carcinoma C57Bl/6 mouse from hind limb (1); Lewis lung carcinoma (2); T = 77K.

the properties of the paramagnetic under influence of mechano-magneto-chemical treatment increased to 10^{14} mg^{-1} in comparison with conventional DR which is diamagnetic ($8\cdot10^{13}$ mg^{-1}).

IV. Conclusion

In this paper, it was demonstrated that Lewis lung carcinoma on 14 day after inoculation had the properties of weak soft ferromagnetic with saturation magnetic moment m_s = + 0.187 emu/g in contrast to environment tissue of the tumor which are diamagnetic. However, ferromagnetic properties aren't specific for malignant tumor [1]. Concentration of paramagnetic centers in Lewis lung carcinoma is about three times greater than the concentration in environment tissue. Antitumor antibiotic DR after mechano-magneto-chemical treatment is paramagnetic in contrast to conventional drug which is diamagnetic.

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Entering the Nano-Cosmos of the Cell by Means of Spatial Position Determination Microscopy (SPDM): Implications for Medical Diagnostics and Radiation Research

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Keywords **– localization microscopy, Spatial Position Determination Microscopy, nanostructures of membranes, organization of the endoplasmatic reticulum, chromatin conformation changes.**

I. Introduction

A serious impediment to exploit the potential of light microscopy to study cellular structures has been the conventional optical resolution due to diffraction limits of the objective lenses used. Using visible light the resolution limit described as the smallest distance between two discriminable object points results at about 200 nm laterally and 600 nm axially. Novel microscopic techniques, however, enable effective optical resolutions down to about 20 nm or even better [1]. One of these high resolution techniques is localization microscopy based on the fundamental concept of using fluorophores that can be switched between two different spectral states to achieve a temporal isolation and thus a spatial separation of signals. Here applications of an improved version of Spatial Position Determination Microscopy (SPDM) [2, 3] are described using conventional fluorophores which can be switched to a "dark" state by a light induced reversible photobleaching process.

II. Aapplications of spdm

So far SPDM has found a broad spectrum of biological, biophysical and biomedical applications in 2D and 3D localization microscopy [1]:

a) Certain types of breast cancer are characterized by an overexpression of erbB-2 which can be associated by a copy number increase of the Her2/neu gene on chromosome 17. In order to study tumour typical conformational changes of erbB-2 receptor clusters on cell membranes different mamma carcinoma cell lines and cells of a breast biopsy of a healthy donor were analyzed. The characterization of the erbB-2 distribution yielded typical receptor clusters with a mean diameter of 67 nm independently from the cell line. Statistical analyses of the receptor antibody distances within the clusters revealed significant differences in clustering of erbB-2 between the different cell lines.

b) The importance of CD8 T-cells for the control of cytomegalovirus (CMV) infection has raised interest in the identification of immunogenic viral proteins as candidates for vaccination and immunotherapy. Gene m164 of murine CMV thought to represent a 'host adaptation' gene involved in virus-host interaction. The m164 protein was analyzed by SPDM [1].

c) A combined approach of SPDM and statistical methods was used to interpret the nuclear nanostructure after specific labelling of all nucleosomes by green fluorescent proteins (GFP). The results show that different mechanisms of expression of the same nuclear protein type lead to significantly different patterns on the nanoscale below 200 nm nucleosome distances and to pronounced differences in the detected compressibility of chromatin.

d) The same cells expressing nucleosomal labels by GFP were used. Combining this labelling with specific antibody labelling against heterochromatic or euchromatic regions in the cell nucleus revealed typical chromatin rearrangements after exposure to ionizing radiation.

e) With the completeness of genome data bases, it has become possible to develop a novel FISH (Fluorescence In Situ Hybridization) technique called COMBO – FISH (COMBinatorial Oligo FISH). In contrast to other FISH techniques, COMBO – FISH makes use of a bioinformatic approach for probe set design. By means of computer genome data base search, several oligonucleotide stretches of typical lengths of 15 – 30 nucleotides can be selected in such a way that all uniquely colocalize at the given genome target. For a probe repetitively highlighted in centromere 9, the results indicate that COMBO-FISH probes with blinking dyes are well suited for SPDM which will open new perspectives on molecular nanostructure analysis of the genome.

III. Conclusion

SPDM allows imaging of single molecule positions in 3D conserved cells after specific labelling of nanostructures. For biomedical applications SPDM has the advantage that it can be implemented in standard microscopic systems so that objects can be analyzed under different detection modi without changing the instrument. Moreover, specimens can be prepared according to standard protocols and with well established dyes and labelling strategies. These advantages will open new perspectives in biological and biophysical research as well as in medical diagnostics.

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The Influence of Temperature and Carbon Source on Expression Of Recombinant HBcAg

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***Keywords* – Recombinant Hepatitis B core-antigen, virus like particles, T5 promoter, expression.**

I. Introduction

Biotechnological aspects in the field of recombinant protein production were analysed in this work, which includes the investigation of factors for the production of VLPs for-med by recombinant HBcAg in inducible bacterial (*E. coli*) expression system. Expression system *E. coli* RB791 IS104-31 used in this study is based on the expression plasmid pQE60 (Qiagen) basis, where the transcription of HBcAg gene is controlled by T5 promoter and two Lac operators. The use of a commercially available low-copy expression plasmid with the strong promoter T5 (vector pQE60) led to high intracellular HBcAg synthesis levels after optimizing the induction conditions in batch cultures.

II. Materials and Methods

A. Bacterial strain and plasmid

E. coli producer used for testing growth and HBcAg expression was RB791/IS104-31 (W3110 lac I_qL8) with expression vector pQE60 (Qiagen), which consisted of promoter of the T5 bacteriophage, two operators of *lac* operon and HBcAg gene.

B. Media composition

The main culture media was 2PY, which consists of Pepton (Reachim – 16g/L, yeast extract (Difco) – 10 g/L, NaCl (Lachema) – 5 g/L (pH 6.8 – 7.0).

Phosphate solution (containing stock solution 125,4 g/L K_2HPO_4 and 23,13 g/L KH_2PO_4) was used for buffering and as a phosphate source.

Antibiotic stock solution was ampicillin (Biochemie) – 50 g/L H_2O. For 100 ml culture media 0,1 ml ampicillin was used..

As carbon source 40% glucose (1 ml/100ml culture media) or 80% glycerol (2,5 ml/100ml culture media) were used.

C. Cultivation conditions

Cultures were grown in sterile 500 ml shake-flasks in an incubator shaker at 200 rpm. The cultivation time was 20-24 hours in two temperatures: 30ºC and 37ºC. For the experiments 0,2% lactose was used as inductor. Lactose was added with the inoculum in sterile conditions.

III. Results

Auto-induction method was applied as an alternative cultivation method to increase protein yields. Thus in all the experiments lactose, instead of IPTG, was used as inductor. The level of expression of HBcAg by cultivating the producer IS104-31 RB791 at two different temperatures (30º C and 37ºC) and using (i) glucose or (ii) glycerol as two carbon sources, of which (ii) did influence the catabolite repression on the promoter (T5). The variations of temperature can influence the stability of the target protein which in turn, can lead to a higher yield. HBcAg expression was investigated using 0,2 % glucose or 0,5% glycerol at both temperatures indicated.

The cell yield was similar on both substrates however the production at 30ºC was lower both in terms of growth rate and the final concentration compared to that at 37ºC. The expression level after 6 hours was fairly similar in all the experiments however after 24 hours 2-3 times higher expression level was obtained when glycerol was used as the carbon source. This finding indicates that the expression can be further improved by increasing the cultivation time and the concentration of glycerol. On other hand, the intensity of degradation in the presence of glucose was somewhat lower compared to glycerol.

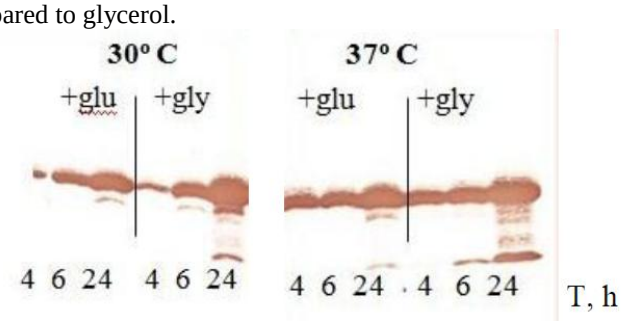

Fig.1. The expression of HBcAg in IS 104-31 RB791 depending on two different temperatures and carbon sources

The level of expression at the lower temperatures was slightly increased when glycerol was used as carbon source whereas the application of glucose resulted in slightly higher expression level at 37ºC however also the degradation was more pronounced.

After gel filtration and ion exchange treatment protein samples with a concentration 14 mg/g cells (30ºC) and 11,2 mg/g cells (37ºC) were obtained by cultivating the producer *E. coli* RB791 IS104-31 in 2PY medium.

To investigate the heterogenity of the produced protein SEM analysis were made and it was concluded that more virus-like particles were obtained in the fraction No. 6 after cultivation at 30ºC compared to the cultivation at 37ºC.

IV. Conclusions

The cell yield of the producer *E. coli* RB791 IS104-31 was 30% higher when glucose was added as the carbon source whereas HBcAg expression level was about twice higher when the cells were cultivated in the presence of glycerol.

Two Proteins, Hsp70 and GAPDH, Play Opposite Roles in the Formation of Aggregates in Models of Huntington Disease

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***Keywords*- Hsp70, glyceraldehyde-3-phosphate dehydrogenase, Huntington disease, aggregation.**

I. Introduction and particular aims

Most of known neurodegenerative pathologies stem from the formation of cytotoxic oligomers or aggregates on the base of mutant proteins and other cellular polypeptides sequestered. Some of these structures can be assembled using intermolecular covalent links, similar to those formed between glyceraldehyde-3-phosphate dehydrogenase (GAPDH) and mutant huntingtin as shown in case of Huntington disease (HD), one of so-called polyglutamine pathologies. Since molecular chaperones, particularly Hsp70, can elicit anti-aggregation activity in a variety of neurodegeneration simulations, we suggested that the chaperone can play an important role in HD pathology through binding both probable participants of the growing aggregates. The aim of the study was to prove the pivotal roles played by Hsp70 and GAPDH in the formation of cytotoxic species of mutant huntingtin in cell and cell-free models of HD.

II. GAPDH is a necessary component of aggregates of mutant huntingtin

First part of the study aimed to show that GAPDH binds polyglutamine-enriched (mutant) huntingtin and enhances the aggregation. This part was performed using SK-N-SH human neuroblastoma cells transfected with polyglutamine repeats located within the Exon I of huntingtin amounting to 103 CAG (Q103) or 25 CAG triplets (Q25). The existence of GAPDH-Q103 complex was first demonstrated with the aid of confocal microscopy and of a newly developed protein-protein interaction assay (PIA). The complex was formed by covalent links between polyglutamine chains and GAPDH as proved by the former destruction under the action of tissue transglutaminase inhibitor, cystamine. Positive GAPDH regulation, the addition of pure enzyme to the extract of cells over-expressing Q103 increased the amount of the material insoluble in sodium dodecylsulfate, SDS, in filter trap assay and in gel shift assay. Vice versa, depletion of GAPH with the aid of specific antibody was found to reduce based on Q103 aggregates. Next we explored the effects of factor able to reduce the amount of GAPDH in cells imitating HD and found that specific siRNA partially reduced the level of Q103 aggregation. Finally, pharmacological substances known to bind GAPDH when incubated with cells over-expressing Q103 were shown to inhibit the aggregation and to decrease its cytotoxic effect. The results obtained are in line with the evidence of potential danger of the accumulation of cytotoxic forms of GAPDH in a cell or cell nucleus. Therefore the factors with a strong affinity to the enzyme are of growing interest to pharma directed to design anti-neurodegenerative medicines.

