ISSN 1407-7493 COMPUTER SCIENCE DATORZINĀTNE 2008-34

APPLIED COMPUTER SYSTEMS
LIETIŠĶĀS DATORSISTĒMAS

FORESIGHT PROCESS MODELLING

FORSAITA PROCESA MODELĒŠANA

Dace Apšvalka, *Riga Technical University,*
Department of Systems Theory and Design,
1 Kalku, Riga, LV-1658, Latvia, researcher, M.sc.ing.,
dace.apshvalka@gmail.com

Dace Doniņa, *Riga Technical University*
Department of Systems Theory and Design,
1 Kalku, Riga, LV-1658, Latvia, dacelim@yahoo.co.uk

Mārīte Kirikova, *Riga Technical University,*
Department of Systems Theory and Design,
1 Kalku, Riga, LV-1658, Latvia, associated proffesor, Dr.sc.ing.,
Marite.Kirikova@cs.rtu.lv

Foresight, knowledge-intensive process, modelling, cognitive-social

1. Introduction

Modern world has become complex and rapidly changing. Adaptation to changing environment and ability to cope with complexity is crucial for sustainable competitive capacity both for individuals and business organizations, as well as for universities and government institutions. However, to succeed in the modern world, it is not enough to be adaptive to the current changes in the environment. It is necessary to foresee possible changes to be able to overtake competitors and to avoid disasters.

A new discipline called Foresight has emerged during the last few years. Foresight is about bringing together experts from different areas and stakeholders interested in particular projects to work together on making a 'big picture' by thinking, debating and shaping the future to be able to set priorities and make decisions in specific areas of interest [1]. A wide spectrum of expertise and interests help them to deal with problem complexity and to see how one thing influences another.

Foresight process is knowledge-intensive process, which means that the value of a process can only be created from the knowledge of process participants. Results of a Foresight

process depend on knowledge of many different participants, their communication, collaboration, and understanding.

In this paper, we discuss Foresight process as a knowledge-intensive process and cognitive-social modelling approach for modelling Foresight process. Our research is focused on knowledge and knowledge related processes within individuals and groups in a Foresight process.

2. Foresight process

The term *Foresight* has been used increasingly in a specific way since the late 1980s and currently has become fashionable [1, 2].

Foresight is not predicting the future or trying to guess the future. Foresight is shaping the future. It is about deciding what actions to take today to create the best possible future. To decide about the best actions for the future, it is necessary to develop and to understand a range of views of possible ways in which the future could develop. In that context future is not something predetermined, but something we can build ourselves. It is about acting today to create the tomorrow. As it is defined in the Foresight literature, the main activities in the Foresight process are thinking, debating, and shaping the future [1].

Every organization exists in a specific physical, technological, cultural, and social environment to which it must adapt. Environment is the source of the inputs to be proceeded by the organization, just as it is "sink" to which all outputs are delivered. Organizations not only are influenced by but also affect their environments [3]. Therefore to shape the future for a particular organization, one needs to see the possible ways how organization's environment and interrelated systems can develop and to understand how these developments will influence the organization and how the organization could influence these developments. Consequently, to understand future developments of interrelated systems, it is necessary to work together with experts from these systems, to learn together with them how these interrelated systems could influence each other in future to make the best outcome for all of them.

Because of that, Foresight activities involve a number of different groups of actors from multiple domains (systems). Foresight is much about collaboration between a wide set of actors. They all come together and through thinking, debating, knowledge and insight sharing are trying to create a common view about current situation and to identify possible future situations, to imagine desirable future situations and to define strategies to be able to meet desirable future in both global (set of interrelated systems) and local (their specific systems) areas of interest. Therefore Foresight is also about widening social networks. As Foresight process involves wide set of different actors and wide range of domains and social networks, it is very complex process.

Based on the literature [1, 2] we can outline four main phases in Foresight process: knowledge gathering, knowledge interpretation, knowledge assimilation, and action (see Figure 1).

