RIGA TECHNICAL UNIVERSITY
Faculty of Mechanical Engineering, Transport and Aeronautics

INSTITUTE OF AERONAUTICS

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Doctoral Student of the Doctoral Study Program "Transport"

EVALUATION OF PROFESSIONALLY IMPORTANT QUALITIES OF AIRCRAFT MAINTENANCE PERSONNEL

Summary of the Doctoral Thesis

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The present Doctoral Thesis has been submitted for the defence at the open meeting of RTU Promotion Council on 23 March, 2017 – 15.00, at the Institute of Aeronautics, Riga Technical University, Lomonosova Street 1A, Building 1, Room 218.

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DECLARATION OF ACADEMIC INTEGRITY

I hereby declare that the Doctoral Thesis submitted for the review to Riga Technical University for the promotion to the scientific degree of Doctor of Engineering Sciences is my own and does not contain any unacknowledged material from any source. I confirm that the present Doctoral Thesis has not been submitted to any other university for the promotion to any other scientific degree.

Oleg Gorbacovs ..... (Signature)

Date: .....

The Doctoral Thesis has been written in Latvian. The Doctoral Thesis comprises an introduction, 5 chapters, conclusions, bibliography with 44 reference sources and 9 appendices. It has been illustrated by 46 figures and 24 tables. The total volume of the present Doctoral Thesis is 143 pages.

TABLE OF CONTENT

GENERAL DESCRIPTION OF THE PRESENT RESEARCH

Topicality of the Research

Aviation technical staff is of particular importance in addressing the major challenges in the aviation industry. The safety and regularity of flights in civil aviation largely depend on the qualitative training level of these professionals.

Dominance in the aviation market of several major manufacturers, such as Boeing, Airbus, Bombardier and others, unifies the requirements and standards for training of technicians, which is carried out on the basis of clearly established procedures in accordance with EU Council Regulation 1321/2014 Annex III, IV (Part-66, Part-147) [13].

Until the liquidation of Riga Aviation University in 1999, Latvia was the leading country in the training of highly qualified specialists (engineers) in the field of aviation engineering in Eastern Europe and a major training centre of specialists for many developing countries. At present, such training continues at the Institute of Aeronautics, RTU in accordance with the qualification standards that have been in force for more than 10 years [16]. The standards of these disciplines and regulations for the training of technicians and engineers list specific issues, knowledge of which forms competencies of the future experts necessary for the professional performance of duties related to aircraft maintenance in accordance with the specialty and the license. On the basis of these standards and guidelines, study programmes are implemented at higher education institutions.

The quality of the training process and graduates' professionalism is assessed on the basis of reviews, interviews, survey of airline executives, graduates, etc. However, such studies are virtually absent, as well as scientific approaches and technologies for their conduct. At the same time, the current level of advances in the information technology allows bringing this work to a new and effective level of assessment of conformity to the requirements of the aviation industry. The most important element of such a system should be a list of professionally important qualities of the technical staff based on the requirements of existing standards in this area.

First of all, the development of professionally important qualities is important for the training of engineers at the Institute of Aeronautics, RTU – the only higher education institution among the Eastern European countries of the European Union, where the engineering programmes have been operating for a long period of time and are combined with a modular training of technical personnel.

All the above-mentioned considerations determine the topicality of the Doctoral Thesis.

The Aim of the Research

The aim of the research is to develop theoretical and methodological approaches to the assessment of professionally important qualities of aviation technical staff and their impact on flight safety.

The Tasks of the Research

To achieve the aims of the research, the following tasks have been set:

- On the basis of a questionnaire, to develop a basic list of professionally important qualities of the aviation technical personnel.

- To develop a methodology for identifying professionally important qualities of the aviation technical specialists during training at an educational institution.
- To define and test a methodology for evaluating compliance of actual professionally important qualities of aviation technicians working at aviation enterprises after graduation from educational institutions with basic professionally important qualities in view of their posts, seniority, types of improvement of professional skills, etc.
- On the basis of mathematical modelling, to develop a model for the assessment of risks associated with changes in the activity of aviation technical personnel and the guilt of the individual specialist safety and regularity of flights of the airline.
- For real operating conditions of aircrafts, to develop a model of system for the management of risks associated with abnormalities in the work of the staff of the technical centre.

Methods of the Research

Wthin the framework of the present Thesis, the following research methods have been used: probability theory, mathematical statistics, mathematical processing of data and mathematical modeling using SPSS “Statistics”.

Thesis Statements

- Basic list of professionally important qualities of aviation technical personnel, which includes eligibility criteria and elements of the future work of the expert.
- Methods to identify professionally important qualities of aviation specialists in aircraft maintenance in the course of training at an educational institution.
- Assessment methodology for compliance of actual professionally important qualities of aviation technicians working at aviation enterprises after graduation with basic professional qualities important in view of their positions, seniority, types of training, etc.
- Risk assessment model associated with abnormalities in the activity of aviation technical personnel and guilt of a single expert, affecting the safety and regularity of flights of aircraft.
- Risk management system associated with abnormalities in the activity of the technical centre staff and reducing their effect on the safety and regularity of flights of aircraft.

Scientific Novelty

Identified the components of professionally important qualities for aviation technician and the dynamics of their formation in the process of learning and career.

Basic list of professionally important qualities of aviation technical experts and assessment methodology for compliance have been developed.

The model of the relationship of professionally important qualities of aircraft technicians and deviations in their work resulting in reduced safety and regularity of flights has been developed.

Research Results

Within the framework of the research, the following tasks have been performed:

- On the basis of a questionnaire, a basic list of professionally important qualities of aviation technical personnel, which includes eligibility criteria and elements of the future work of the expert, has been developed.
- A methodology for identifying professionally important qualities of aviation specialists in aircraft maintenance in the course of training at an educational institution has been developed.
- Evaluation methods of compliance of the actual professionally important qualities of aviation technicians working at aviation enterprises after graduation with basic professional qualities important in view of their positions, seniority, types of training, etc. have been defined and tested.
- Based on mathematical modeling, a model for assessing the risks associated with abnormalities in the activity of aviation technical personnel and guilt of a single expert affecting the safety and regularity of flights of aircraft has been developed.
- For the actual conditions of operation of the aircraft, the model of the risk management system associated with abnormalities in the activity of the technical centre staff and affecting the safety and regularity of flights of aircraft has been developed.

Practical Significance of the Research

- The results of the study allow formulating the recommendations for the organisation and conduct of professional selection and evaluation of aviation technical personnel, improving the quality and effectiveness of these procedures, conducting a comprehensive diagnosis of professionally important qualities of these professionals with the help of modern technologies.
- The developed evaluation method of professionally important qualities of aviation technical personnelcan be used in the real training process of aviation personnel. Despite the fact that the resulting methodology is focused on the preferential use of airlines, it can be used for training and retraining of personnel at other transport enterprises. This method of situational psychological training enhances the level of professional competence of the aviation technical personnel, the efficiency of their activities, the quality of aircraft maintenance, while improving the flight safety indicators.
- This study contributes to the introduction of innovative approaches to the organisation and conduct of psychological professional selection, evaluation and training of aviation technical personnel and other experts.

The Approbation of Research Results

The main results of the research have been presented at the following **international conferences:**

1. The Eleventh International Seminar. “The Analysis of the System of Motivation of Aviation Technical Specialists in the Latvian Airlines”. 15–16 October 2014, Vilnius, Lithuania.