III. Hsp70 reduces polyglutamine-GAPDH aggregation

To verify the anti-aggregation activity of Hsp70 chaperone we have employed SK-N-SH cells stably expressing the gene in a metal-controlled manner. The increase of Zn ions in the culture medium was found to elevate Hsp70 quantity and to reduce the amount of cells with Q103-GAPDH aggregates and the size of the latter. Introduction of pure Hsp70 into the extract of HD-modeling cells decreased the amount of SDS-insoluble material and vice versa immunodepletion of Hsp70 from the extract recovered degree of aggregation.

Suggesting that Hsp70 could inhibit aggregation of mutant huntingtin partially by binding GAPDH we studied the interaction of two proteins using immunofluorescence and found that Hsp70 is co-localized with the enzyme throughout the cytosol. The binding between the chaperone and GAPDH was confirmed also with the aid of reciprocal immunoprecipitation and PIA.

Further studies showed that Hsp70 added to the cell-free HD assay could bind both Q103 and GAPDH, and pulling out these complexes with the aid of specific antibody to the chaperone we removed both components of aggregation system. This depletion led to a strong reduction of aggregation capacity.

Furthermore, employing factors able to influence interactions between three proteins, Hsp70, GAPDH and mutant huntingtin, NAD and ATP, we probed above complexes with the aid of modified PIA. It was found that Hsp70's binding to Q103 can be inhibited with ATP indicating chaperonic nature of this interaction. Importantly, introduction of ATP into cell-free HD model was found to stabilize aggregates in contrast to the effect of Hsp70. Interaction of Hsp70 with GAPDH was dependent on the presence of NAD, and this factor was found to reduce aggregation when applied to the cell extract made of Q103-expressing cells [1].

In conclusion, glycolytic enzyme GAPDH and Hsp70 chaperone affect aggregation process in HD-imitating cells in different modes; first protein strengthen the aggregates of mutant huntingtin while Hsp70 by binding above proteins prevents aggregation. It is evident that both proteins are important targets for diseases associated with GAPDH-related aggregates.

The work was supported by RFBR grant 11-04-12047 ofi-m (IG and VL) and grant of RAS Program "Fundamental Science to Medicine" 2012 (BM)

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Development of Poly(vinyl alcohol) Cryo-systems with Medicines and their Comparative Study of Antimicrobial Activity and Cytotoxicity

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Keywords **– poly(vinyl alcohol); cryogel systems; cytotoxicity; biocompatibility; microbial adherence.**

I. Introduction

The aim of the work was to develop the stable poly(vinyl alcohol) cryogel systems (PVA_{GS}) with medicines by freezing-thawing method [1]. In our research work we incorporated plant extracts (PPe) and simple conventional medicine (Cm) into the PVA_{GS} and compared their effects. The following PPe were chosen: calendula (C), peppermint (P), St.-John`s-wort (JW), paste of pine extract (Pro); the following simple Cm was chosen: *Viride nitens* (Vn) and methylene blue (Mb).

As well as *in vitro* studies of PVA_{GS} microbial contamination risk – the colonization level of the microorganisms and adhesion activity for the use of gel materials for the wound care were made and biocompatibility/cytotoxic properties were examined.

II. Materials and Methods

15 % PVA water solution is chosen for preparation of PVA_{GS} (6h 80°C). The PPe and Cm were added in following concentration: PPe 0.5 and 2.5 w% and Cm 0.15 w% and 0.3 w%. PVA_{GS} were prepared by freezing-thawing method: freezing for 12h at -20°C followed by 12 h at 20°C thawing, exposed by 1 to 3 freezing-thawing cycles (n_C).

Additionally, the stability of gel systems was determined and the gel content (G_f) was calculated. The swelling behaviour of the samples was investigated to establish the capacity to absorb exudate from the wound. Refer to Part II Section B in the full version for more details.

PVA_{GS} with PPe, Cm and without were incubated in *Ps. aeruginosa* and *S. epidermidis* suspensions in concentration of 10, 10^2, 10^3 and 10^4 (if the sample of the PVA_{GS} possible antimicrobial effect) CFU/ml at 37°C for 2 h for determination of the colonization and adhesion intensity of microorganisms. Additionally, bacterial adhesion was examined using a scanning electron microscope (SEM) and plate count method.

For the determination of PVA_{GS} cytotoxicity and biocompatibility GFP–expressed cell lines PT-67 (mouse embrional fibroblast) and MG-63 (human osteoblast) were used.

III. Results and Discussion

A. Stability of PVA_{GS}

The results of the experiments of gel stability showed that the most of medicines decreased G_f and increased the swelling degree (S) values. It is evident, that the medicines have influence on preparation of systems and crosslinking of macromolecules. However, PVA_{GS} prepared by three cycles of freezing-thawing have a stable structure and relatively high swelling degree also in systems with PPe and Vn, where ethanol was used.

B. PVA_{GS} microbiological colonization and adhesion intensity studies

Microbiology studies showed that *Ps. aeruginosa* chain and colonize the samples of PVA_{GS} more intensively than *S. epidermidis*. The best effect of delaying the colonization and adhesion was shown by PVA_{GS} containing 0.3% of the Vn. However, PPe practically did not decrease the adhesion of bacteria and showed a very high level of colonization of bacteria that is practically uncountable.

C. PVA_{GS} biocompatibility and cytotoxicity studies

PT67-GFP cell line proliferation assay revealed that cells were not attached either on the sample surfaces, or in the pores. This effect is positive for wound care since the new formed fibroblast will not be damaged during the changing process of dressing. The same effect was observed for osteoblast culture MG63-GFP, which is especially acute in the case of deep damage of the skin and underplaying tissues.

Cytotoxicity studies show that pure PVA_{GS} is biocompatible and can be used as biomaterial, for development of wound dressing. PVA_{GS} with Mb and with PPe Pro, P, JW have more pronounced cytotoxicity against human cells PT67-GFP. However, PVA_{GS} with 2.5% C –– 107.2 % alive cells and did not influence the PT67-GFP cell viability and therefore use of C in wound care materials can be considered.

IV. Conclusions

The stability of PVA_{GS} with and without PPe and Cm prepared by freezing-thawing cycles were investigated. The appropriate approach for development of stable PVA_{GS} with incorporated medicines was found. PVA_{GS} with and without medicines prepared by three cycles of freezing-thawing have a stable structure and relatively high swelling degree, therefore those PVA_{GS} are more suitable for practical application.

Microbiology studies showed that the best effect of delaying the colonization and adhesion is shown by PVA_{GS} containing 0.3% of the Vn.

The cell adherence to the PVA_{GS} were determined as the further prospective is that the developed systems can be easily removed without damaging the epithelium cells.

Cytotoxicity studies showed that the PVA_{GS} can be used as wound dressing.

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Acknowledgement

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Real Estate Economics and Construction Entrepreneurship

Methodological Solutions for Evaluation of Land Use Efficiency

Armands Auziņš (*Riga Technical University*)

Keywords **– land use efficiency, factors, criteria, evaluation methods indicator system.**

I. INTRODUCTION

Land use efficiency can be evaluated by using both selected methods and developed system of appropriate indicators. This system is created and applicable for analysis the socio-economic and environmental aspects of the dynamic changes of land use efficiency, as well as land usage in general, according to land use objectives of particular territory. This paper is concerned with the results of study regarding to development of a methodology for evaluation of land use efficiency.

Thus the *hypothesis* of the study is set – substantiation for land use in a public benefit is created, if the evaluation of the land use efficiency according to established methodological framework is provided. Accordingly the results of the study include the methodological framework for decision-making into different land management levels. This framework is developed as a result of made assessments of used evaluation approaches and indicators for the purpose to promote land use in the best and most efficient way from the point of view of both the single landowner and local society.

Finally *findings* of the study show the applicable integrated methods and usable indicator system for evaluation of land use efficiency, as well as recognized significant procedures and analyzed outcomes and problems.

II. LAND USE EFFICIENCY

The land use efficiency as an economic category in its general form refers to the function, which includes both land use effect and consumed resources to gain this effect. However the evaluation of land use efficiency is related to identification of its *dynamics – qualitative changes* in the land use process, if comparing the changes in both the effect and consumed resources.

Generally it can be calculated using the equation below:

$$\Delta E = {}^{\partial Rz}/_{\partial Rs}, \quad (3)$$

where ∂Rz – the changes in effect, comparing the land use activities; ∂Rs – the changes in consumed resources for gaining the effect.

a. Definition

The definition of land use efficiency is proposed after exploring the theoretical aspects of efficiency in relation to land use and assessing its socio-economic and ecological meaning. Thus the *land use efficiency* concerns the comparative assessment of either the intentional activities of the actors involved in a land management or usage of the land resources that is acquired relating the achieved outcome to the consumed resources for gaining this outcome.

b. Objectives for evaluation

It is recognized that *variability* of the influencing factors of the land use outcomes indicates to the significance of efficiency domain in the studies of land management field, considering the potential land use objectives and outcomes, as well as necessary resources for their achieving.

The results of performed analysis show that coincident influence of *socio-economic, environmental and institutional* factors and its linkages substantiate the criteria determination and development of particular indicator system for evaluation of land use efficiency (see Fig.1).

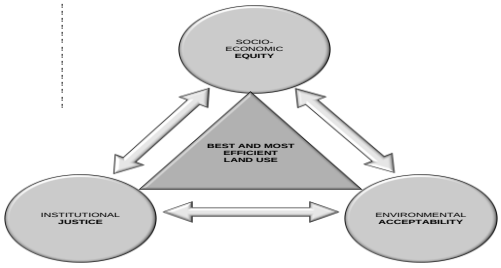

Fig.1. Objectives for evaluation of land use efficiency.

III. EVALUATION METHODS

The choice of methods may be explained by acquisition of the values of effects – land use results and consumed resources to gain these results, as well as by interpretation of outcomes.

The main mathematical methods used for evaluation of land use efficiency that support decision-making according to a range of problems to be solved are Multi-Criteria Analysis (MCA) and Analytic Hierarchy Process (AHP). Input-Output Analysis (IOA) is used for assessments, analysis and modeling of the land use procedures.

Expert assessments are used and sociological surveys system introduced for evaluation of land use efficiency.

Application of *integrated evaluation methods* provides opportunities for using specific and weighted efficiency indicators in calculations.

IV. INDICATOR SYSTEM

The hierarchy of proposed indicator system is developed and provided for evaluation of land use efficiency, accordingly to previously analyzed factors and its linkages that essentially influence the efficiency.

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The Challenges for Real Estate Mass Valuation and Taxation System for the Economic Stabilization of Latvia

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Keywords **– mass valuation, real estate tax, property tax reform and administration**

I. Introduction

The real estate tax policy, as well as a massive reform in the real estate mass valuation was among major reforms of the Latvian government in the financial crisis management plan. These reforms were supported by the International Monetary Fund and European Commission.

One of the directions for economic recovery suggested by the lenders to Latvia was a reform of taxation system including reviewing of stagnated real property tax principles. This reform met total criticism from society, local governments, as well involved state institutions and agencies.

Property tax reform implementation began in 2010 and still continues today. The proposed procedures included important amendments in taxation and its related legislation, the review of duties of responsible institutions, as well as increasing role of taxpayers in improving of data.

I. Mass valuation in Latvia

The mass valuation in Latvia started from 1998, when Law "Law On Immovable Property Tax" became into force, and the mass valuation procedure obtained obligatory status. This law stated that taxable value of property was estimated against the property market value set using mass valuation approach. The implementation started with urban land assessment, then building assessment in 2001 and engineering structures assessment in 2010 (Fig.1).

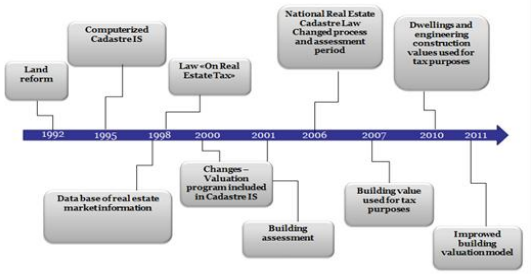

Fig.1. Main steps of implementation of mass valuation in Latvia.