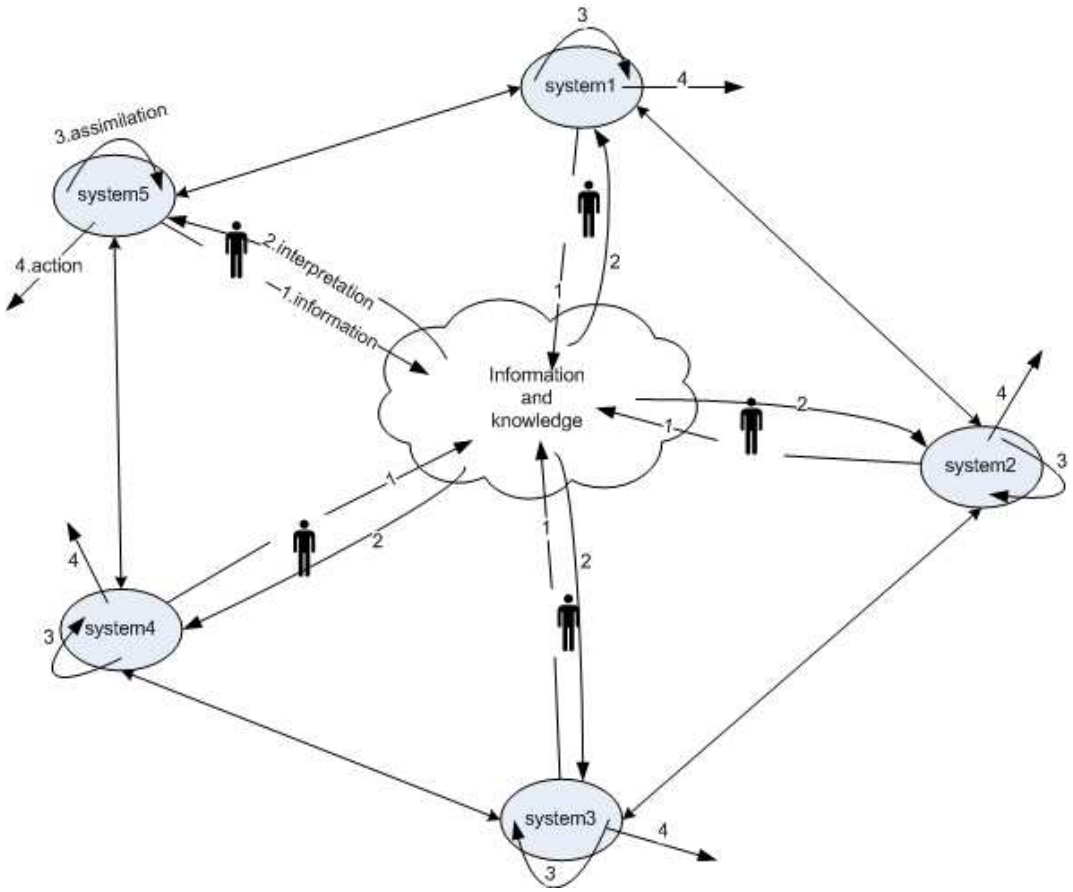

Figure 1. General Foresight process with four phases

Figure 1 represents Foresight process where participants from different organizations (systems) come together and share information of each other's knowledge resources, strategic orientations, and visions of the future (phase 1). Further, participants interpret gathered knowledge and bring it to their organizations (phase 2) where it is assimilated (phase 3) and certain actions are performed (phase 4).

Phase 1: Knowledge gathering

Foresight process starts with bringing together a wide range of sources of knowledge, such as experts, business networks, personal networks, customers, suppliers, the literature, research, and surveys. Information on futures themes, trends, ideas, and viewpoints etc. is collected from these sources.

Different experts (agents) are brought together to share their knowledge and to develop strategic visions and anticipatory intelligence. Structured approaches are employed to focus on long-term social, economic and technological developments and the challenges they pose; feasible and desirable options are explored. The methods of analysis are interactive and participative [1].

The major characteristics of gathered knowledge and information are that it is very broad in scope, overlapping, and often contradictory. The collected information is summarised in order to present it in a manageable form. There are general methodologies and processes available such as scenario building, list writing and prioritising, graphical comparisons, cross impact analysis etc. [2].