2. The 55th International Scientific Conference of Riga Technical University. “Производственная практика студентов как фактор формирования будущего инженера”. 17 October 2014, Riga, Latvia.
3. Scientific Conference “Engineering and Transport Services”. “Связь профессионально-важных качеств авиационно-технического персонала и безопасности полётов”. 25th July 2014. Riga Latvia, Aeronautical Institute.
4. Scientific Conference “Engineering and Transport Services”. “Aviation Engineers Training Requirements in European Union Environment”. 24th July 2014. Institute of Aeronautics, Riga, Latvia,
5. International Scientifc Conference “Aviācijas personāla svarīgāko profesionālo iemaņu novērtēšana”. 30 April 2014, Institute of Aeronautics, Riga, Latvia.
6. Scientific Seminar “Izglītība, kā pamata elements aviācijas tehniskā personāla profesionāli svarīgo īpašību veidošanā”. 30 April 2014, Institute of Aeronautics, Riga, Latvia.
7. CAA; EASA; PART-147 Seminar. 20 March–23 March 2012, Cologne, Germany
8. “17th Aviation Leaders Seminar-Conference. 15 November 2012–16 November 2012, Estonian Aviation Academy, Tartu Estonia.
9. International scientific conference “Intelligent Transport Systems 2012”, Transport and Telecommunication Institute, (ITS’12), 18–20 July 2012, Riga, Latvia.
10. The 53rd International Scientific Conference of Riga Technical University. 11–12 October 2012, Riga, Latvia.
11. ES CAA; EASA, International Seminar “Regulators Auditing Techniques”. 1–4 September 2015, Baines Simmons, Cologne, Germany.
12. Reliability and Statistics in Transportation and Communication (RelStat 10). 20–23 October 2011, Transport and Telecommunication Institute, Riga Latvia.

Research results (publications) that have been published in the scientific periodicals:

1. O. Gorbacovs. Education as a basic element of improving professional important features of aviation technical personnel. Scientific Journal RTU – 2013, 6(5), pp. 57–61 (2,5 p. l.). Riga, 2013.
2. O. Gorbacovs, I. Arandas. Aviation Engineers Training Requirements in European Union Environment. Proceedings of the International Scientific Conference “Engineering and Transport Services – 2014”, 25 July 2014, ISBN 978-9984-9996-5-4. © Rigas Aeronavigacijas instituts, 2014.
3. O. Gorbacovs, I. Andris Vaivads, V. Šestakovs. Связь профессионально-важных качеств авиационно-технического персонала и безопасности полётов. Proceedings of the International Scientific Conference “Engineering and Transport Services – 2014”. 25 July 2014, Riga, Latvia. ISBN 978-9984-9996-5-4. ©Rigas Aeronavigacijas instituts, 2014.
4. O. Gorbachev, V. Shestakov, H. Simakova, K. Tsareva. The Theoretical Aspects of the Study of Professionally Important Characteristics of the Aviation Technical Personnel in Civil Aviation. *Riga Technical University, Faculty of Transport and Mechanical Engineering, Institute of Aeronautics.* Riga, 2015.

The Structure of the Doctoral Thesis

The Doctoral Thesis comprises an introduction, 5 chapters, conclusions, bibliography with 44 reference sources and 9 appendices. It has been illustrated by 46 figures and 22 tables. The total volume of the present Doctoral Thesis is 143 pages.

- The **introduction** gives an overview of the topicality of the research, thesis statements, aims and tasks of the research, research methods, object and subject of the research, scientific novelty, theoretical and practical significance of the research results.
- **Chapter 1** gives a detailed explanation of the aviation technical personnel, its category and the requirements for specialist maintenance and repair of aircraft. The characteristics of the working environment and the common problems that affect the working conditions of aircraft maintenance are decribed in detail.
- **Chapter 2** describes the analysis of the conditions, circumstances and dynamics of formation of professionally important features of aviation technical personnel on the basis of questionnaires. The method of identifying and evaluating professional skills of aviation technical personnel is described in detail, as well as the analysis of the survey results is conducted to identify professionally important features of aviation technical personnel using probabilistic and statistical methods.
- **Chapter 3** provides an analysis of professionally important features of technical experts in real working conditions. The analysis of professionally important features of motivation in the performance of professional duties is carried out through the example of aviation and technical experts in the Latvian airlines.
- **Chapter 4** describes the technique of managing the risks associated with abnormalities in the activity of the technical staff at the airlines technical centre and evaluates their impact on safety and operations.
- **Chapter 5** is devoted to the development and testing of models for assessing the relationship of professionally important features of aviation technical personnel and inconsistencies in their work and the impact on safety.
- **Finally,** the advantages of the developed methods are considered and recommendations for the improvement of the processes of formation of professionally important qualities of the aircraft maintenance technicians are formulated.
- **Appendices** comprise: questionnaire, tables with processing results and tables with calculation results.

THE SCOPE OF THE RESEARCH

Chapter 1. Professional Activity Features of Aviation Maintenance Technicians

The chapter presents the current state of classification, training and professional activities of aviation technical personnel and common problems affecting the working conditions related to aircraft maintenance. Aviation technicians are engineers, aircraft mechanics and aircraft. When servicing the aircraft, they are divided into aircraft engine specialists (B1) and avionics specialists (aviation specialists in digital and electronic equipment) (B2). Issues of their classification, training and professional activities are defined by regulatory documents, the most important of which are the EU PART-66, Part 145, PART-147 (Commission Regulation 1321/2014).

Figure 1.1 demonstrates the aircraft maintenance operating system (environment), which includes a number of subsystems that contribute to the formation of professionally important features.

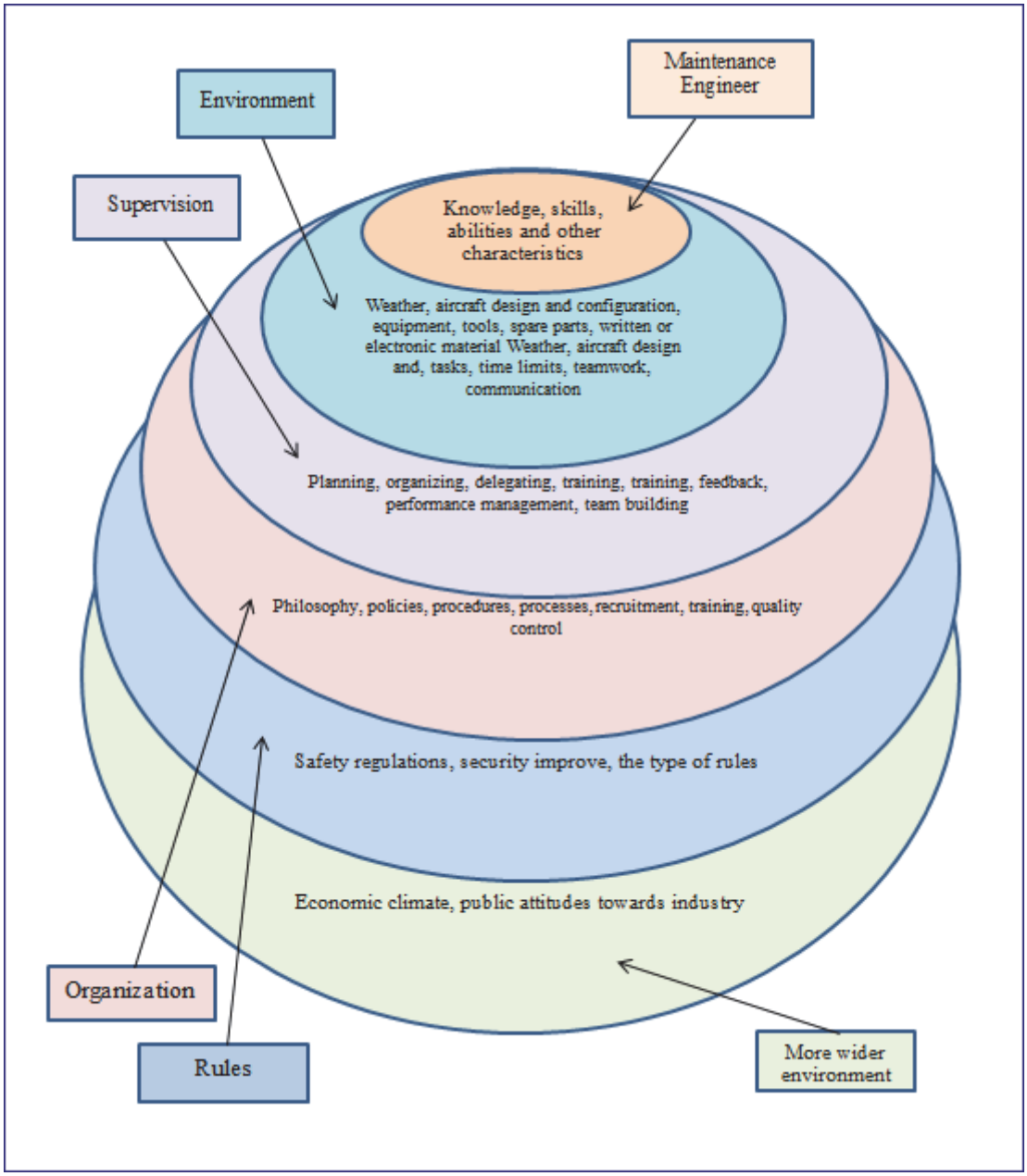

Fig. 1.1. Maintenance system.