II. Real Estate taxation

Real estate taxation is based on actual mass value of the specific real estate (land, building, and engineering structure) Real estate tax was imposed on land since 1998. Building mass values of buildings has been used for taxation purpose since 2007. Taxation of engineering structures was imposed since 2010. Taxation of subsidiary buildings was implemented since 2012.

Real estate tax rates are imposed by Law "Law On Immovable Property Tax". Currently the tax rate for all land units is 1.5% from actual mass value. The same tax rate is applied to buildings used for economic activity and engineering structures.

From 2008 to 2011, increases in real estate taxes were limited by law to 25% from one year to the next. This limit on the increase in tax does not apply to houses, calculated taxes that are less than 5 LVL and taxes for uncultivated farmland.

From 2010 government implemented new taxation policy for the purpose of increasing of tax incomes. This policy implemented also new real estate taxation policy by increasing of objects of taxation and taxation rates.

From 2010 the real estate tax was imposed on residential buildings. The tax rate for residential buildings in 2010 was within limits 0.1%- 0.3% depending of amount of estimated mass value of the specific building. From 2011 taxation rate for buildings was doubled (0.2%-0.6%) using previous application principles regarding building value. From 2012 the real estate tax was imposed also on subsidiary buildings using the same rate as for residential buildings.

From 2010 tax rate for uncultivated agricultural land is 3% from actual mass value of specific land.

In accordance of law from 2012 municipalities has a right to determine application of real estate tax rate on the specific taxable objects (land, subsidiary buildings) in their territory. Many municipalities (Riga, Liepaja, Ventspils, and Jelgava etc.) used this delegated by law rights and did not imposed property tax on subsidiary buildings.

III. Conclusions

Latvia's real estate tax is a good source for covering Latvia's huge fiscal deficit. Although much of the adjustments will have to be achieved by reducing costs, that may not be enough. The mass valuation system, as well as property taxation system demands reform, as well as support from society in matters of transparency and distribution of incomes from real property tax.

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Reequipment of heating systems in apartment buildings technical economical solutions

Viktors Bloks *(Riga Technical University)*, Baiba Pļaviņa *(Riga Technical University)* Ineta Geipele *(Riga Technical University)*, Sanda Geipele *(Riga Technical University)*, Iveta Stāmure *(Riga Technical University)*

Keywords **– housing fund, renovation, energy efficiency, financing models.**

I. INTRODUCTION

House managers understand that repairing or renovation of the building should be started with fixing of the engineering systems, but there are a lot of different opinions regarding the way how to do this. One point of view supports a complete replacement of the old systems, because new and on modern technology-based system renovation will guarantee a safe and long term use, however, this replacement is expensive and not available to all. It is undeniable that the aforementioned approach is considered to be the right one, if the necessary resources are available.

II. NECESSITY FOR IMPLEMENTATION OF ENERGY EFFICIENCY MEASURES

At present, energy is in the spotlight not only in Latvia, but also in all Europe and the entire world - everywhere solutions for alternative energy supply options are looked for, putting great emphasis on local and renewable resources as well as on improving energy efficiency to the end users. To achieve the desired result the focus shall be transferred from energy supply management, which continues to dominate in the post-Soviet countries, to energy consumption management.

Complex house renovation or refurbishment of certain systems, energy efficiency and heat losses are the issues which consumers become topical for consumers when heating prices are raised again and a monthly residential bill is received. Energy consumers can save money by insulating homes, renovating heating systems, restoring utility systems, controlling and regulating room temperature. Increasing energy efficient in the high-rise apartment houses is important not only in order to reduce the cost of energy, but also to extend the building maintenance time.

Implementation of energy efficiency measures in multi-storey residential building sector in Latvia will not only reduce energy rating of each house, but also reduce country's dependence on imported energy. Implementation of such measures will improve the comfort of house residents and quality of surrounding environment. Referring to the importance of energy efficiency, renovation of heating system as one of the most energy efficiency measures to be realized within a short period of time and gives economic effect is studied in this research.

III. MODERNISATION SOLUTIONS AND TECHNOLOGY OF MULTI-STOREY APARTMENT BUILDING HEATING SYSTEM

Water heating system with forced circulation, one-pipe with the upper or lower division, where the heaters are connected in series or have parallel connection to the riser, the centralized heating system is mainly used in the multi-storey apartment house buildings.

To address issues of energy efficiency, reduce payments for heating and looking for the solutions for the heating system modernization, a number of preparatory work has to be done: to assess and summarize the status of existing heating system, energy consumption and its costs; advantages and benefits of the heating system modernization and development prospects, as well as financial solutions shall be demonstrated.

In conclusion, the utilities in the multi-storey apartment buildings are worn out, heating systems are outdated, their operation lifecycle is from 30 to 40 years and therefore they need replacement or modernization; increase of heating rates and taxes facilitate modernization of heating system; by upgrading heating system, the consumption of thermal energy reduces twice, but it does not reach the performance standards determined in the laws and regulations; modernization of the heating system ensures implementation of a number of energy efficiency improvement measures; modernization of the heating system provides a visible economic effect which is supported by the results of this study.

IV. CONCLUSIONS AND PROPOSALS

To ensure implementation of energy efficiency measures in multi-storey apartment buildings, it is necessary to continue to pursue and implement the financial and informational support measures aimed at the availability of ERAF and national co-financing resources; educational and informative work with people regarding the heating system modernization options, technical solutions and economic reasoning, in accordance with specific target group's needs and interests shall be carried out. Full house renovation, which includes the conversion of the heating system with personal tracking shall be conducted, the work shall be performed in accordance with elaborated projects and technical calculations, in compliance with the technological requirements of producers, simplifying opportunities for receiving the co-financing when completing the necessary documents and formalities, the time necessary for examining the documents submitted to the responsible institutions shall be shortened; it is necessary to introduce incentive tools for energy savings for each consumer, for example, tax benefits, if certain energy efficiency indicators are achieved (including those objects which do not participate in the European programs).

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On competitiveness based management for manufacturing wood products in Latvia

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Keywords **- competitiveness, on competitiveness based management, wood products manufacturing**

I. INTRODUCTION

Manufacturing of wood products includes forest resources, manufacturing of products, trade and consumption in one system in which all components are closely connected.

Topicality of the research is connected with the significant role of wood products manufacturing in the Latvian economy, because geographical position, amount of forest and its quality set belonging to the states where forest products serves for the local production as well as takes significant place in foreign trade. Given the economic slowdown of 2008, Latvian timber products can be regarded as a "crisis time" option. Therefore it is necessary to find solutions for further development of industry by balancing the extraction of wood resources and figures of forest regeneration for ensuring of sustainable development and also to develop proposals for improving the competitiveness of local wood products in the market, taking into consideration on competitiveness based management conditions for wood products manufacturing.

II. THEORETICAL ASPECTS OF WOOD PRODUCTS MANUFACTURING ON COMPETITIVENESS BASED MANAGEMENT

The economic science considers that competitiveness is an ability to compete with the analogous objects (goods or services) on a specific market by using the competitive advantage (price, quality, etc.) to achieve the objectives. Competitiveness as a complex economic category can be analyzed in several levels of management: products competitiveness; company's competitiveness; industry's competitiveness; national competitiveness.

Nevertheless, at each of these levels it is possible to identify different factors that influence competitiveness, among all of the analytical levels of competitiveness there is strong internal and external relationship present. The competitiveness, at the national and sector level, depends on the ability of *specific product manufacturer (service provider) to offer the competitive product (service)*, which means the ability of the specific manufacturer (service provider) to give preference by offering its products on the market. However, at each management level the analysis and evaluation of competitiveness could have their specific features.

Summarizing competitiveness factors and the correlation of product, company, industry and national level, the authors want to draw attention to the very wide view on the competitiveness and its multiple dimensions, because factors of competitiveness in the world market, at the national level, within industry, at enterprise level and at the level of wood product itself, although their way of expression is a little bit different, they will affect the competitiveness at any of the levels.

Based on the explanation of the definition of the competitiveness, one of the key business objectives is to fulfill customer expectations and needs, which means that the consumer will be the one who will "evaluate" the level of competitiveness, therefore, it is essential to develop on competitiveness based management solutions at all levels.

III. DINAMICS OF FOREIGN TRADE AND ITS IMPACT ON COMPETITIVENESS BASED MANAGEMENT

Analyzing and evaluating Latvian wood product contribution to the state foreign trade, authors acknowledge that for the successful and sustainable development for wood products manufacturing it is necessary to balance import and export volumes. The above statement means that need to make greater use of local wood resources for the needs of local market. An important part of Latvian wood products exports consists of wood products with a relatively low added value. In order to analyze dynamics of import and export, it is useful to look at key trends related to import and export activities of wood products manufacturing (Figure 2.).

Fig. 2. Volume of the Latvian forest export and import, thous. Ls

IV. CONCLUSIONS

Summarizing the results obtained in the conducted research, the authors conclude that the issues related to competitiveness based management should be addressed systemically - the competitiveness of the entire wood processing industry in influenced by the competitiveness of the companies operating in this market, therefore, improving the competitiveness of the competitiveness-driven management is closely related to the availability of high-quality wood resources, adequate infrastructure, high-quality products, implementation of innovative solutions in the operational activities of the wood products manufacturing companies thus gaining strategic management advantages, as well as applying logistics solutions in the wood products manufacturing in Latvia.

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Energy efficiency sustainable development in Latvia at national and regional perspective

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Keywords **– energy efficiency, sustainable development, planning at national and regional level**

The main objective of energy policy is to develop sustainable energy efficiency in national and regional level. This policy is based on Latvian energy strategy, which is the highest hierarchical planning document.

In every country (including the highly developed ones) there are less developed peripheral regions, and studies show that it is possible to raise more rapidly energy efficiency on a national level by improving just the underdeveloped regions. That is why the EU is developing regional programs where planning and their implementation are essentially different from planning on a state (national) level with the traditional methods. Special regional planning centers are being created for planning in the regions, carrying out also implementation of the plans by a deeper study of the potential of the local resources in the regions. Latvia is adapting and developing the model of the Sustainable Energy Community (SEC).

The strategy is one of the most important elements of the system planning methods the national energy policy is based on. Plans are elaborated in accordance with EU directives and other EU strategies and policy documents. Implementation of energy efficiency sustainable development agenda will require involvement of all economic sectors.

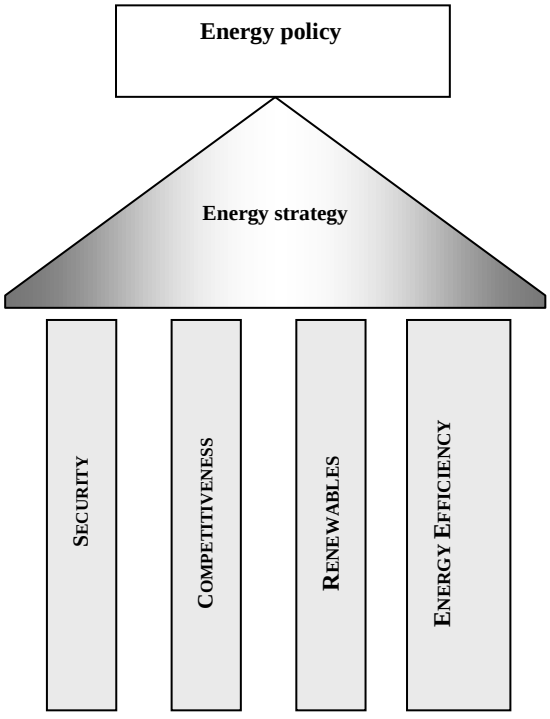

Fig. 1.Main pillars of energy policy

Main pillars of energy policy (see fig. 1.) also can be used developing the sustainable energy efficiency plan. [1]

It is important to select a plan, depending on many factors – EU directives, as well as the mix of energy resource, the export - import, energy consumers and supplier's activities, etc. Latvia first developed guidelines, and on that basis long-term and short-term activity plans by year 2020.