Phase2 : Knowledge interpretation

The gathered knowledge needs to be converted into understanding. This requires interpretation into issues, road maps, views, priorities, or scenarios of the futures that are relevant and specific to the particular system (or organization). Participants from different domains need to understand what all this means for their organizations, what can they do about it today. Interpretation of gathered knowledge is about generating various possible futures views for a particular organization. There is at present no methodology for doing this and it is extremely difficult to do [2]. It is always assumed that managers somehow automatically realise what a change in the future business environment means for the future of their business. They do not. Third parties are essential to interpretation. The managers of the business can provide the business knowledge but a third party is needed to facilitate the processes of creative and lateral thinking, to ask difficult questions, and to help managers to think outside-the-box. A good interpretation will yield a list of strategies and actions which can be taken today to address various possible futures which have been revealed. Interpretation is in fact translating from an understanding of possible tomorrows into an understanding of actions which can be taken today [2].

Phase 3: Knowledge assimilation

The understanding generated in Phase 2 needs to be assimilated by those whose job it is to carry out the resulting actions. This is why the Foresight process cannot be done for business by someone else; going through the process generates not just ownership of the outcome, but also facilitates assimilation and commitment. However, it is usually impractical for everyone in a business to be involved in the Foresight process and much of the outcome will still need to be communicated to a wider audience [2].

For communicating the results of the Foresight process to managers written reports are unlikely to be effective. Seminars, workshops, and informal networks will work better, because it is impossible to precisely codify all Foresight outcomes. Most important outcomes will remain tacit, as Foresight output tends to be much less absolute and guaranteed than the content of most business reports. The future is never predictable in any way and the communication of Foresight results needs to have this uncertainty at its centre [2]. This is not the usual way in which business information is presented, and a better understanding of subjects such as cognitive science may be required here to understand how tacit knowledge and understanding is passed among people.

Phase 4: Action

The understanding generated in Phase 2 is of no value unless it gets to the right person, is assimilated, and unless a commitment to actions develops. This last phase the only place at which the value of all the foregoing work can be realised. As with all business decisions, the feedback from those actions can be slow and this is especially the case with Foresight which is inherently longer term [2].

The formal results of the Foresight process may include such outputs as scenarios, action plans, priority lists. Another type of output is more informal, but can equally be part of the explicit objectives of Foresight. It involves the establishment of networks among the agents concerned. These networks should allow for members to share awareness of each other's knowledge resources, strategic orientations, and visions of the future [1].

3. Foresight as a knowledge-intensive process

As Foresight process involves wide set of different stakeholders and wide set of research areas, the whole Foresight is very complex and is a knowledge intensive process. In a knowledge-intensive process dominant resource is not labour or capital, but knowledge. Typically such process is non-routinised, dominated by information processing, dependent upon the knowledge and motivation of workers, demanding interdisciplinary and cross-functional cooperation. Knowledge-intensive process is process in which knowledge is used to make decisions or create an output [4], and the value of the process can only be created through the fulfilment of the knowledge requirements of the process participants [3].

Table 1 defines attributes of knowledge-intensive processes. These attributes are summarized from the knowledge-intensive process literature [3] and [6].

Table 1. Attributes of knowledge intensive processes

1.	Attribute	Description
2.	**Contingency**	Knowledge-intensive processes depend on numerous eventualities (i.e. contingency of political influence).
3.	**Decision scope**	The agent has several possibilities how decisions in process can be made. They can decide autonomously.
4.	**Agent innovation**	When agent is solving the problem, he must do it creatively and with innovation.
5.	**Half-life**	The knowledge that an agent needs must be updated often because it obsoletes quickly.
6.	**Agent impact**	Agent has major impact on the outcomes of a process.
7.	**Learning time**	Agent needs a long time to learn skills that he needs to solve the problems.
8.	**Not clear event flow**	The event flow is no clear from the very beginning. It can change during the process.
9.	**Actors from multiple domains**	Many actors have different knowledge from multiple domains at different levels.
10.	**Lack of metrics**	Processes often lack metrics for rating the success of the process.
11.	**Not complex IT-support**	IT-support for processes is often not very complex.
12.	**High level communication**	In the process, communication is concerned with information exchanges between agents.
13.	**New knowledge**	Process must produce or add new knowledge.

Foresight process corresponds to all attributes described in Table 1 and therefore classifies as knowledge-intensive process. In a knowledge-intensive process knowledge flows are vague and unstructured and cannot be modelled by conventional modelling tools. Important elements like the representation of tacit knowledge or the creation of knowledge through conversions cannot be modelled [6]. Therefore for modelling Foresight process it is necessary to use special modelling methods.