Carrying out duties of aircraft maintenance due to the impact of many unfavorable factors (Fig. 1.2) originating from the maintenance subsystem (Fig. 1.1), as well as insufficient training of specialists, there are discrepancies in their work, i.e., deviations from the requirements of regulatory documents stipulating specific functions that can pose the risk of occurrence of specific situations, accidents or incidents during the flight.

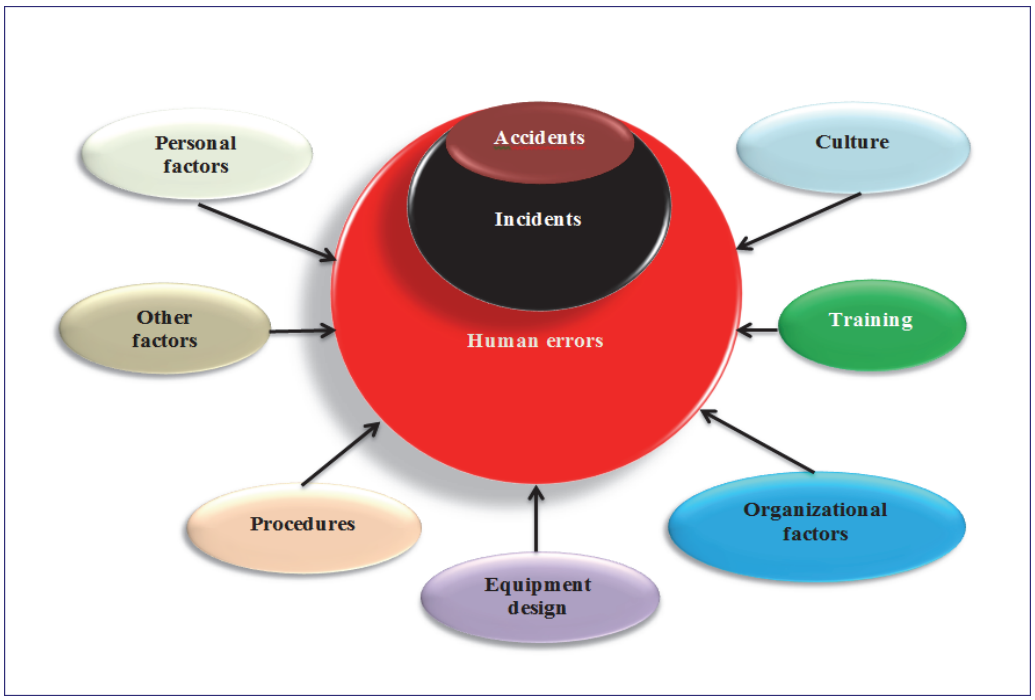

Fig. 1.2. Factors influencing human errors.

This chapter provides a detailed analysis of the current views on the human factor, including the activities of aviation specialists examined in the works of M. J. Kroes, Harry Kinnison, Tariq Siddiqui, Manoj S. Patankar, Dale Crane, Raoul Castro, Thomas C. Lawton, А. М. Андронов, С. Н. Климов, Т. И. Леженкина, А. В. Лебеденко, Л. С. Нерсесяна, Ю. Г. Семёнова, В. З. Шестакова and others.

Chapter 2. The Survey-based Analysis of Conditions, Circumstances and Dynamics Influencing the Formation of Professionally Important Qualities of Aviation Technicians

The chapter is devoted to the analysis of theoretical approaches to the identification and evaluation of professionally important features of aviation technical personnel. The theoretical and methodological foundation of the research is based on theoretical and empirical findings on the various issues of human activity, the use of socio-economic models of training, the formation of professionally important features of the staff to work in stressful conditions of production (L. S. Vygotsky, A. N. Leontiev., S. L. Rubinshtey), system-activity approach (A. N. Leontiev, B. F. Lomov, etc.); systemogenesis psychological theory of activity (V. D. Shadrikov); subject-activity approach (A. V Brushlinskii, K. A. Abulkhanova-Slavskaya, L. I. Antsyferova, etc.); labor approach (E. A. Klimov, A. A. Krylov, N. S. Pryazhnikov, etc.); the formation of man as the subject of training and activities (K. A. Abulkhanova Slavskaya, A. V. Brushlinskii, B. F. Lomov, V. A. Petrovsky, V. I. Slobodchikov and others); functional status and functional comfort (G. M. Zarakovsky, A. B. Leonova, L. D. Chaynova, V. I. Medvedev, etc.); assessment of quality of life (G. M. Zarakovsky); psychological security of principal professional activity (V. M. Lviv, N. L. Shlykova, etc.); professional attributes (V. A. Bodrov, V. P. Zinchenko, E. M. Ivanov, G. M. Zarakovsky, B. F. Lomov, V. M. Lvov, A. N. Glushko, S. L. Lenkov, V. M. Munipov, K. K. Platonov, P. Y. Shlaen, etc.).

2.1. Survey of Changes in the Viewpoint of Professionally Important Qualities by Different Level Aviation Maintenance Students

In general terms, the process of obtaining and continuous improvement of professional knowledge and skills of future specialists is depicted in Fig. 2.1.