The guidelines are medium-term policy planning document focused on the achievement of specific, significant for the country objectives that covers a wide range of issues and are established for the period from five to seven years.

The concept is a policy planning document, which shall inform the authority about the existence of certain problems or the nature of the necessary regulatory framework for possible future action on problems or possible solutions.

The coherence of the vertical and the horizontal dimensions of the General policy assessment methodology (GPAM) are being activated, and tasks are formulated to gain sustainable energy developing. The GPAM is research method in which the coherence of the vertical and the horizontal dimensions are developed. The coherence of the vertical dimension is developed starting from the global international (EU) policy, the national governmental policy for SE, the policy of the local authorities for SE, the policy of the regional energy supply companies for SE, etc. The coherence of the horizontal dimension is developed to coordinate the SE policy with the other spheres, cross-cooperation and coordination of the branch institution with the SE policy, stimuli, sections, taxes, etc. [3]

Policy coherence is understood as the systematic promotion of mutually reinforcing policy across the governmental and regional departments and agencies creating synergies towards achieving the agreed objectives; the term has two dimensions and can be differenced into vertical policy coherence (coherence and coordination between different administrative levels) and horizontal policy coherence (cross-departmental coherence and coordination of adjacent policy areas). [7]

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Financing Models for Housing Fund Renovation in Latvia

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Keywords **– housing fund, renovation, energy efficiency, financing models.**

I. INTRODUCTION

More than 20 thousand buildings in Latvian cities and rural areas, which are occupied, need renovation. These buildings are inhabited by hundreds of thousands of households with different level of income, located in areas with different level of socio-economic development. Late renovation can be facilitation factor for critical condition of particular residential buildings and consequently lead to their exclusion from the housing fund, thus increasing social tension in the social housing sector.

Current renovation rate is insufficient and it cannot reduce the increased number of houses which need renovation. One of the key factors affecting the increase of renovation intensity is the technical condition of housing fund and inadequate financing compared with the household income.

II. HOUSING FUND AS A PART OF THE REAL ESTATE SYSTEM

Real estate is the basis of real estate management. If the real estate does not exist, then the field of this economic activity would not be active and develop.

Economic, political and social development of each country is determined and affected by its ownership of real estate resources – land, natural resources, buildings, structures, etc. Real estate is one of the most important economic resources and one of the essential components of national wealth, which all-in-all constitutes 50% from all the world wealth.

New ideas and technologies are required for the development of the housing fund of Latvia. Application of innovations is one of the factors why currently in Latvia there is no high-rise apartment house built in which green building elements and passive energy principles are used.[1]

Housing fund is defined as a number of residential buildings and structures, including all respective auxiliary buildings.

Buildings and structures, where living space is less than 50% of the total area are considered to be residential buildings.

In Latvia, from 1998 till 2012 in the fields of real estate management and facility management different real estate administration and management models were developed and implemented.

The main aim of the renovation is the reduction in energy consumption. Any enclosing construction has some degree of heat resistance, but it is low in the buildings which were built during the Soviet times, which leads to large heat losses for the building and for the inhabitants who receive large heating bills. By insulating the enclosing construction of the building and, in addition, renovating the heating centers, heating communications, etc., the heat consumption and the payments will reduce. But thinking about the environment - currently, the world's biggest concern is the reduction of CO_2 emissions - by reducing energy consumption, the amount of CO_2 emissions in the atmosphere will reduce as well.

III. TOPICAL ISSUES REGARDING HOUSING FUND IN LATVIA

Central parts and high-rise residential areas in many cities of Latvia have developed historically. Residential areas built during the Soviet times are too large, standardized, utilitarian and impersonal the technological and construction quality of which is very low. The measures to improve the quality of living environment shall be implemented in all regions of Latvia.

Low income level of households affects the potential and required co-financing in renovation of the housing fund that is in an ownership.

IV. OPPORTUNITIES TO ATTRACT FINANCIAL INSTRUMENTS TO INCREASE ENERGY EFFICIENCY OF THE BUILDINGS

Financing models applicable for paying for housing fund renovation works, taking into account the technical condition of the buildings which are subject of the renovation, the ability of households to pay and other important variables were analyzed. Possible financing models and funding sources for the housing fund renovation were compared and the main risks for implementation financial instruments were identified.

IV. CONCLUSIONS AND PROPOSALS

By identifying quantitative and qualitative aspects of the housing fund to be renovated as well as nature and trends of their change, collecting and evaluating information on the main financial models used for financing the housing fund renovation works abroad, finding out the main factors preventing broader deployment of housing renovation works, increasing energy efficiency of residential houses and cost reduction in facility management, to discover their causes; to assess the potential and required co-financing of households in renovation of the housing fund that is in an ownership; to analyze financing models applicable for paying for housing fund renovation works, taking into account the technical condition of the buildings which are subject to the renovation, purchasing power of households and other topical variable parameters; assess advantages and disadvantages of the proposed financing models compared to the existing ones.

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Problems and their solutions in valuation of commercial type real estate for the needs of mortgage lending

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Keywords **- mortgage loan, loan collateral, collateral value, replacement cost method, direct capitalization, cash flow discount**

I. INTRODUCTION

Mortgage essentially is a long-term loan that is secured by real estate collateral. The amount of the loan depends on the real estate or collateral value. In Europe, in determining the collateral value, the value of the real estate collateral is taken into consideration. In Latvia, in the real estate valuation practice it is assumed that the value of the collateral is a forced sale value, the base of which is the market price. While the real estate market price represents the country's economic situation in the short term, as a result of which the estimated mortgage security couple of years ago in 2011 and 2012 in Latvia do not correspond to the actual forced sale value.

The main cause of Latvian economic downturn was that the amount of money in circulation was not relevant to the amount produced. Everyone, the state, actively attracting European Union funds, companies receiving foreign investments and households, taking more and more loans, spent more than they had actually produced and earned. Mortgage loans make a large part of the borrowings. Favorable conditions for obtaining mortgage (low interest rates, the minimum down payment, long repayment period) offered by credit institutions contributed to the households' activity to buy dwelling houses, which created a huge demand, and thus led to a sharp increase in real estate prices. Mortgage lending was actively used also by the companies to acquire new commercial real estate objects and to increase credit line limits in order to expand their operations and improve their quality.

The aforementioned describes the topicality of the article in order to determine the appropriate approach to commercial real estate valuation for mortgage lending needs.

Latvian and European valuation standards as well as special scientific literature are taken as the *methodological basis for the research*.

For evaluation of the information the following *methods* were used: statistical method (calculation of the relative amount), table and graphical methods – for statistical purposes; inductive method – for making general conclusions applying real estate valuation results.

II. RESEARCH RESULTS

Valuation object is classified as a specialized real estate which has the nature of efficiency that is restricted by the way of its use or by particular users and which in the open market is rarely sold, except for the sale of the company. In accordance with the valuation practice in Latvia, in case of the valuation of the specialized real estate, the remaining replacement value method is used. However, the study authors believe that the income method can also be applied for the valuation of the property use. Income assessment method can be applied on condition that economic activity of the real estate is stopped and the expenses for the accommodation of premises for other commercial activities (alternative use value) are required. Such approach involves risks related to the termination of economic activity.

Using the direct capitalization, property value is calculated by estimating income from the real estate business activities and rent of premises, taking into account the expenditure forecasts by capitalization of the potential net income. Summarizing all results acquired in the valuation process, two values of the assessed property are distinguished - real estate market value and the value of the specialized real estate. The real estate market value is described by the replacement cost method and the cash flow discount estimated value. Replacement cost method reflects the land and construction value, regardless of its current use. Income method is used, taking into consideration alternative use of the property. Consequently, the replacement cost method and the cash flow discount calculated values best describe the value of the property in the long term, because the influence of external factors (impact of risks related to the economic activity) on the value of the property is minimized. Specialized real estate value consists not only of land and construction, but also of the technical equipment (mechanical ventilation system, floors, etc.) used for ensuring economic activity. With the direct capitalization method value of the real estate actual use is calculated, consequently the equipment is also included in the total value of the property. Specialized real estate value is also characterized by value calculated using the replacement cost method and by adding equipment costs.

III. CONCLUSIONS AND PROPOSALS

The authors conclude that the collateral value is best described by real estate market value estimated applying the expense substitution method, and by the alternative use value, because they take into consideration risks related to external factors, and considers the real estate in the long run. Research results indicate that the forced sale value of assessed real estate which is expressed as a percentage against the estimated market value shall be considered as a loan collateral or the collateral value.

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Revitalization and Development of the Green Real Estate of Riga City

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Keywords **– development, green real estate, urban parks, revitalization.**

IV. Introduction

A leading author on sustainable development Herbert Girardet *(Herbert Girardet – eng.)* considers that public spaces and parks form a crucial feature of liveable cities. Unlike in many 19th-century cities, frequently not enough space is kept aside for them. Too often, attractive, safe and well-maintained spaces are located in privately owned, enclosed shopping centres. Yet public parks are important for people. From whose lives the experience of green space and biodiversity has gone missing. [1] Enrique Penalosa *(Enrique Peñalosa – spa.)*, former mayor of Bogota *(Bogotá – spa.)*, observes that parks and public spaces are important to a democratic society because they are the only places where people truly meet as equals. Parks are also essential to the physical and emotional health of a city. However, this is not obvious from most budgets, where parks are treated as somewhat of a luxury. Roads, the public space for cars, receive infinitely more resources and less budget cuts than parks, the public space for children. [2] In Enrique Penalosa opinion parks play many non obvious roles in constructing a society. However, one of the most important is to make cities more egalitarian.

V. Riga – The City of Gardens

Describing the development of gardens in Riga, he notes that during the late 19th century a new movement emerged in the public gardens of European cities – greenery based on the principles of the natural sciences. The landscape gardeners of Riga were ready for this. Analyzing historical development of the green areas in Riga City it is necessary to note, that the first significant town planning measures were the establishment of two the so-called Tsar Gardens *(Государевы сады – rus.)*[4]:

- at Gustavsala *(Gustavsala – latv.)* or Petersala *(Pētersala – latv.)*;
- at the Alexander *(Aleksandra – latv.)* bastions.

Initially the parks were conceived as a part of an ensemble of the Tsar's palaces *(Государевы дворцы – rus.)*, which were to be built in these places. Later, however, the citizens of Riga were able to utilize these parks for their rest and recreation. At the beginning of the 19th century, a plot of land given to the town by the widow of the merchant Vermanis *(Wöhrmann – deu.)* was planted with trees and shrubs. In line with the terms of the gift deed, this park was open to the public. In due course the park expanded and became one of the most remarkable open spaces in the city. [4] The gardens created at the beginning of 19th century were intended for all of society, but the truly public gardens in the city were designed and installed after the Riga Gardens Directorate *(Rīgas dārzu direkcija – latv.)* was established in 1879. Riga's gardens became an urban treasure – a place where people could take walks and relax – and these gardens wisely unified and supplemented the urban space.

Nowadays Riga is widely known in Europe for its parks, gardens, squares and alleys. Green areas are popular place for recreation and sport among the local residents and foreign tourists. Urban open space and parks are significant element of the *"green"* real estate of the municipality of Riga.