4. Modelling knowledge-intensive processes

Modelling is a way how to manage complexity. Models are explicit representations of some portions of reality and help to understand the reality, to experiment with it and analyze it. For better understanding of complex Foresight process, it is necessary to develop a process model. Such model would help to understand different knowledge flows within a process to analyze and decide how to organize Foresight exercises to achieve the best results.
One methods of knowledge-intensive process modelling is describing the process in Knowledge Modelling and Description Language (KMDL).

When modelling knowledge intensive processes it is necessary to divide tacit knowledge and explicit knowledge. Tacit knowledge is personal knowledge that cannot be easy shared. Such knowledge can be mental models, beliefs, understandings, and perspectives. However explicit knowledge can be easy shared and communicated. Such knowledge can be formal, codified, knowledge in handbooks, and papers. KMDL supports both explicit and tacit knowledge modelling [6, 7] and modelling knowledge-intensive processes as sequence of tasks with knowledge flows and transformations in and between them [8].

KMDL uses six objects to model knowledge intensive processes (see Figure 2):

- Tasks
- Information object
- Knowledge object
- Person
- Role
- Role requirement

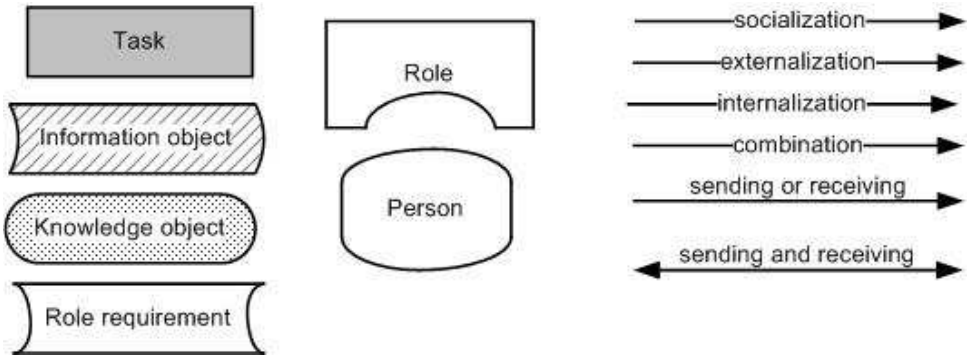

Figure 2. KMDL associations and objects [7]

For describing sequence of business processes KMDL uses tasks. There must be certain information as input for starting to execute the task. Task generates information as output or result. The information object is used as any information or explicit knowledge. Roles execute tasks. Roles can be assigned to several persons. This gives chance to model whole personal company structure. Each task needs certain skills to be solved. Theses skills determine requirements that the role, assigned to appropriate task, must have. Role requirements define the tacit knowledge which is needed to complete the task assigned to the role and to generate the output using specific input. Every requirement is a tacit knowledge object of role. The person who performs a task is assigned to a role and the knowledge objects (tacit knowledge)

are attached to this person. Knowledge objects are used to track the knowledge objects of a person that are relevant to process. Each knowledge object is linked to a person and is personal [6, 7, 8].

In addition, KMDL makes it possible to visualize four types of knowledge conversion (see Figure 2). These four types come from Nonaka and Takeuchi knowledge conversion model [9] which has become very popular among Knowledge Management researchers and practitioners. These types are as follows:

- Socialization – conversion from tacit knowledge of one person to tacit knowledge of another person. Often it is done by sharing experience. Socialization begins at one knowledge object of one person and ends at knowledge object of another person.
- Externalization – conversion of tacit knowledge into explicit knowledge. Externalization begins at least with one knowledge object and ends with an information object.
- Internalization – conversion of explicit knowledge into tacit knowledge. Internalization begins at information object and ends with a knowledge object.
- Combination – conversion from explicit knowledge to explicit knowledge. Combination begins at least with two information objects and generates new information object.

In Figure 3 we give generalized and abstract Foresight process model written in KMDL language.