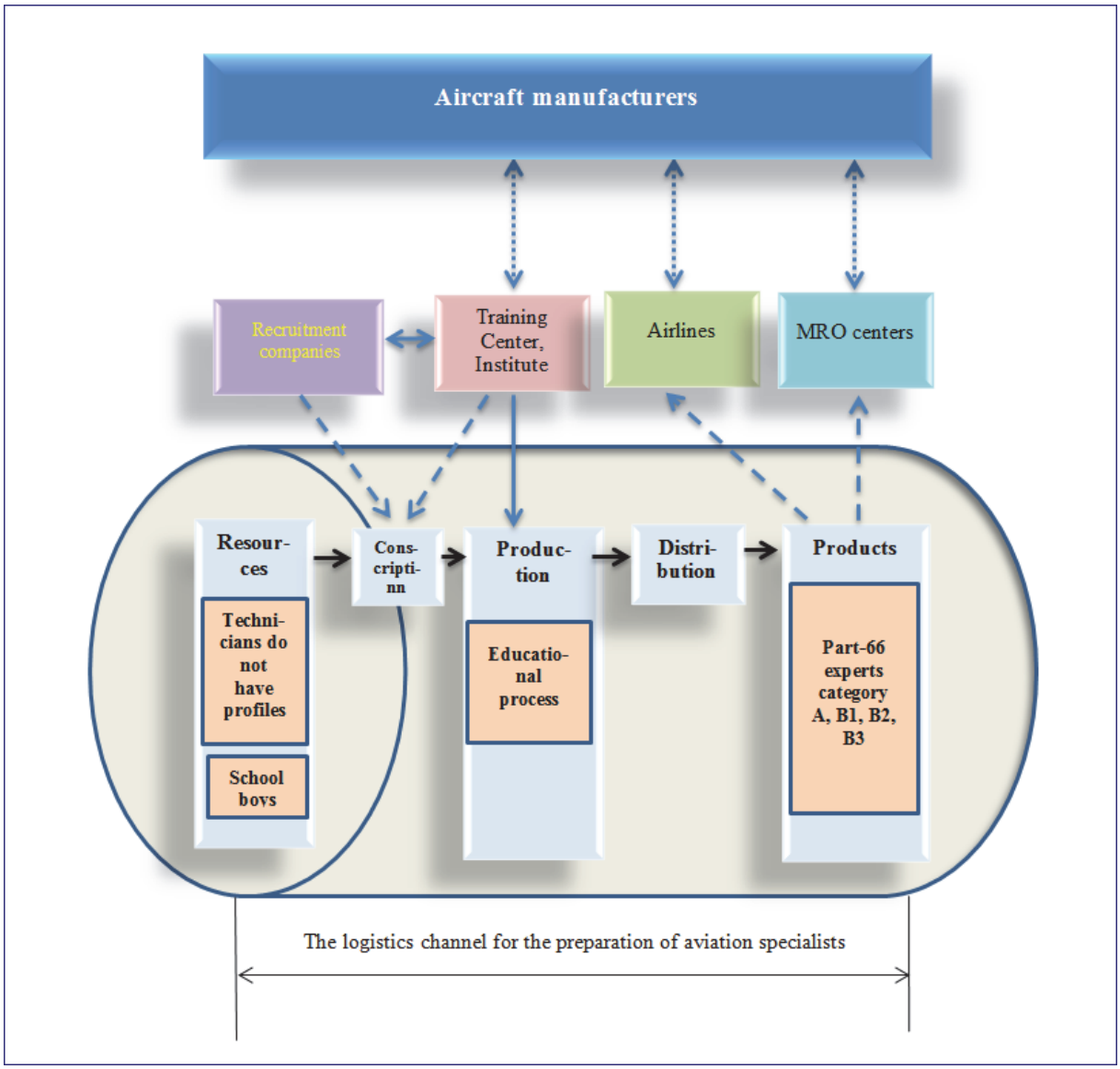

Fig. 2.1. The process of obtaining and continuous improvement of professional knowledge and skills of future specialists.

To identify the dynamics of professional awareness of the students' chosen specialty during the study process, the 1st, 2nd, 3rd and 4th year students were surveyed. At the same time, in different courses, the number of questions and their contents were different (Appendices 1.1, 1.2, 1.3). The results of the survey of the 1st-year students are presented in Fig. 2.2.

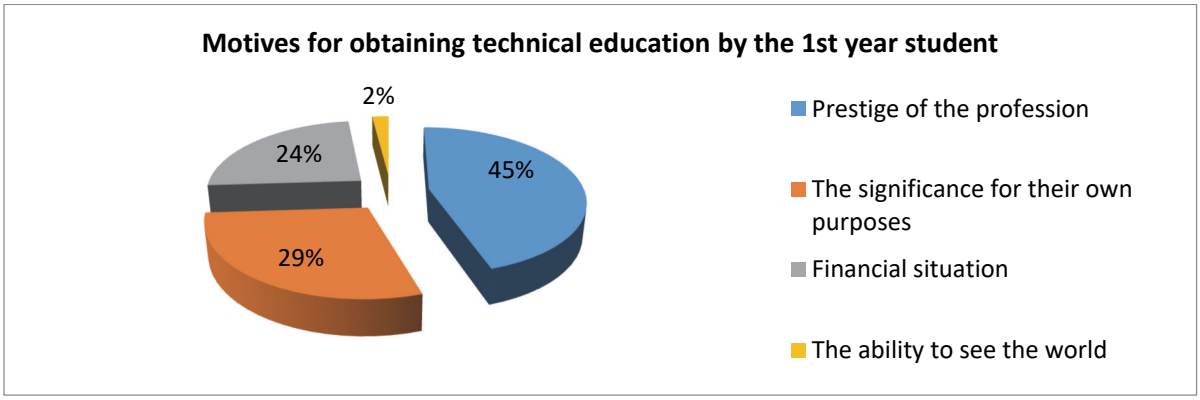

Fig. 2.2. Motives for obtaining technical education by the 1st year students majoring in aviation.

Indicators of the 3rd year students are shown in Fig. 2.3.

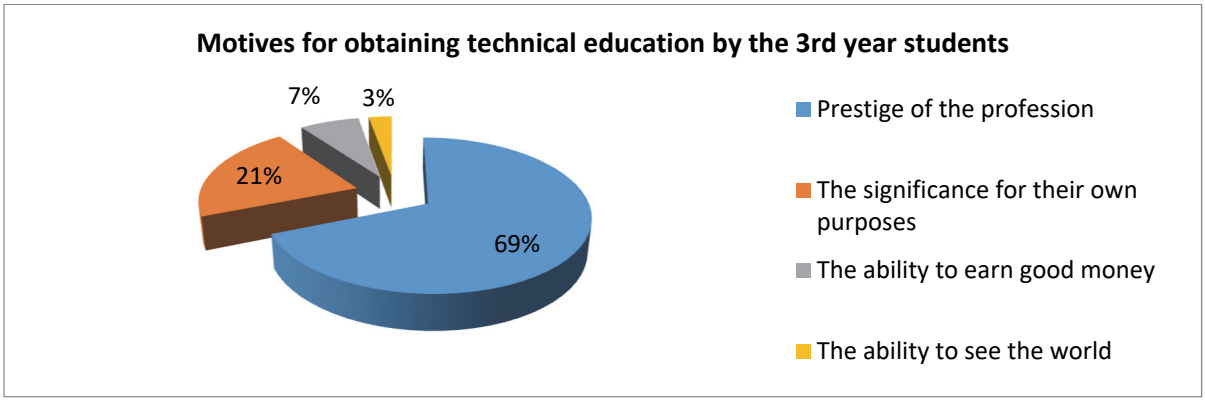

Fig. 2.3. Education motives of 3rd year students majoring in aviation.

As a result, a survey was conducted among 4th year (graduate) students to find out their reasons for obtaining a degree in aviation. The data are shown in Fig. 2.4.

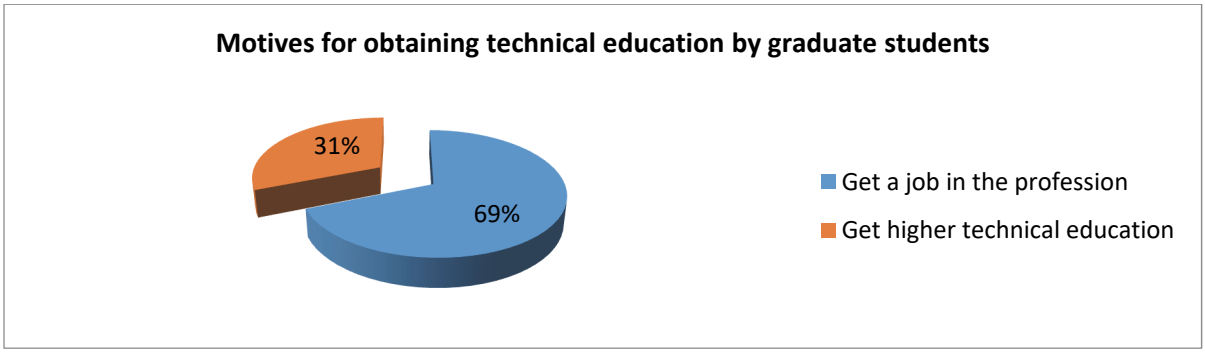

Fig. 2.4. The number of final year students who wish to work in their specialty.

To complete the study, a survey was conducted among the same students, asking them a question: “If you had to choose the sphere of your professional activities, would you choose aviation specialty once again?” The results of the students are reflected in Fig. 2.5.