VI. Revitalization of Green Real Estate of Riga City

In accordance to the Riga Development Plan *(Rīgas Attīstības plāns – latv.)*, the general purpose for the capital of Latvia is to facilitate Riga long-term development, providing the possibly highest quality of life for all the people working, living, investing into or simply visiting Riga. [5] In order to achieve an above mentioned purpose Municipality of Riga City *(Rīgas dome – latv.)* has started an ambitious project in 2012. It is aiming to arrange and to revitalize green open space areas in Riga – Lucavsala *(Lucavsala – latv.)*, area around Mara's pond *(Māras dīķis – latv.)*, AB dam *(AB dambis – latv.)*, Grizinkalns *(Grīziņkalns – latv.)* and its surroundings, etc. In general, approximately 2.5 million Latvian Lats from the budget of the Municipality of Riga as well as 4.7 million Latvian Lats from European Union funds will be invested in the development of green areas. [6] It is important to note that within the project of the development and revitalization of the green real estate of the Municipality of Riga City a new, broader view of parks, that has recently been emerging, is identified. Chris Walker *(Chris Walker – eng.)*, Urban Institute senior researcher, focused attention on the fact that this new view goes well beyond the traditional value of parks as places of recreation and visual assets to communities. [7] It focuses on how policymakers, practitioners, and the public can begin to think about parks as valuable contributors to larger urban policy objectives, such as job opportunities, youth development, public health, and community building.

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Modeling health risk factors in Russia using input-output and econometric approaches

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Keywords: **health risk factors, a forecast for the Russian ecological-economic development, regression analysis of morbidity.**

I. Introduction

The period of transition from a command economy to a market economy is characterized by a severe health aggravation of Russian citizens. The yearly registered number of people who fell ill with cancer for the first time increased by 86% from 1990 to 2009; the number of those who fell ill with diseases of the digestive system increased by 22%, and the number of those who fell ill with diseases of the circulatory system increased nearly as much as twice.

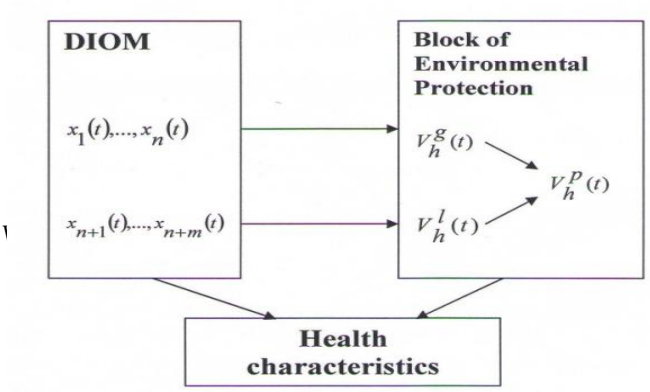
II. General Regulations

Public health is formed and supported by a combination of living conditions. The particular reasons that cause aggravation of health are called risk factors. Risk factor parameters and the intensity of their influence on the population's health changed during the period of Russia's economic reforms. Specialists single out the following risk factors that have had a negative influence on the health of Russians in the last 15 years: 1) economic (the low level of salary and retirement payment, worsening of conditions of life and of labor, worse structure and quality of food etc.); 2) psychological (excessive stress situations caused by the socio-economic instability of the society and its high level of criminalization); 3) cultural (the fall of the general level of culture, including sanitary and hygienic culture, which contributes to bad habits and an unhealthy way of life); 4) medico-infrastructural (quality and quantity of medical service, a low level of medical care and preventive health care); 5) genetic (parents' health); 6) climatic and ecological (worsening of climate and of the environmental situation in the country).

Specialists of the World Health Organization believe that 20% of public health deterioration is due to the bad environmental situation, that's why the main stage of our research was concerned with constructing a forecast of ecological-economic development of the Russian Federation for 2011 - 2015. To do this the CAIIN (Comprehensive Analysis of Intersectoral Information) System with an environmental unit was used. The CAIIN was developed by an Interindustry research department at the Institute of Economics and Industrial Engineering of the Siberian Branch of the Russian Academy of Sciences under the guidance of Professor V. N. Pavlov. Figure 6 presents a brief diagram of a variant of the CAIIN system, functioning with an environmental protection block (EP block).

III. Objects

Fig.1. A brief diagram of the CAIIN system with an



EP block.

$x(t) = (x_1(t),...,x_n(t),x_{n+1}(t),...,x_{n+m}(t))$ – vector of gross outputs

$V_h^g(t)$ - volume of pollutants generated in the production process,

$V_h^l(t)$ - volume of a recovered natural resource (liquidated or trapped pollutant) of type *h*,

- volume of pollutant *h*.

IV. Other recommendations

Research results presented here give a numerical estimate of the influence of various factors on the health of the Russian population; they also make a forecast of the effect of ecological factors on total sickness rate. The set of dynamic intersectoral models used in the forecast makes it possible to take into account the influence of structural biases in the Russian economy (which occurred as a result of the world economic crisis) on the ecological situation and on the number of the first-time sick. The proposed approach combines the application of the advantages of intersectoral modeling methods and econometric methods in order to analyze and forecast ecological-economic processes.

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The Importance of European Union Funding for Infrastructure Development in Latvia

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Keywords **– infrastructure, road construction, financing sources**

I. Introduction

Good infrastructure historically proved to be an indispensable precondition for the sustainable economic development of the nations; however national budget restrictions are leading governments, even in developed countries, to use structural funds and private financing for infrastructure projects as they are not able to fully finance them through the government budget.

The paper deals with the problem of relocation of financing sources for infrastructure development in Latvia. In the paper the authors focus on road construction industry and aggregates market as well as the industry has a huge need for raw materials: sand, gravel and granite, and searches continually for cheap sources for road construction, maintenance and repair projects, thus having negative impact on quality of works and sustainable development.

The main goal of the paper is to emphasize the importance of European Union funding for different projects related to infrastructure development in Latvia.

II. Financial Sources for Road Construction, Maintenance and Repair Projects

Adequate and stable financing is essential for infrastructure development thus supporting social and economic growth and allows countries to participate in the global economy by increasing their competitiveness. Lack of above mentioned gives negative impact on economic well-being. The World Bank supports implementation of using financial instruments to cover risks for the private investors as well as governments. There is also possibility to make an agreement between governments and International Monetary Fund to carry out public-private partnership projects thus creating long term liabilities for public partner. Private Public Partnership (PPP) can be an effective way to maintain and improve the road network raising quality and encouraging innovation.

Public road and highway construction is financed by Government and local authorities. Amount allocated for road construction and maintenance varies by years depending on financial situation in economy and needs in other sectors. Spending on road construction in Latvia highly depends on general financial situation of country, as infrastructure projects are financed from government or local budgets with support from several European Union funds. European Cohesion Policy is at the centre of the effort to improve the competitive position of the European Union as a whole, and its weakest regions in particular.

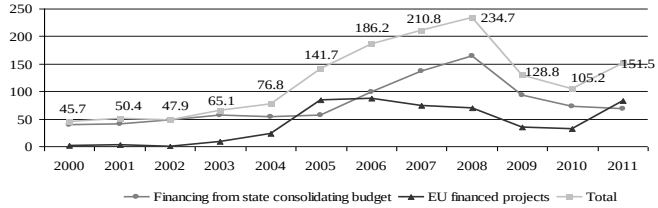
Cohesion Fund financing according to "Transport development national program" is provided for trans-European transport networks (TEN-T) development. Minimal Project size is €10 million, financing is possible up to 85% from total applicable costs. Tenders are organized according to local legislation. European Regional Development Fund (ERDF) is other EU structural fund, which finances development of transport infrastructure. ERDF support is planned for regional transport network development with aim to connect main economic development centres with TEN-T and according to EU requirements and standards improve road quality, safety and reduce harmful effects of traffic on environment.

III. Financing of Latvian State Road Programme

In 2011 there was about 20% increase in road construction and according to Latvian Stated Roads data the biggest contribution to that were the investments in road construction from EU Structural Funds. In total the investments in the construction of state roads was about 77 million Lats and there were constructed and reconstructed 165 kilometres of bituminous pavements and 400 kilometres of pavements were renewed with surface tratment for 8.5 million Lats. European Union investments play significant role for the renewal of specific road sections, however, as availability is limited, EU co-financing will not stop deterioration of the state roads.

TABLE I

FINANCING OF LATVIAN STATE ROAD PROGRAMME, M LVL



IV. Conclusions

Overall changes of financial and economical situation globally and in Latvia, have forced country to borrow money and sign agreement with International Monetary Fund, which as a result sets several limitations for country and its spending. Such limitations have significant impact on Public Private Partnership project development. Main reasons why PPP projects in Latvia have been stopped are: limited finances, insufficient political support.

The government should prioritize the next planning period of seven years and declare the renewal of roads as one of state budget priorities in the next years in order to stop further deterioration of the road network. There is high importance to proclaim the road renewal as a priority in political level and provide stable and long-term financing.

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Improving of Economic Cooperation: Forms Investigation and Gravity Model Implementation

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Keywords **– gravity model, institutions, sustainability, transborder cooperation.**

While national social and economic systems of countries face global world changes the question of institutional cooperation inside and outside of emerging social and economic systems such as Euroregions, countries that are partners in trans-border cooperation, transnational corporations etc. becomes more and more actual. European Union becomes wider and wider, it expands it boundaries, but if EU policy still save national identities, national discourse, do not destroy national institutions? How do EU's discourse influences on institutional cooperation inside EU countries, inside EU and outside EU – countries that border with EU? Do consequences of global changes for emerging social and economic systems consist of improving of institutional cooperation or of destroying the national stable systems? *New* changes that are caused by *new* policy of *new* leaders in economics and in society result in advantages and disadvantages for modern system of national and international institutions. So, the aim of the given research is to investigate the form and the expression of the EU's international discourse and to create methodic approaches for improving *institutional cooperation* between EU's and bordering countries.

In globalization era new types of international cooperation became significant. One of such types of cooperation is trans-border cooperation. While implementing this cooperation into practice the borders of countries are gradually disappeared. Number of economic and social advantages as well as disadvantages can be named. In the given paper author develop scientific and methodical principles for creation of logic-structural framework for implementation mechanism of trans-border cooperation. Author proposes definition of TC mechanism as a complex system of elements (subsystems, participants) which have direct and indirect connections between themselves and are created and make their activity aiming to achieve clear defined purpose. The logic-structural framework of trans-border cooperation consists of providing and institutional subsystem; functional subsystem; adaptation and instrumental subsystem; results-and-purpose subsystem; participants of direct and indirect impact; direct and indirect interconnections between all components. One of the main blocks of the scheme for trans-border cooperation mechanism is *institutional subsystem*. The detailed description and explanation of institutional subsystem for emerging social and economic systems is given on example of trans-border cooperation. It is suggested by author that both existed institutions of countries and new institutions of emerging social and economic systems should take into consideration the strategy for sustainable development achievement. Author proposes that this strategy can be realized due to following next principles and implementing them one by one: decreasing unsustainability of existed institutions, creating sustainable institutions, creating of totally new type of renovated institutions.

The paper presents the principles for constructing the effective framework, which could be implemented in the trans-border cooperation for ecological development of regions involved in this cooperation. The research discusses and suggests environmental and economic tools for such an implementation. In particular, suggested approach allows policy makers to account for environmental criteria in their decisions related to trans-border cooperation, which is omitted in the existing approaches. Based on estimation the factors of both environmental and economic efficiency we develop the strategy for improving combined efficiency of trans-border cooperation aiming to achieve sustainable social, ecological and economic development.

To our mind to have possibility of making the estimation of environmental and economic efficiency of trans-border cooperation system of clear and complete indicators is essentially needed. This system should consist of such indicators, which allow making clear and understandable conclusions and suggesting appropriate regional development strategies. Also the important stage for ecological regional development as important task of trans-border cooperation is to create effective trans-border cooperation mechanism, main element of which is multilevel governance. Thus, in the paper system of environmental and economic indexes and criteria, which is the basic element of adaptation and instrumental subsystem of trans-border cooperation mechanism, was created. It allows accounting for environmental factors and economic instruments influence on trans-border cooperation efficiency. And also we suggest the complex trans-border cooperation mechanism that consists of the following elements and can be presented as a scheme: providing and institutional subsystem; functional subsystem; adaptation and instrumental subsystem; results-and-purpose subsystem; participants of direct and indirect impact; direct and indirect interconnections between all components.