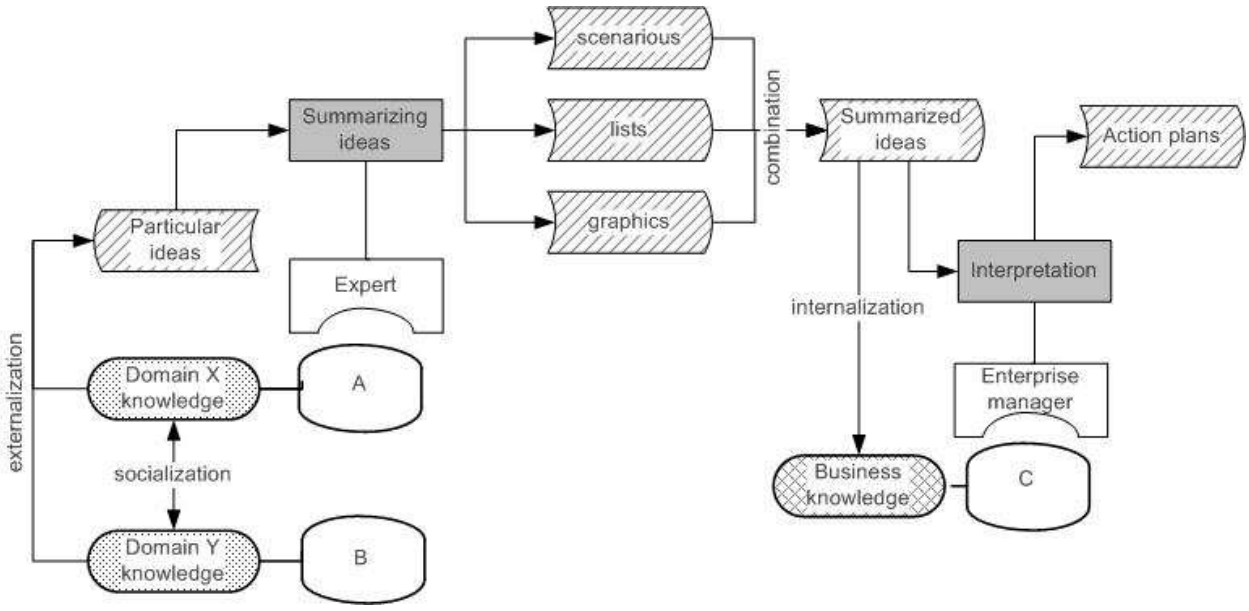

Figure 3. Generalized Foresight process model

Model in Figure 3 represents that there are two experts (role) A and B (persons) who are responsible for summarizing ideas (task). They socialize and share their domain specific knowledge (knowledge object). They make some of their shared knowledge explicit by externalizing their visions and understandings and defining particular ideas (information object). Socialization between these two experts and externalization of their knowledge is

needed to perform the 'Summarizing ideas' task. Within this task they produce scenarios, lists, and graphics (information objects) which are combined together and the final summary of ideas (information object) are produced. The summary of ideas is passed to enterprise manager (role) C (person) who is responsible for the interpretation of these ideas to be able to assimilate them and put into action. To be able to interpret the summary, he needs to internalize it into his understandings and knowledge about business processes (knowledge object). Based on his interpretation, particular action plans (information object) will be developed.

Detailed model of Foresight process helps to understand different tasks, roles, and information and knowledge flows for particular Foresight exercise. This will help to decide about particular steps how to carry out the Foresight process and about what methodologies to use.

However, although KMDL is appropriate for modelling tacit and explicit knowledge flows in knowledge-intensive process, it does not provide understanding how knowledge is processed and how decisions are made in the main knowledge processors – humans. KMDL model does not specify how tacit knowledge and understanding is passed among people.

The main resource of the Foresight process is people and their knowledge and the success of the Foresight process depends on communication and collaboration among process participants. Therefore better understanding of how knowledge is processed inside the person and how understanding is passed among people is needed to understand many important factors required for successful Foresight process. For example, factors influencing human openness, trust, creativity, comprehension and decision-making. To model and understand such factors flexible and interactive approaches of modelling human cognitive and social processes are needed. These requirements can be met by modelling human interaction as multi-agent system.

4. Modelling Foresight as cognitive-social multi-agent system

Multi-agent system is a community of autonomous entities each of which perceives, decides, and acts on its own, in accordance with its own interest, but may also cooperate with others to achieve common goals and objectives [10].