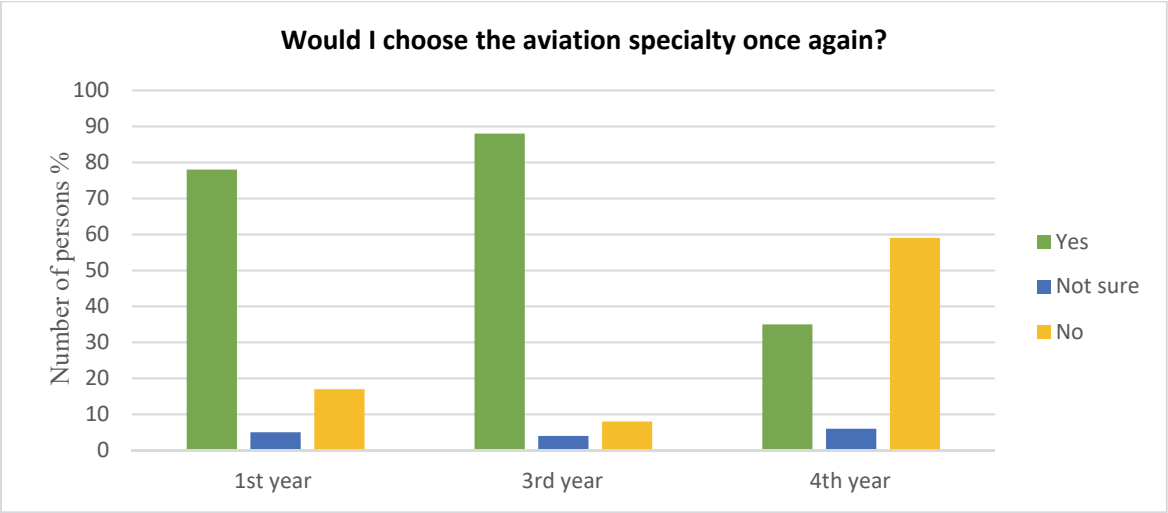

Fig. 2.5. The results obtained after the survey of 1st, 3rd and 4th year students.

2.2. Identification of Professional and Personal Qualities of Aviation Technicians

Within the framework of the research, a profile comprising more than one hundred personal qualities was developed (see Appendix 1.1). Based on the results of the analysis, 20 professional and important indicators of aviation technician were formulated, which were used in further studies (Table 2.1).

Table 2.1

Professionally Important Personal Indicators of Aviation Technician

1	Competence (professionalism)	11	Emotional stability
2	Discipline	12	The ability to understand others
3	Responsibility	13	Communication skills
4	Ability to organise work	14	Friendliness
5	Ability to make decisions according to the situation	15	The open nature
6	The ability to predict the development of the situation	16	Vision
7	The efficiency	17	Overconfidence
8	Accuracy	18	Tact
9	Memory	19	Sense of humor
10	Creative thinking	20	Neatness

The next stage of research included a survey of students (1st, 3rd, and 4th year) in order to identify the dynamics of their ideas about the importance of various professional qualities of the person in the field of aviation. For greater clarity, tabular data of 1st year students' survey are presented in graphical form (Fig. 2.6).

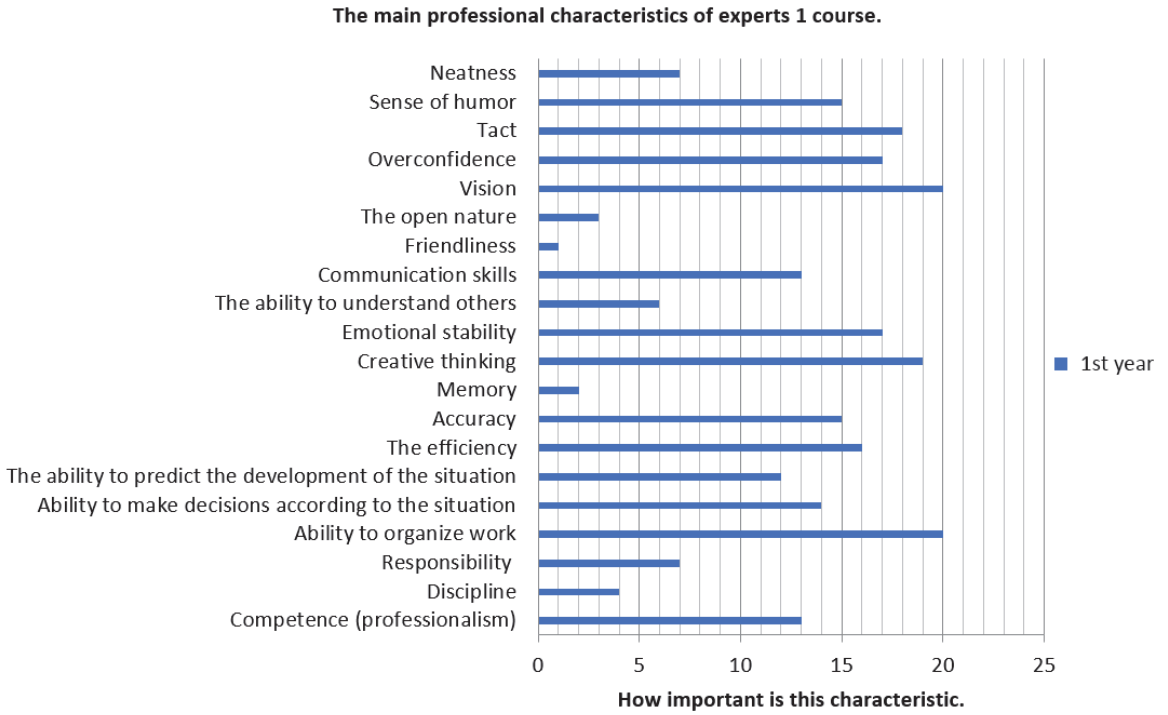

Fig. 2.6. Evaluation results of engineer's professionally important qualities by 1st year students.

Results of evaluation of engineer's professionally important qualities by 3rd year students are presented in Fig. 2.7.

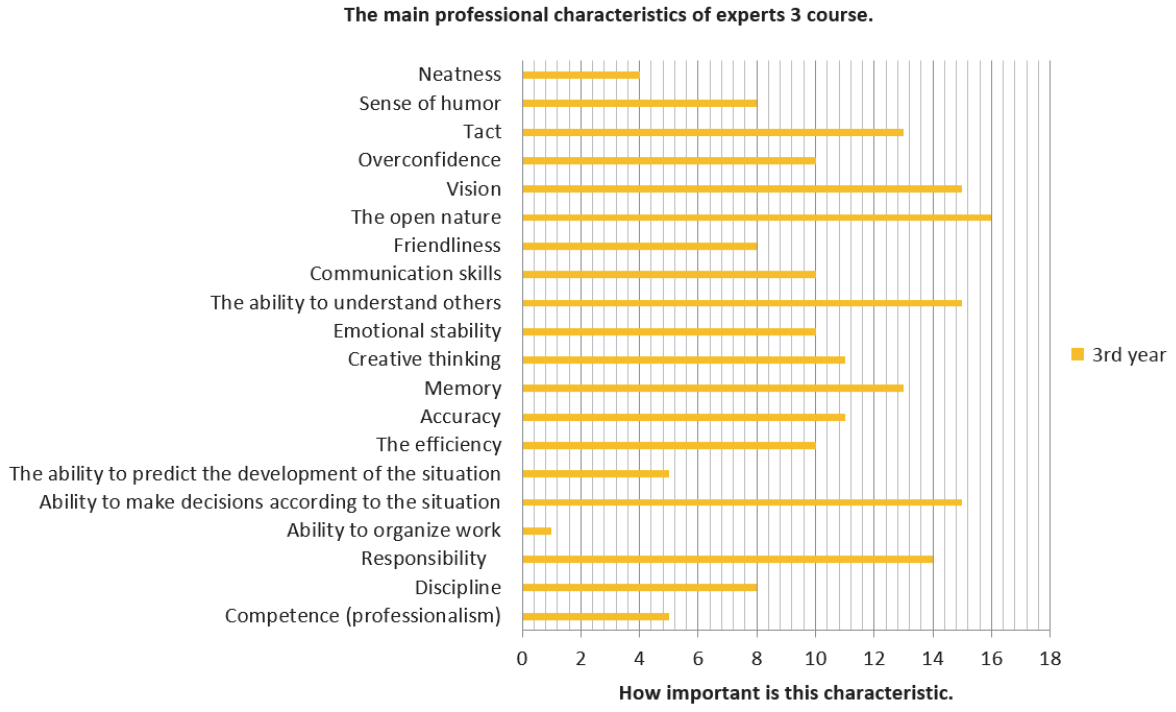

Fig. 2.7. Evaluation results of engineer's professionally important qualities by 3rd year students.

By the end of training (Fig. 2.8), the graduate students'opinion on the most important professional qualities of the person is similar to the baseline.