In conclusions author examines and explains the nature of factors of gravity increasing/decreasing between national and international institutions, and justified accordance the institutional cooperation and the EU's international discourse creation to gravity model.

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The Dualism of Economic Systems and Environmental Issues

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Keywords **– economic systems, discrete unit (corpuscle), field-essence, dualism properties, the phenomenon of dualism.**

Physicists know the so-called effect of dualism, when particles at the same time exhibit properties both of discreteness and field (photon wave) [1]. But if certain effects are inherent in the microworld, do they work as well at the macro level – at the level of economic systems? In particular, do economic agents show qualities similar to properties of discrete particles and fields? Most likely, we can say yes to that, to some extent any part of any system, including economic has the property similar in its manifestation to dualism.

The phenomenon of dualism lies in the fact that a particular element has both properties: a) *discrete unit* (*corpuscle*), which coordinates can be uniquely determined in space and time as a certain *point*, and b) *field-essence*, which has a substantial length in space and duration in time.

Such considerations provoke the idea of dualism of economic systems. It is known that any system exhibits significantly greater qualities (properties) than those possessed by its subsystems. What is the source of this new quality? Let us assume that they are carriers of the same parts (subsystems) that make up a whole new system, but do not act as discrete units, and field essence. Prior to the formation of this whole the mentioned qualities occur in each subsystem (part of the whole) but on the virtual (i.e., potentially possible) level not on the real one.

Economic systems exhibit their field properties in space and time:

Any company, showing the properties of the essence (i.e., a discrete unit) with its address (legal or individual), property, performers has at the same time impact on other areas of activity outside of their formal presence, as if creating a kind of *economic field*. For example, we can say that every company creates prerequisites for the operation, respectively, resource providers and consumers of their goods.

The automobile industry development in the United States is an excellent illustration. The car (assuming the specific company for its production) has created infrastructure, related products, life style of America, provided the development of petrochemical industry, road construction, tanker fleet, cars service, training drivers for road police control and nowadays satellite navigation, and many other things.

In the 1970s the work of American scientists H. Odum and E. Odum have significantly deepened the research period prior to production history of economic assets. It goes about a kind of gradual energy concentration of materialized production factors.

"Externalities". Economic research of 1960-1970 allowed "see" another facet of the virtual images of the field nature of economic agents. A new economic concept – "externalities» became to be used in everyday life [4;5]. Non formalized effects of businesses that are not "captured" by the official (documented) system of economic accounting businesses that they have produced are called so. More often externalities are understood as environmental impacts. In principle they can be any results that are perceived by other economic agents from the activities of enterprise [3;6;7]. Thus, each company creates a unique information-energy field. Directing capital flows of different degrees of power in different areas (sectors) of activity (e.g., resource production, or use of goods), this field is the source of a specific quasi-energy of companies. And this energy is in a certain way directed and concentrated by the information. The mentioned above gives grounds to speak about the information vector of the energy field. The field spreads in space and extends in time. As we have seen, this field can have both negative and positive value, bringing destructive effects or additional benefits of economic and informational forms to other businesses (for example, in the form of increased costs, damages, lost profits).

The role of economic dualism in the evolution of economic systems. The formation of quasi-energy field is a prerequisite for creating variability in the possible change in economies state. Each of the virtual variants of development options for economic systems evolution must pass natural selection, proving its worth in terms of efficiency and the ability to reduce the production of entropy. In his Nobel speech, and a number of publications, Nobel Prize winner Werner Arber has suggested a genetic dualism which manifests itself at the level of biological organisms. In particular, the genetic mechanism is responsible for not only life and development of each individual biological organism, but also the evolution of the entire population to which it belongs [2]. Similar processes occur at the level of economic systems development, which content and form are determined by the mechanism of evolutionary triad (heredity-variation-selection) operating in tough competition.

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Time factor in economics

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***Keywords* – costs, economic, indicators, measuring, time.**

The *time factor* is a phenomenon of system state change due to changes in the time parameters. Over time due to different reasons productivity, goods price, value of capital may vary. As a result, the same costs in the same location but at different times have different *effects* on the economic system change:

A. The same costs cause different quantitative and qualitative results.
B. The same results are achieved by the different quantity and quality costs.

Parameters of time are the economic indicators, which are directly or indirectly based on indicators of time. They reflect the key temporal characteristics of the production process: sequence, duration, pace, level of synchronicity, the switching time. The time parameters may change on the base of two groups of *criteria*:

A. Duration of the economic process: time during which there could be changes of the economic system;
B. Density of the time units: this indicator shows the number and quality of economic events occurring per time unit.

One of the main tasks of the economists is to consider quantitatively the impact of the time factor in economic events. Indeed, 'time – indeed the money'! But how to express the unit of time in cost units?

There are several *directions of time factors impact* on the economic system indicators:

1) time as a multiplier of the result of the economic system activity;
2) time as a factor influencing the economic indicators;
3) time as a factor of 'consolidation' (increasing intensity) of economic processes;
4) 'consolidation' of time by improving the information structure of the economic process [2].

Time is a one of the key economic category and there are some *practical problems* with its implementation. We can suggest our own view on some problems of time influence on the economic activity. One of the main questions is a comparison of some economic indicators which have different time measuring. Some economic indicators have in a most cases exact moment time measuring (end of the day/week/month/year): circulating assets, commodity (goods) in stocks, etc. At the same time some indicators have in a most cases interval time measuring (as an integrated result of certain time period): basic (fixed) assets, cost price, etc. But also some of indicators can be calculated by both variants: on exact moment and on time interval. For example, amount of employees at the moment and the average number of employees (and what about age of employees or their experience/seniority).

Other example could be the situation with credits. We can take a loan for 10 years. From the economic point of view it's a long-term loan (as it appears in the balance sheet), but if we took credit 9 years ago or 1 year ago it is a different economic situation (perspective) for us.

In this case we propose to divide all economic indicators on two basic categories: moment and interval time economic indicators. We suggest to make a *time-slice analysis* of economic activity where we should compare indicators which have the same time slice.

Main directions of time factor analyses in the enterprise:

- Dynamic of technical and economic indexes of the enterprise;
- Seasonality of production or sales, which results in seasonal fluctuations in supply of raw materials, production or its demand, inventory and receivables;
- Physical depreciation of fixed assets, which makes the overall downward trend in their performance and increase the cost of their maintenance, operation and maintenance during the billing period;
- Change in time the price of goods, produced and consumed resources;
- Change in time parameters of the environment (prices, rates, taxes, customs duties, excise taxes, minimum wage, tax and other legislation, etc.);
- Tears of time (gap) between the production and marketing of products and between payment and consumption of resources;
- Time differ costs, results and effects throughout the time period of the project, not in a one fixed time point.

Diagnostic processes of the enterprise are closely linked to the influence of the time factor. Any diagnostics is primarily dependent on time, duration, frequency, urgency, and others. Today, however, poorly structured and orderly use of time in the diagnostic, its influence is underestimated. Besides analyzing the effectiveness of the economic systems we usually focus our attention on the money component, although the time use sometimes is more priority.

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ECOPOLIS as innovative vector of greening the economy

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***Keywords* – Ecologization, Ecoregion/ECOPOLIS forming, Instruments for environmental policy, Greening the Economy, Sustainable Development.**

I. Introduction

Advanced features of the instability of the economic sphere, and non-dynamic transformation at the socio-economic and ecological systems caused by modern conditions of their existence. However, the provisions of the concept of sustainable development provide insight on ways to improve development. Ecologically oriented economic development must be closely linked to the sustainable use of natural resources and waste management, support biodiversity, ecosystem conservation and economic use of natural resources potential. That is, ecologically oriented region's economic development – a dynamic transformation of the economy, taking into account the principles of sustainable development through innovative approaches. One of the best ways to solve the above problems is to create in certain regions such as the development of innovative forms of ECOPOLIS.

II. Ecopolis as a system of the formation innovations

In our opinion, the formation of ECOPOLIS – is the strategic direction of the innovative socio-ecological-economic development of areas where industrial activity is consistent with natural processes and environment-friendly attitude to the environment.

The authors understand ECOPOLIS as the scientific and industrial-educational complex, which functions are to create and implement innovative environmental product lines. This form of territorial development is able to accumulate in the economic potential for a gradual transformation of the existing innovation centre in the "life", which will increase the share of production and consumption of goods for environmental purposes, as a means of making a profit in the economic sphere will address regional environmental problems.

In contrast to the environmental activities designed to address specific environmental problems in the formation of ECOPOLIS main goal is profit from sales of innovative products for environmental purposes, which may directly or indirectly contribute to solving some environmental problems. This innovative ecologically oriented transformation does not cancel and do not substitute for environmental protection, but increases in both business entities and in the management of desire and motivation to achieve environmental objectives through the development of "green economy".

Among the major benefits offered by ECOPOLIS innovative approach include: the gradual conquest of markets for environmental goods and services, increased export capacity, the conversion of productive capacity towards improving research and information capacity and reduced material and energy intensity of production, efficient use of facilities of scientific and industrial complex , the reduction of destructive pressure on ecosystems and healthy human environment and creating conditions for the export of educational and training programs for the maintenance of products for environmental purposes, which will be produced for export. These are the reasons and the basis for the development of "green economy" as a basis for ECOPOLIS innovations. The development of "green economy" through a system of organizational activities, innovation, restructuring the production and consumer demand, technological conversion, rationalization of nature, the transformation of environmental activities that are implemented at both the macro-and microeconomic levels. This requires the development of criteria evaluation framework the environmental performance of products, which creates prerequisites for improving the reproduction mechanisms of development of "green" economy.

TABLE I
Environmental Evaluation of products for environmental purposes in Sumy Region

Type of activity	Products for environmental purposes	P'_e
Agriculture and forestry	Production of organic crop production	12
	Services in Forestry	9
Manufacture of food products	Eco-friendly foods	9
Manufacture of wood and wood products	Wooden windows and doors	6
	Decorative wood products	10
Pulp and paper industry	Paper pulp from waste paper	7
Production and distribution of electricity, gas and water	Electricity from renewable sources	7

III. Summary

The analysis shows that one of the most effective forms of regional innovation systems is ECOPOLIS. The results of enlarged environmental assessment of products formed the basis for providing sound recommendations for the development of production and consumption of certain products and services that help to reduce social ecological and economic losses, such as: clean food, paper pulp from waste paper, electricity from renewable sources tourism and educational services of the Botanic Gardens, dendrology parks.

Potential of Sumy region in the production and sale of product innovation for environmental purpose creates objective economic conditions for the formation ECOPOLIS elsewhere.

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Strategic Development Directions in Road Construction

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Keywords **– road construction, strategic development, environmental advantages and disadvantages of road construction industry, financing models.**

I. INTRODUCTION

Total road density in Latvia is sufficient but its technical condition is unsatisfactory and does not meet the safe and continuous traffic flow requirements. Currently, the road condition in Latvia is disastrous compared to its neighboring or the old EU countries. Almost half of the roads with asphalt surface and one third of the gravel road surface are on the brink of the collapse. Currently, the road construction industry is one of the most destroyed sectors in Latvia. Consequently, the increased attention from the public, politicians, and other state controlling authorities is paid to this industry sector. The authors of this study consider that it is important to explore the history of the development of road construction industry, to analyze strengths, weaknesses, opportunities and threats of the road construction and, in accordance with the findings, to determine the development perspectives of the road construction industry.