In the context of Foresight process, all involved participants can be seen as agents forming society of agents or multi-agent system. Apart from that, each of these agents has their own unique knowledge. As knowledge is the most important resource in the Foresight process, and as we want to understand how knowledge is processed inside individual agents and how knowledge is passed among different agents, we need better understanding of knowledge to be able to model it within a multi-agent system.

Human knowledge is something personal and resides in human mind [11]. The traditional model of human mind is expressed by three basic human mental processes: cognition, emotion, and motivation. The original source of this structure comes from Plato who was arguing for a tripartite structure of the human soul [12]. Based on the traditional view of mind, human knowledge can be represented as residing in a three dimensional space, where cognition, emotion, and motivation are three dimensions of knowledge space [13]. The three dimensions affect each other and are closely interwoven. Each process pervades the other to a great extent. The same external stimulus results in responses from all three processes. None of the three exists in a vacuum without the other two. Since knowledge is at least cognitively based, it is impossible to know something without having an affect and conative (motivational) reaction to it, these reactions adding to and becoming a part of knowledge [13].

Based on that theory of human knowledge, agents in a multi-agent Foresight simulation system must have these three dimensions attached to their knowledge base. Namely, each agent must have its cognitive system consisting of such components as cognition, emotion, and motivation. The parameter values of these components are changing over time and in different situations, same as human beings are not in the same emotional state forever or in the same emotional state when meeting friend and when meeting enemy. Because of these changes the same input at different points of time may lead to different outputs depending on the agent's personal state in the given time. As well, different agents may react differently to the same input depending on their current personal state. Apart from that, in a multi-agent system dynamic relationships are formed among different agents and these relationships initiate changes in their personal states and behaviour. To understand Foresight process and to model it as a multi-agent system, we need to understand both cognitive processes and social processes. Therefore multi-agent Foresight simulation system is not only cognitive system or social system. It is both cognitive and social or so called cognitive-social system.

Modelling Foresight as cognitive-social system and implementing it as a multi-agent simulation can help to test and experiment with a process model written in KMDL language (see Figure 3) and to look inside the 'minds' of process performers (see Figure 4) to analyze how knowledge is processed and shared.