Fig. 2.8. Evaluation results of engineer's professionally important qualities by 4th year students.

The data reflected in Fig. 2.9 give a visual representation of assessment results of professionally important qualities of aviation specialists by 1st, 3rd and 4th year students 1.

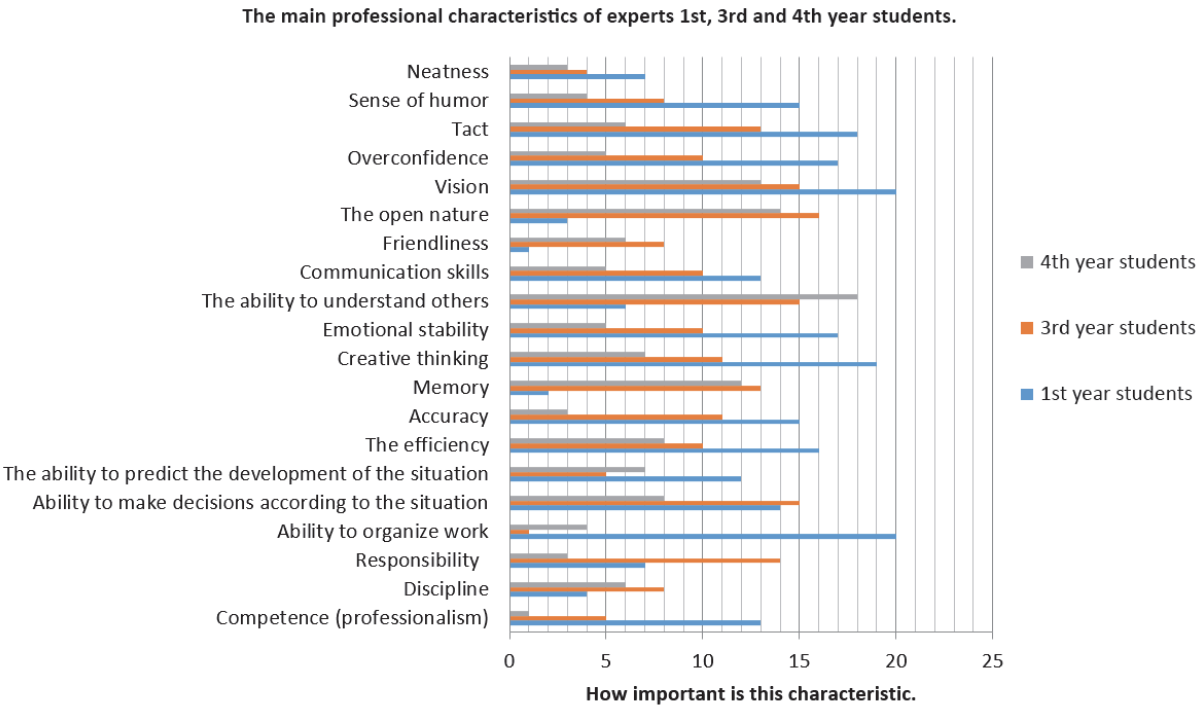

Fig. 2.9. Evaluation results of enginer's professionally important qualities by 1st, 3rd and 4th year students.

2.3. Survey Analysis to Identify Professionally Important Qualities of Aviation Maintenance Personnel by Probabilistic and Statistical Methods

According to this method, each student identified distribution function (probability density), which allowed determining the probability of his presence in a particular area of information space. In the research, a 20-point grading scale was used on the basis of the number of professionally important qualities of aviation technical staff. The experimentally individual students' distribution functions were calculated by mathematical expectation, dispersion and the obtained data on asymmetry of these functions can be used to rank students' characteristics. The individual distribution functions found on the basis of a 20-point grading scale are shown in Fig. 2.10.

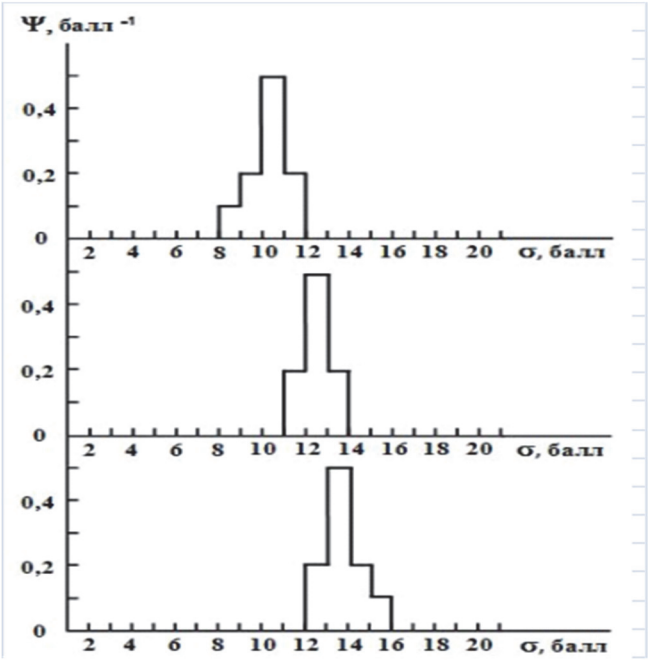

Fig. 2.10. Typical view of the students' distribution functions, number 4 was ranked first (specific subject knowledge).

For simplicity, a transition is provided from a numerical function space, namely, each of the distribution functions is associated with a set of numerical values $\{\mu_n\}$– moments of the distribution function from zero to an infinitely high order (n = 0, 1, 2,).

zero-order moment:

$$\mu_0 = \int_0^\infty \Psi(\sigma) d\sigma = 1 \tag{2.1}$$

the probability of finding an individual throughout the information space, and, therefore, is unity.

The moment of the first order:

$$\mu_1 = \int_0^\infty \sigma \Psi(\sigma) d\sigma \tag{2.2}$$

determines the mathematical expectation (mean value, distribution centre coordinate).

The moment of the second order:

$$\mu_2 = \int_0^{\infty} [\sigma - \mu_1]^2 \Psi(\sigma) d\sigma \ . \tag{2.3}$$

It characterises the dispersion of the distribution function.

Moments of the n-th order (n>1) have the form:

$$\mu_n = \int_0^{\infty} [\sigma - \mu_1]^n \Psi(\sigma) d\sigma \ . \tag{2.4}$$

Analysis of the data presented in Table 2.2 shows that the mathematical expectation, dispersion and the nature of individual students' asymmetry of the distribution functions, preferring the same professionally important qualities can vary significantly. This serves as the basis for the ranking of students' preferences in relation to professionally important qualities.

Table 2.2

The Moments of the Distribution Functions of the Students who Ranked First the Importance of Professional Quality "4" (Subject Matter Knowledge)

№	1	2	3	4	5	6	7	8	9	10
μ_1, points 1	14.50	12.60	14.20	12.80	14.45	10.30	13.70	14.10	11.80	10.60
μ_2, points 2	1.20	1.29	0.81	2.02	0.55	0.76	0.76	0.64	2.01	0.49
μ_3, points 3	0.00	-0.29	-0.14	0.86	-0.27	-0.34	0.34	-0.17	0.86	-0.05

2.4. Development of Methods for Determining Errors in the Identification of Professionally Important Qualities of Aviation Technical Personnel on the Basis of a Questionnaire

Research of professionally important qualities of aviation technical personnel on the basis of the survey can be attributed to the so-called non-continuous statistical observation. Error discontinuous monitoring is also called a mistake or an error margin of representation. The magnitude of this error can be expressed by the following equation:

$$\xi_{\tilde{x}} = \tilde{x} - \overline{X} \ . \tag{2.5}$$

Hence, the limit of probability sample of square error arithmetic average of professionally important qualities in points can be defined by the formula:

$$\xi_{\tilde{X}} = t_z \times \sqrt{\frac{\overline{\sigma_X^2}}{n}} \ , \tag{2.6}$$

where:

t_z – the ratio (ratio) limit of quadratic sampling error to the mean square error sample; t_z – the magnitude that depends on the probability $P=2\Phi(t_z)$ of covering marginal quadratic statistical sampling error of sampling error (the probability is also called the probability of occurrence less $\pm\xi$ mistakes, confidence level or reliability of sampling characteristics);

$$P = 2\Phi(t_z) = \frac{2}{\sqrt{2\pi}} \int_0^{t_z} e^{\frac{t^2}{2}} \times dt \quad . \tag{2.7}$$

The performed studies allow us to formulate the basic objective professionally important qualities of aviation technical personnel (see Table 2.3). This basic professional important features of aviation technical staff address the safety and regularity of flights.