II. IMPACT OF THE ROAD CONSTRUCTION IN THE NATIONAL ECONOMY AND ITS DEVELOPMENT

Convenient infrastructure is the main condition for attracting investment and facilitating the growth of national economy. All major investment projects are in places where access roads are convenient and in good condition. Its focused development or, contrary, the gradual collapse, has a direct impact on each citizen and region, as well as it influences competitiveness and viability of the country not only in its neighborhood, but in the international market as well. State responsibility and concern for the roads is taking care of its inhabitants from the capital to the most distant parish in Latvia that in reality should be in line with ensuring the minimum infrastructure across the entire country all year round. State and local municipality road and street infrastructure shall ensure that there is safe and speedy flow of goods, that workers can get to workplaces and students can safely get to school and that every citizen is able to receive timely medical assistance, and assistance in case of emergency or natural hazards.

III. INTERNAL AND EXTERNAL ENVIRONMENT INFLUENCING THE CHOICE OF STRATEGY FOR ROAD CONSTRUCTION IN LATVIA

To ensure effective functioning, the industry has to choose a good strategy, which, in turn, must be developed taking into account the strengths and opportunities, i.e. making use of industry advantages.

Analyzing the strengths and weaknesses, the authors as the first advantage indicate the current optimal road network. The total road length of the country is 20 116.332 km. Average density of the national road network is 0.312 km per 1 km^2.

Well considered and smart road management system is advantage to be highlighted. Latvian road sector development priorities which are in line with the EU priorities are strength. These are Transport development guidelines, which determine the policy principles, development goals and transport sector priorities for 2007 - 2013. Pursuant to the Rules of Procedure of the Cabinet of Ministers, the guidelines are developed for the period of seven years, which coincides with the European Union's financial planning period. Currently, work on the next programming period from 2014 – 2020 is in progress. At the same time Latvian experience of implementation of the EU-funded projects (KOH, ERDF, ISPA and PHARE, etc.) can be considered as the road construction strength.

Strong depreciation of the existing road network as well as non-compliance with the road safety requirements shall be mentioned as the industry weakness. Significant traffic flows cross village centers. Throughput of the state roads of the main importance as well as the arterial streets of the cities in most cases is sufficient, however, in many places it is close to its maximum potential. Insufficient financing allocated for the industry from the state budget shall be mentioned as a weakness. Due to the financial crisis of 2009, every year the state has decreased the amount of financing allocated for the road maintenance. In 2007 it was 136.1 million Ls, in 2008 - 164.9 million Ls, which decreased to 93.4 million Ls in 2009, but in 2010 the budget allocation was only 73.2 million Ls and in 2011 - 60.3 million Ls. By studying the statistics for the last five years, the proportion of the roads which are in poor condition has increased on average by 10% and the overall road quality continues to deteriorate. This indicates the next weakness in road construction - insufficient quality of transport infrastructure.

IV. CONCLUSIONS AND PROPOSALS

Total road density in Latvia is sufficient but its technical condition is unsatisfactory and does not meet the safe and continuous traffic flow requirements. Insufficient road sector financing is the main reason why the roads are in catastrophic condition.

At the existing insufficient level of road maintenance and amount of financing allocated for road development, an increase of traffic intensity and heavy vehicle proportion, there is continuous collapse of the road network and costs of road users are irrationally increasing as well as there is increase in the number of traffic accidents. The main reasons for surface deterioration are weariness of structural pavement layer material, natural aging of a binder agent and, to a lesser extent, the quality of works performed in previous years. Road maintenance and preservation shall be highlighted as a sector priority in the coming years.

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Economically advantageous location assessment for the industrial business in Latvia

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Keywords **–business in the Baltic Sea Region, R&D activities, economically advantageous location, location strategy, market attractiveness assessment.**

I. INTRODUCTION

There are a number of reasons to assess the local market attractiveness to allocate the business.

The authors targeted to work out the questionnaire to conduct the survey in Latvia for the leading companies in the industrial business origin from the Baltic Sea Region.

The main idea is to get to know the key principle in their choice of the most appropriate territory to the industrial objects.

A research object is industrial real estate property market in Latvia. The subject of the research is the leading manufacturing companies in Latvia with the headquarters from the Baltic Sea Region.

The main methods of the research used are the qualitative data analysis to obtaining a list of the required companies according to the criteria number worked out, and a literature observation which has indicated the theoretical background of the statistics and the issues of the market attractiveness, strategic analysis and business scope in the Baltic Sea Region.

II. THEORETICAL ASPECT

Investigation for the spatial analysis as territory concept development and support of the strategic real property allocation theory characterizes the beginning of the 21st century and few decades earlier. The latest works devoted to the multiple criteria decision analysis using the programming. The authors considered the competition effect, local market particularities and investment environment, locational strategy (Le Bas and Sierra 2002) and multinational cooperation (Yeaple 2003). Sweden invested into the developing Baltic economies most actively in the second and third year of the target countries' GDP growth. The financial crisis coursed the prompt capital outflow of the investigated Swedish assets and its reallocation. It has increased the assets the stable economies countries. The Lithuanian scientists facilitate forecasts of possible trends of fixed investment and corresponding economic growth (Staube and Geipele 2011).

The authors have obtained the list of 500 multinational entrepreneurs from the BSR of the large and middle scale of C, D, E (NACE categories) working in the territory of Latvia.

III. THE ASSESSMENT CRITERIA FOR MARKET ATTRACTIVENESS

When looking at the business allocating and local market development plans issue the authors categorize it in three types of collaboration: 1) industry and agriculture; 2) trade and services; 3) construction as a support and interaction branch.

The strategic decision on what to build or what cropper to grow and where effects the real estate market expansion opportunities in the aspect of location availability.

However, the Headquarter analyze the countries' business attractiveness values.

TABLE I

THE MARKET ATTRACTIVENESS ASSESSMENT CRITERIA

1	**Advantageous geopolitical location**
2	**Attractive tax policy**
3	**Low level of rivalry**
4	**Low price level of the staple in Latvia**
5	**Close collaboration with local scientists in the company's R&D activities**
6	**Beneficial credit terms and conditions for the industrial business**
7	**The advance to use the local natural resources for the manufacture**
8	**High professional level of the local specialists**
9	**Well-developed transport infrastructure**
10	**The company has full manufacturing process organized in Latvia, including its realization in local market**

IV. THE ASSESSMENT CRITERIA FOR ECONOMICALLY ADVANTAGEOUS LOCATION

Formulating the right location criteria might be influenced by a choice of Headquarter, collaboration perspectives with the local authorities, the development plans of the administrative territory or location correspondence to the manufacture's requirements.

It is considered to outline three tasks of the survey: 1) to determine the influence of a level and conditions of the market development; 2) to define threats in a territory acquisition; 3) to analyze if the current locations match the strategic plans of the enterprise.

The author highlights the following issues: the role of the market development stage and conditions; the main obstacles in the location choosing and territory's planning and management, the companies' strategic plans.

A hypothesis of the research says that Latvia does not use its advantageous location effectively. There is still a misbalance in a real estate market and the locations do not require the long-term plans of the operating companies. Low market capacities, limitations of the locations' physical and strategic development characteristics, protective tax policy and recent brain exodus create threats for attracting businesses. Companies rather use lower cost development countries and the location in the Latvia's neighboring countries.

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Building information systems for sustainable construction

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Keywords **– sustainable construction, building information system, information models.**

The importance of construction in the national socio-economic development is obvious. It affects both the life of an individual and society as a whole as well as the environment and the natural ecological balance. It creates a logistical base in other economic sectors and describes economic development and culture of the country.

Since the early 1990s, sustainable construction has been widely accepted in the construction industry all around the world. Building houses to meet the present need, we must take care of not compromising the ability of future generations to meet their needs. The basic definition of sustainable construction was formulated in the conference organized by CIB, held in the USA in 1994: its the creation and management of the healthy environment in the construction works and beyond their limits, following the principles of the efficient consumption of resources and environmental friendliness (Šaparauskas, 2001 etc.). This conception also covers the sustainability-ensuring constructional materials, safe construction practice and new technologies.

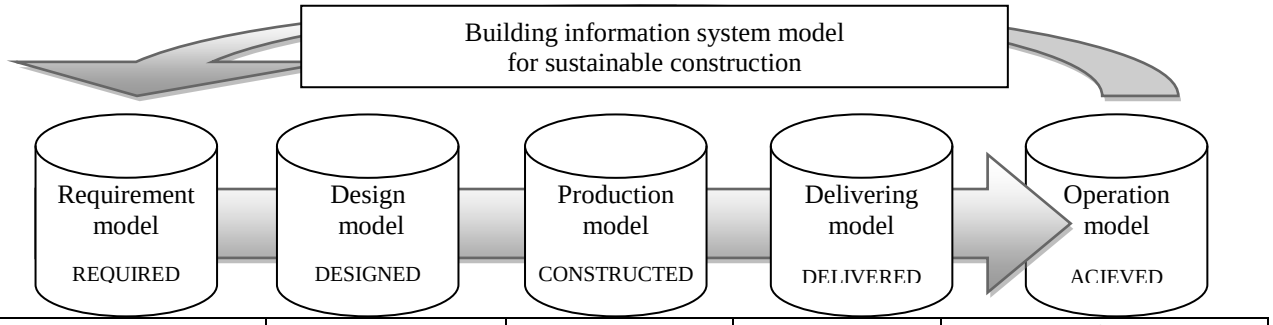
Now it is looking more and more for the solutions and techniques how to reduce the negative impact of the construction process on human health and the environment throughout the construction life cycle. Such actions must be orient to creation of high – quality, environmentally friendly and healthy living space.

The aim of research is to create new and more efficient business processes in the construction sector. All this should facilitate the sector's great potential for increased productivity and competitiveness, furthering sustainable development and cost reduction.

Companies use information systems to support their various business processes and activities for internal operations such as manufacturing, order processing, and human resource management. (Jessup and Valacich, 2006).

Research results improve information exchange in the design, production and management of buildings, and the performance based set of standards for sustainable development.

Figure 1 illustrates building information system model. It includes responsible supply, operation and maintenance of buildings that meet the needs of their owners and users over the life span with minimal unfavorable environmental impacts whilst encouraging economic, social and cultural progress.



Performance in use	• User requirements • Desired performance in use	• Designed technical solutions • Estimated performance	• Planned building, potential performance	• Built and validated conformity	• End user satisfaction • Performance in use
Environ-mental impacts	• Targeted environmental impacts over the life cycle	• Estimated environmental impacts over the life cycle	• Environmental impacts during constructions	• Estimated environmental impacts in use	• Environmental impacts of building and its use
Economic impacts	• Targeted whole life cycle costs • Target business benefits and value of the facility	• Estimated life cycle costs	• Construction costs	• Estimated running costs	• Running, maintenance and refurbishment costs, reuse, recycling, demolition and waste disposal costs • Value of the facility
Other	• Targeted social, cultural and institutional impacts		• Construction safety • Construction ethics		• Social impacts in the neighborhood • Impacts to the cultural heritage

Fig. 1. Building information system model

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Regional model of cluster interactions in the «green economy»

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Keywords **– green economy, regional clusters, cluster interaction**

The basis for this study was provided by two theoretical concepts, which are currently in the center of attention of researchers, theorists, economists, experts, political and public figures: the theory of clustering and the «green economy». Sustainable development implies a qualitative improvement of the social, environmental and economic parameters of the regional economic systems on the basis of «green growth», as well as taking account of the interests and ensuring the consistency of conditions for the functioning of clusters, forming the regional «points of growth». Regional clustering is often used as a fashionable notion that characterizes such well-known phenomena, as well as industrial areas, specialized or territorial industrial complexes and local production systems.

However, in our view, the regional cluster can be defined not only as a geographically bounded concentration of interconnected companies, which reflects the trend of concentration of economic activity in a particular sector of the regional economy. The main goal of the cluster is modernization of the regional space, creation of innovative vertical and horizontal networks, including in the sphere of the use of resources, resource saving and waste processing, environmental modernization of production.

Cluster interactions architecture is formed under the influence of a number of factors that determine the internal environment of the region. Among these factors, resources and capital territorial space, the degree of integration of the territorial entities and the infrastructure.