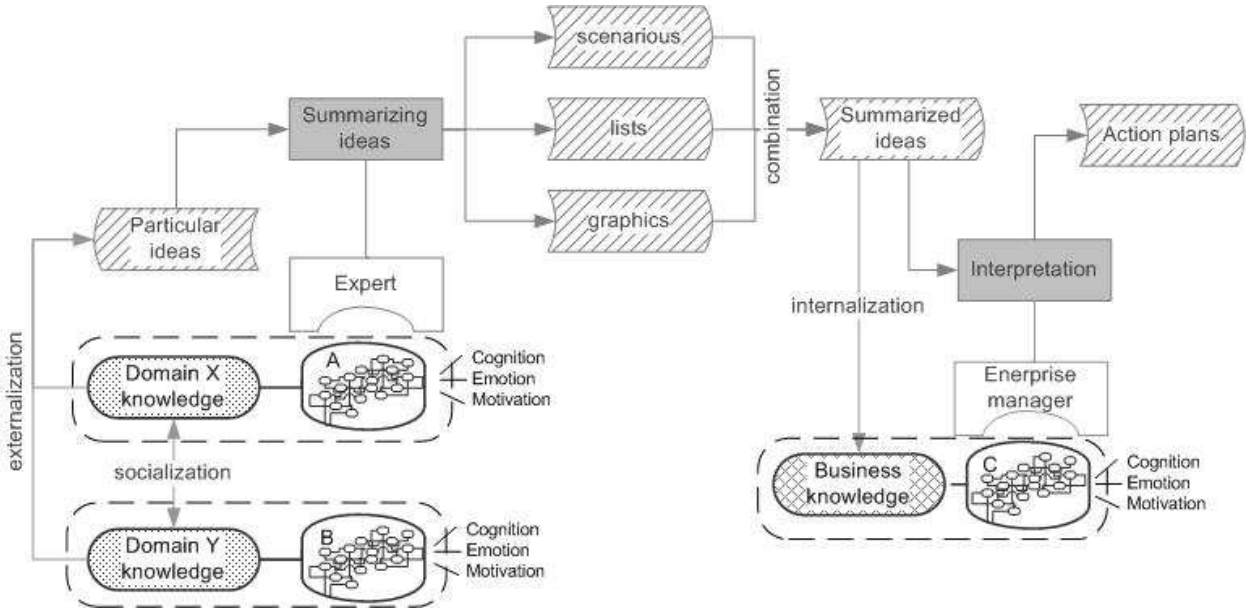

Figure 4. Cognitive-social Foresight process model

5. Conclusion

In a rapidly changing and complex environment where many different systems influence each other organizations need to foresee possible changes to be able to adapt to them and make the best use of them. Foresight is about bringing together experts from different areas and shaping the future. Experts come together and through thinking, debating, knowledge and insight sharing are trying to create a common view about current situation and trying to identify possible future situations. They define strategies for meeting the desirable future in both

global and local areas of interest. Foresight process consists of four main phases: knowledge gathering, knowledge interpretation, knowledge assimilation, and action.

Foresight is knowledge-intensive process as it is non-routinised, dominated by information processing, dependent upon the knowledge and motivation of workers, and demanding interdisciplinary and cross-functional cooperation. In a knowledge-intensive process knowledge flows are vague and unstructured and cannot be modelled by conventional modelling tools. Knowledge Modelling and Description Language (KMDL) is well appropriate for modelling Foresight process. KMDL supports both explicit and tacit knowledge modelling and modelling knowledge-intensive processes as sequence of tasks with knowledge flows and transformations in and between them.

However, KMDL does not provide understanding of how knowledge is processed and how decisions are made in the main knowledge processors – humans and how tacit knowledge and understanding is passed among people. To provide this understanding, Foresight should be modelled as cognitive-social multi-agent system. In a cognitive-social multi-agent system each agent has its own cognitive system consisting of such components as cognition, emotion, and motivation which influence agent's knowledge and behaviour.

In this paper we have described theoretical framework for Foresight process modelling. Our further research will be oriented on developing cognitive-social multi-agent pilot system and running simple knowledge-intensive process described in KMDL.

KMDL and cognitive-social multi-agent system modelling approach is appropriate not only for Foresight process modelling but for any knowledge-intensive process modelling. Benefit of developing process simulation is that it helps to think systematically about the particular process and corresponding cognitive and social processes. It also gives possibility to experiment with different variables and to present results in detailed graphical form, graphs, charts etc., allowing a comparison of results for different times or conditions.

References

1. European Foundation for the Improvement of Living and Working Conditions. Handbook of Knowledge Society Foresight, 2003.
Online: http://www.eurofound.europa.eu/pubdocs/2003/50/en/1/ef0350en.pdf
2. Horton, A. A Model for a Successful Foresight Process // In: FORESIGHT Journal, http://www.alpha2omega.co.uk/, Vol. 1 pp.5, 1999.
3. Scott, W.R., Organizations: Rational, Natural and Open Systems // In: 4th ed., Prentice-Hall, Englewood Cliffs, NJ, 1998.
4. van Leijen, H., Baets, W.R.J. A Cognitive Framework for Reengineering Knowledge-intensive Processes // In: Proceedings of the 36th Annual Hawaii International Conference on System Sciences (HICSS'03) - Track 3 - Volume 3, 2003.
5. Richter-von Hagen, C., Ratz, D., Povalej, R. Towards Self-Organizing Knowledge Intensive Processes // In: Journal of Universal Knowledge Management, vol. 0, no. 2, 148-169, 2005.
6. Gronau, N., Müller, C., Uslar, M. The KMDL Knowledge Management Approach: Integrating Knowledge Conversions and Business Process Modeling // In: Karagiannis, D.; Reimer, U. (Hrsg.): Practical aspects of knowledge management : 5th international conference ; proceedings / PAKM 2004, Vienna, Austria, December 2 - 3, Springer, 2004.
7. Bogen J., Gronau N., Schmid S. Improvement of software engineering by modeling of knowledge intensive business processes. Technical Report, WI 12/2005.
8. Bahrs J., Gronau N., Müller C. Evaluation of KMDL models of knowledge intensive business processes in the area of software engineering // In: Proceedings of I-Know '05, Graz (Austria), 2005.