We assume that these qualities need to be taken into account in the education and training proceess of specialists.

Table 2.3

Basic Professionally Important Qualities of Aviation Technical Personnel

No.	Professional qualities	No.	Personality features
1	Comprehensive training	1	Competence
2	Specific training	2	Discipline
3	Ability to work with technical documentation	3	Responsibility
4	Knowledge of a particular material part	4	Ability to organise work
5	Knowledge of the production organisation	5	The ability to make appropriate decisions in a given situation
6	Skills of aircraft maintenance	6	The ability to foresee the development of the situation
7	Socio-economic training	7	Sincerity
8	Motivation in the performance of professional duties	8	Adherence to principles
9	Learning capacity	9	Self-criticism
10	Intelligent and athletic development	10	Emotional stability

Conclusions:

Comparative analysis of data on general aviation and the survey of students at the different stages of training showed that:

1. The application of probabilistic and statistical methods used to analyze the behavior of students in the process of assimilation of knowledge, based on a comparison, allowed carrying out the ranking of students by knowledge level.
2. The analysis of the distribution of students' expectations in each year of study identified the need to verify the quality and objectivity of students' knowledge assessment.

Chapter 3. Survey of Technical Staff on Professionally Important Qualities in Working Conditions

In order to identify and classify professionally important qualities, the questionnaire of the technical staff of various airlines was held by the author of the Doctoral Thesis. The special questionnaires were sent to airlines that were filled by graduates of various aviation training institutions. Questionnaires were of two kinds: to survey graduates and their leaders in the airlines. 200 questionnaires were sent and over 70 questionnaires were filled in. The survey made it possible to evaluate the theoretical and practical training of technical specialists after their graduation in the natural environment of their future professional activity, to assess the level and importance of professional qualities formed during the study process. The results of the analysis can be used to improve the study process and promote gradute employment at civil

aviation enterprises. According to the analysis of completed questionnaires, the graduates were allowed to work independently after some time.

Figure 3.1 shows time period when the graduates were allowed to work independently.

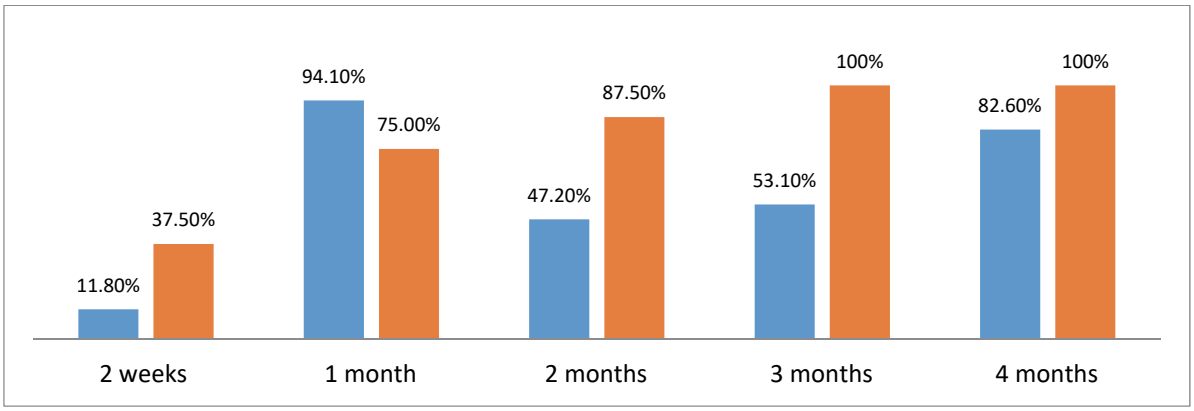

Fig. 3.1. The time period after which the graduates were allowed to work independently.

Suggestions and comments by the heads of airlines to the training of engineers at the higher education institutions:

- To improve training for the acquisition of practical maintenance skills. This recommendation was made by the five heads of the technical operation of avionics and electrical systems of aircraft and the two leaders (graduates) in technical operation of aircraft and engines.
- To improve the training of students in the technical operation of avionics and electrical systems of aircraft and equipment.
- It is desirable that the graduates have a certificate of completion of the theoretical training course of at least one specific type of aircraft.

3.1. The Analysis of Motivation System at Latvian Airlines

- The author of the Doctoral Thesis used questionnaires to find out aviation technicians' motivation. The aim of the research was to analyze the state of the motivation system at the Latvian aviation enterprises and develop recommendations.
- 90.2 % of personnel and 9.8 % of the personnel of the engineering department participated in the survey (see Fig. 3.2). Figure 3.2 demonstrates graphical interpretation of distribution of respondents.

  Table 3.1 summarises random sampling percentage.

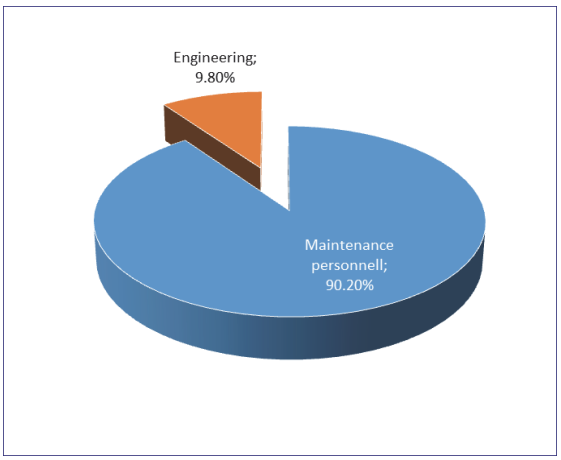

Fig. 3.2. Graphical interpretation of the target groups.

Table 3.1

Random Sampling Percentage

Personnel 96 %								Management Staff
Airline Services	Aircraft maintenance personnel				Engineering			
	90.2 %				9.8 %			
Category	B2	B1.1						
	10.8 %	85.2 %						
Age	Age was not taken into account	20–24	25–29	30–34	35–39	40–44	45–49	Age was not taken into account
		32.7 %	25.55 %	13.51 %	4.57 %	0.72 %	0.03 %	

The total number of samples was determined by the formula:

$$\Delta = t\sqrt{\frac{\sigma^2}{n}(1-\frac{n}{N})}\ , \tag{3.1}$$

where:
t –the value of the normal deviations taken from the table on the probability of normal distribution;
σ^2 – the square of the standard deviation
n – the required sample size;
N – the total number of respondents.

Findings of the study motivation.

The greatest weight among the forms of motivation is a factor of social security, as well as the opportunity to participate in working groups (probably for more rapid career growth).

The existing motivation at enterprises is mainly aimed only at the primary (low-level) requirements: there are tangible labor incentives and intangible ones are virtually absent. These statistics can be used in many tasks to improve the quality of training of technical personnel. In addition to the main goal – readiness assessment of specialist training modules – the resulting test data can also be used for a variety of comparisons that can be claimed by training centres and manufacturing aviation enterprises.

3.2. Identification of Testing Group's Level of Knowledge

This problem is relevant for determining the difference between the two testing groups. In this case, the knowledge of this module may serve as an indicator.

Table 3.2

Selection Criteria for the Identification of Group Differences

	Task	Criterion	Limitations
1	To determine whether therea are differences between two independent groups in any case?	Wallis H test	Group borders limits: (n1, n2≥3) or (n1=2, n2≥ 5) (n1, n2≤ 60)
2	To determine whether there are differences between the three or more independent groups in any case	Kruskal-Wallis H test	Number of groups c=3, group volumes: (n1, n2, n3≤ 5)
		Pearson's chi-squared test (χ^2)	Number of groups c=4 & more, the number of at least one group is greater than 5. Freedom degress number v=c-1
3	Arrange the group formed by attributes (gender, profession, etc.) or by some quantitative trait.	S-Jonckheere's Trend Test	Number of groups 3≤ c ≤ 6, Group number must be the same, and not less than 2 and not more than 10.