Local «poles of growth» in the Krasnodar territory, related to the territorial competitive advantages and laid down in the cluster formations, are the agro-industrial, tourist and transport-and-logistics complexes. The development of the sectors excluding the environmental component of a high cross-cutting externalities, leads to a conflict of interests in the use of natural resources in the near future, can be the reason of decrease in investment attractiveness of the area. The competitiveness of the regional cluster formations can be ensured only through the introduction of innovative technologies, environmental management systems, environmental marketing, environmental technology, allowing providing the interaction between economic development and environmental protection at the region level.

Moreover, for the analyzed clusters there is a common trend of economic development without detriment to the environment: it is a «green building», renewable energy, clean transport, provision of needs for clean water, the construction of new industrial and information infrastructure. Because a successful transition to the model of «green» economy ultimately depends on technological innovations, it is precisely at the level of the cluster have the chance to create environment industry and take advantage of the increasing consumer demand for improved environmental quality.

State support of projects of the «green economy», including tax incentives, the tightening of the technical regulations, loans for scientific-research activities, demonstration projects, as well as «greening» of the state of the infrastructure will serve as a catalyst for the formation of «green» cluster of the regional economy, pointing in the direction of capital, technology and labor, will create a demand for special studies, system of education and training of specialists for «green industries». Creation of new regional «points of growth» to «green» the basis of need, not only for the optimization of existing cluster interactions, prevent the effects of excessive use of natural resources, depletion of ecosystems, but also for creation and consolidation of a wide spectrum of well-paid innovative jobs. The core of the «green cluster may become a sphere of energy efficiency and alternative energy, to whose development in the region have all the necessary conditions and prerequisites.

For different regions the tasks in this sphere and ways of their solution will be different. The only general trend should be «decoupling effect» - division of the trends of GRP growth and changes in consumption of natural resources. The goal of regional management should not be an abstract «improving of the environment», but progressive structural shifts in the regional economic system.

Green structural shifts can be expressed in the dynamics of the quantitative indicators. For the foundation of such a system of indicators the methodology of indicators of sustainable development can be taken, the proposed Statistical Secretariat of the United Nations. Although given the diversity of conditions of Russian regions, the indicators should be specified for each of them.

To change the «green» quantitative indicators will acquire the features of a structural shift and will become irreversible only in the case if there is a change of quantity of shares and proportions of at least between the two indicators will be accompanied by a change of economic interests and the needs of economic entities.

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Socially Economical and Ecological Aspects of the Interactivity of Development of Cities and Regions

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Keywords **– city, regions, ecological aspects, Environment and Sustainable Development**

I. INTRODUCTION

Cities, which have emerged in regional areas, perform catalyst functions of the development of entire region. Taking into account the production concentration and specialization, population density and more modern infrastructure, urban land, labor and other production resources are used more efficiently if compared to rural areas.

Interaction between urban and rural development is included in the study because the resources necessary for urban development, mainly, land and labor, are attracted from the rural areas in return for new jobs and modern social infrastructure. Ecology is an important aspect of this development interaction. The rural areas, in particular, its fertile soils, its forests and waters largely absorb CO_2 - the most important gas that causes greenhouse effect and amortizes other adverse effects of the city on the environment. In the age of globalization of economic development and ecological problems, it is important for Latvia to facilitate balanced urban-rural interaction between socio-economic and ecological context of the development in each region in accordance with sustainable development principles.

II. THEORETICAL ASPECTS OF URBAN AND RURAL DEVELOPMENT INTERACTION

Most important socio-economic and ecological aspects urban and rural development interaction are defined, quantitative and qualitative dimensions used in its valuation are determined and the main socio-economic and environmental regional development issues in Latvia are identified, its quantitative and qualitative characteristics is developed.

III. ENVIRONMENTAL ASPECTS OF URBAN AND RURAL DEVELOPMENT INTERACTION

The impact of social, economic and ecological development on development of other regions and cities is assessed, states the nature and trends of this impact and development of ecological interaction between urban and rural areas is determined.

Quality of modern people living environment - urban or rural environment is an essential indicator of person's welfare. Living environment develops and changes as a result of interaction between a man and a nature. It is important to point out that development of modern urban and regional rural areas there has an impact on almost all environmental components - atmosphere, water, soil, terrain, landscape, climate, flora and fauna, etc. In the areas of settlement, a man constantly is trying to modify and customize surrounding natural environment according to his social and economic needs, as well as in accordance with his understanding and vision of appropriate environmental conditions for living, carrying out economic activities and suitable for recreation.

In line with Latvia's socially economic development and the country's integration into the European Union and consequently, in global business, continuous changes in the development of rural and urban interaction, which inevitably affects the sustainable growth of the country, including environment protection, environmental problems and the quality of environment in populated areas. Therefore, identification, evaluation as well as quantitative and qualitative characteristics of the development aspects of environmental interaction between cities and rural, areas becomes important. For this purpose, within the framework of this study, a model of ecological interaction between large cities and rural areas is developed.

IV. CONCLUSIONS AND PROPOSALS

Quantitative and qualitative dimensions of socio-economic and ecological aspects characterizing the development interaction of major cities and rural areas located in the regions of Latvia shall be used for elaboration of the sustainable development concept for the entire territory of Latvia.

Fiscal proposals for reducing urban and rural development disparities, taking into account the socio-economic and ecological aspects of interaction shall be used for elaboration of the sustainable development strategy for the country.

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Main directions of the Russian ecological policy: a look after «Rio + 20»

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***Keywords* – ecological policy, sustainable development.**

I. Introduction

In recent years Russia shows considerable efforts on transition to principles of «green economy» and «green growth».

On the eve of the World summit of the United Nations on a sustainable development in Rio de Janeiro the President of Russia «bases of a state policy in the field of ecological development of Russia for the period till 2030» which define the purposes, tasks and mechanisms of realization of ecological policy of the country on prospect (30.03.2012) were approved.

II. Ecological Policy

Questions of formation of the realization's mechanism of ecological policy of the country on prospect in a context of solutions of the World summit of "Rio+20" are considered. The main attention is given to development of steady models of production and consumption which will allow to provide stable growth of economy and to remove threats for environment.

The directions of innovative growth and growth of power effective, "green" economy in Russia that is connected also with management of climatic changes and ensuring quality of life, environmental and social standards of population's life locate.

Thus it is necessary to recognize that careful attitude to the nature becomes one of obligatory factors of implementation of large industrial and infrastructure projects, a factor which finally in the future will define competitiveness of economy.

Strategic objective of a state policy in the field of ecological development is the solution of the social and economic tasks providing ecologically focused growth of economy, preservation of favorable environment, biological diversity and natural resources for satisfaction of requirements present and future generations.

Achievement of a strategic objective of a state policy in the field of ecological development is provided with the solution of such tasks, as:

a) a) improvement of standard legal support of environmental protection and ecological safety;
b) ensuring ecologically focused growth of economy and introduction of ecologically effective innovative technologies;
c) prevention and decrease in the current negative impact on environment;
d) restoration of the broken natural ecological systems;
e) ensuring ecologically safe handling of a waste;
f) environment preservation, including natural ecological systems, objects of an animal and flora;
g) development of economic regulation and market instruments of environmental protection and ensuring ecological safety;
h) ensuring effective participation of citizens, business communities in the solution of the questions connected with environmental protection and ensuring of ecological safety, etc.

At the solution of formation's problem of an effective control system in the field of environmental protection and ensuring ecological safety, ensuring ecologically focused growth of economy and introduction of ecologically effective innovative technologies such mechanisms, as introduction in a control system of quality of environment of methodology of definition and an assessment of ecological risks for the purpose of increase of validity of adoption of administrative decisions, formation of the effective, competitive and ecologically focused model of development of the economy providing the greatest effect at preservation of environment, its rational use and minimization of negative impact on environment, in particular, are provided, etc.

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Personal income changes in the long term and its influence on housing fund development in Latvia

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***Keywords* – housing fund, personal income, demographic changes, people's needs.**

I. Introduction

Real estate market sharply responds to changes in such economic indicators as income level and stability, purchasing power of inhabitants, employment of working age population, their migration, etc.

Analysis of the demographic situation covers a sufficiently wide range of issues. Changes in the number of population, age and the chosen profession, territorial division and preconditions for a possible migration can be considered to be the most significant ones.

II. Population Structure and Income Influencing Factors

The most important risk for the development of real estate market in Latvia is the demographic changes - decline in population and its aging, which in the long-term is considered to be the most serious problem.

Demographic change is a reality in the European Union, and the response to them is one of the main future challenges. In majority of the Member States, there is a decline in the birth rate, while the life expectancy is increasing. According to the Eurostat estimates regarding the EU citizens, in 2050 the significant changes in the population's age structure can be foreseen, mainly because of increasing the number of people in the age of more than 60 years. This way of aging also leads to economic, social and society changes. [2]

TABLE I
LIFE EXPECTANCY (YEARS)

	2008	2020	2030	2040	2050	2060
From birth						
man	67,2	68,1	71,3	72,9	74,2	75,1
woman	77,9	78,8	81,0	82,0	82,7	83,3
in the age of 60						
man	75,6	77,0	79,2	80,2	81,1	81,7
woman	81,7	82,4	84,0	84,7	85,3	85,8
in the age of 65						
man	77,9	79,4	81,3	82,2	83,0	83,5
woman	82,8	83,5	84,9	85,6	86,2	86,6

Compared with other EU countries, in Latvia there is one of the lowest contribution rates in the EU, including the lowest among the three Baltic countries. Contribution rate directly correlates with the ability of the employees of each country to pay for a high level of social security (for example, in Germany the social contribution rate in 2008 was 39.42% and expenditure on social security - 27.60% of the GDP, while in Latvia - 16.9%). [14] [9]

In 2009 when the economic situation of the country rapidly became worse, unemployment increased and income of working population decreased, revenue in the special budget also reduced, leading to the situation that in 2009 the revenues did not cover budgetary expenses, therefore, in order to cover the expenditure, financial reserves accumulated during the previous years were started to be used (see Fig. 1). [14]

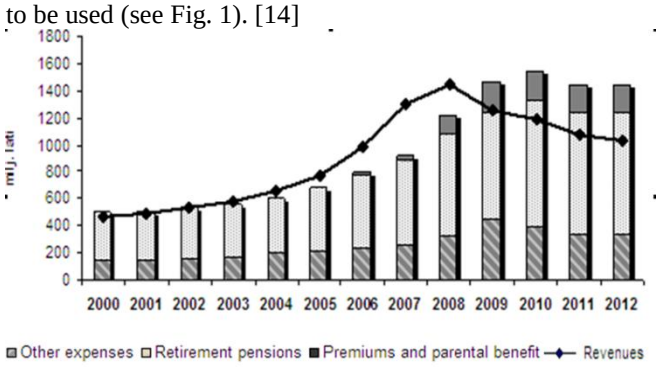

Fig. 1. Special budget of social insurance

III. Development Opportunities of the Housing Fund in the Long-Term

Due to the limited housing fund adapted for low-income persons and persons with special needs, it can be identified that the highest need is for the social houses and residential buildings with appropriate infrastructure which would provide care and availability of other services.

IV. Conclusions and Proposals

To identify people who are the most disadvantaged and in the most unfavorable situation and to provide them the necessary support in carrying out measures aimed at the solution of specific problems in the respective risk group. In order to implement this concept, it is intended to use grants allocated for social needs, which would allow local governments to build apartments not only for individuals and households with a certain level of income, but ensure provision of housing also for those who are disadvantaged and have problems with access to the housing, not only because of their low income, but also due to their health problems, age or other unfavorable life circumstances.

Extending the choice of the place of living for the people at the retirement age with low-income is a forced necessity that shall be considered and implemented immediately. The afore-mentioned projects provide the most efficient use of limited areas, labor and capital resources, thus increasing the level of public welfare.

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