9. Nonaka, I. & Takeuchi, H. The Knowledge-Creating Company. New York, Oxford University Press, 1995.
10. Sun R. (ed.) Cognition and Multi-Agent Interaction, Cambridge University Press, 2006.
11. Davenport, T.H. & Prusak L. Working Knowledge. MA: Harvard Business School Press, 1998.
12. Davidson R. J., Goldsmith H. & Scherer K. R. (Eds.) Handbook of the Affective Sciences. New York and Oxford: Oxford University Press, 2003.
13. Meredith, R., May, D., Piorun, J. Looking at Knowledge in Three Dimensions. An Holistic Approach to DSS Through Knowledge Management // In: Monashh DSS Lab Publication, http://dsslab.sims.monash.edu.au, 2000.

Apšvalka D., Donina D., Kirikova M. Forsaita procesa modelēšana

Mūsdienu pasaule ir kļuvusi sarežģīta un strauji mainīga. Pielāgošanās strauji mainīgajai videi un spēja tikt galā ar sarežģītību ir kritiska pastāvīgai konkurētspējai gan indivīdiem, gan biznesa organizācijām. Tomēr, lai gūtu sekmes mūsdienu pasaulē, nepietiek tikai ar spējām adaptēties pašreizējajām izmaiņām. Ir nepieciešams paredzēt iespējamās izmaiņas, lai spētu apsteigt konkurentus un izvairīties no neveiksmēm.

Pēdējos gados ir radusies jauna disciplīna – forsaits. Forsaita procesā tiek pulcināti kopā dažādu sfēru eksperti un ieinteresētie, kuri domā, debatē un veido nākotnes „lielo bildi", lai spētu noteikt prioritātes un pieņemt lēmumus specifiskās savu interešu sfērās. Plašais ekspertīzes un interešu loks palīdz viņiem risināt problēmu sarežģītību un saskatīt, kā viena lieta ietekmē citas.

Šai rakstā mēs apskatām forsaita procesu kā zināšanu intensīvu procesu un kognitīvsociālās modelēšanas pieeju forsaita procesa modelēšanā. Mūsu pētījums ir orientēts uz zināšanām un zināšanu procesiem, kas norit indivīdos un grupās forsaita procesa ietvaros.

Apshvalka D., Donina D., Kirikova M. Foresight Process Modelling

Modern world has become complex and rapidly changing. Adaptation to changing environment and ability to cope with complexity is crucial for sustainable competitive capacity both for individuals and business organizations. However, to succeed in the modern world, it is not enough to be adaptive to the current changes in the environment. It is necessary to foresee possible changes to be able to overtake competitors and to avoid disasters.

A new discipline called Foresight has emerged during the last few years. Foresight is about bringing together experts from different areas and stakeholders interested in particular projects to work together on making a 'big picture' by thinking, debating and shaping the future to be able to set priorities and make decisions in specific areas of interest. A wide spectrum of expertise and interests help them to deal with problem complexity and to see how one thing influences another.

In this paper, we discuss Foresight process as a knowledge-intensive process. We also discuss cognitive-social modelling approach for modelling Foresight process. Our research is focused on knowledge and knowledge related processes within individuals and groups in a Foresight process.

Апшвалка Д., Донина Д., Кирикова М. Моделирование процеса форсайта

Современный мир стал сложным и быстро изменяется. Адаптация к изменяющейся окружающей среде и способность справляться со сложностью является критической для жизнеспособной и конкурентоспособной возможности людей и деловых организаций. Однако, чтобы преуспеть в современном мире, недостаточно быть адаптивным к текущим изменениям в окружающей среде. Необходимо предвидеть возможные изменения, чтобы быть в состоянии опередить конкурентов и избежать бедствий.

Новая дисциплина с названием Форсайт (предвидение) появилась в течение нескольких прошлых лет. Форсайт – это сотрудничуство экспертов из различных областей и заитересованных лиц из проектов для создания „большой картины", думая, дебатируя и формируя будущее, чтобы быть способными установить приоритеты и принять решения в определенных областях интереса. Широкий спектр знаний и интересов помогает им разрешать сложные проблемы и видеть, как одна вещь влияет на другую.

В этой статье, мы обсуждаем процесс форсайта как знанииемкий процесс. Мы также обсуждаем удобство и простоту использования познавательно-социального подхода моделирования для того, чтобы моделировать процесс форсайта. Наше исследование сосредоточено на знаниях и связанных со знаниями процессах между индивидами и группами в процессе форсайта.