Chapter 4. The Risk Management System Development Associated with Abnormalities in the Technical Staff Activity at the Airlines Technical Centre and Their Impact on Flight Safety

The discrepancy in the operation of technical staff is the mistakes that have led or may lead to the loss of the system "ground service specialist – aircraft" properties, and thus pose the risk of occurrence of specific situations, accidents or incidents during flight (Fig. 4.1).

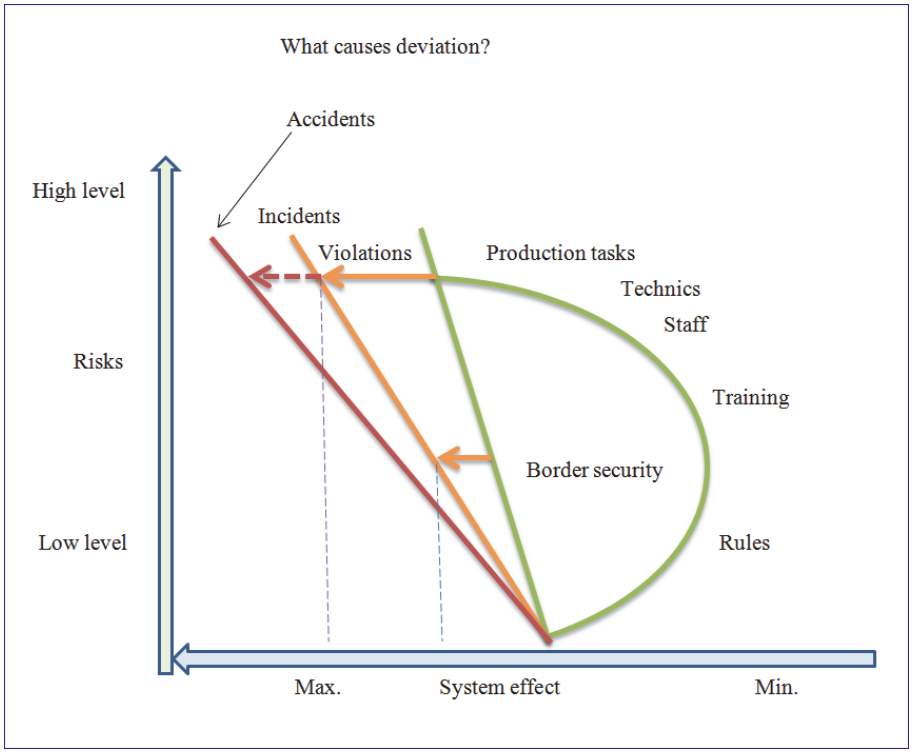

Fig. 4.1. Description of inconsistency in the maintenance personnel activities.

To identify the relationship of professionally important characteristics of technicians and deviations in their work related to the maintenance of aircraft, the statistics available in the Automated Management System "Security" (1999–2009) was analysed and linked to basic service set documents: Part-145 and Part-M Subpart G. Variance analysis of specialist activities in the maintenance of aircraft is presented in the table (see Appendix 1.10). Based on the analysis of statistical data on abnormalities in the activity of the technical staff, the group and the quantitative assessment of the causes of their manifestation were held. The results are shown in Table 4.1

Table 4.1

Quantitative Values of the Causes of Discrepancies in the Results of Specialists in Data Analysis of Automated Control System

Staff key assumptions and disruptions to staff.	Periodic maintenance group (%)	Line maintenance group (%)	Periodic and line maintenance (%)	Avionic group (%)
1. Negligence in maintenance	31.7	6.16	14.5	–
2. Poorly maintained	19	8	3.22	–
3. Breach of discipline	16	16.7	4.8	2.85
4. Failure to comply with servicing program points	6.0	14.28	12.88	–
5. Failure to follow oral and written instructions	2.7	10.55	14.05	5.7
6. Violation of maintenance technology	7.42	14.28	12.88	–
7. Failure to comply with orders of the company's management.	–	4.4	4.8	–
8. Late paperwork	4.72	6.16	8.05	11.4
9. Poor quality of troubleshooting	7.42	14.28	12.88	–

To solve this problem, approaches were used based on the theory of semiotic systems. One of the approaches in knowledge representation semiotic system is a model based on multi-level logic (multi-layer logic (MLL)).

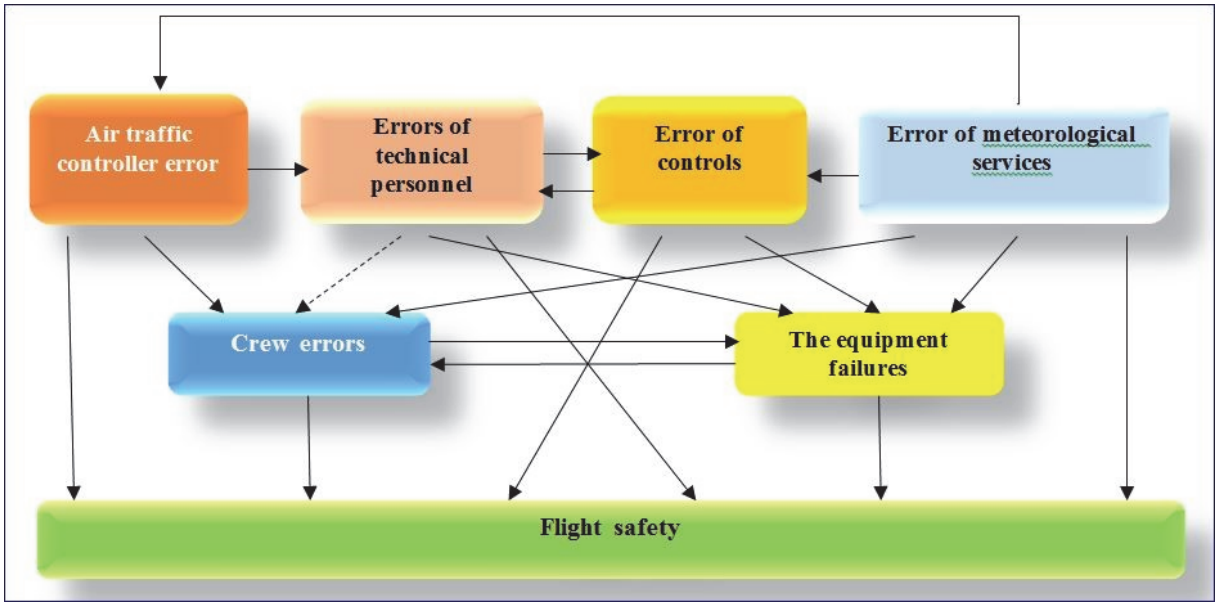

Fig. 5.1. The total effect of the semiotic scheme inconsistencies and abnormalities in the activity of aviation personnel of different categories.

The qualitative assessment of the impact of inconsistencies in the activities of maintenance personnel can also be represented as a semiotic model of sequence of eight stages (Fig. 5.2).

The results of the ranking allowed developing activities aimed at the localization of the most dangerous consequences of human error in maintenance, eliminating the causes and thus increasing the level of safety. When quantifying the level of safety, there are two cases.

The 1st case: implications for maintenance specialists' errors pose a direct threat to the safety of flight, causing the output of the determining parameters of the system "Pilot Flying" to reach the permissible limits of safety conditions of flight.

The 2nd case: mistakes of technicians cause failures of aviation equipment during the flight.

Errors of maintenance technicians manifesting themselves through the cracks in flight aircraft pose a threat to flight safety and therefore require the intervention system "pilot-aircraft" in order to avoid the consequences. Probabilistic models should be presented as a graph whose nodes are random events, and branches – the probability of these events. In that case, if the aircraft for the flight preparation process consists of a series of technological and control operations carried out by maintenance personnel, the graph has the form shown in Fig. 5.3.

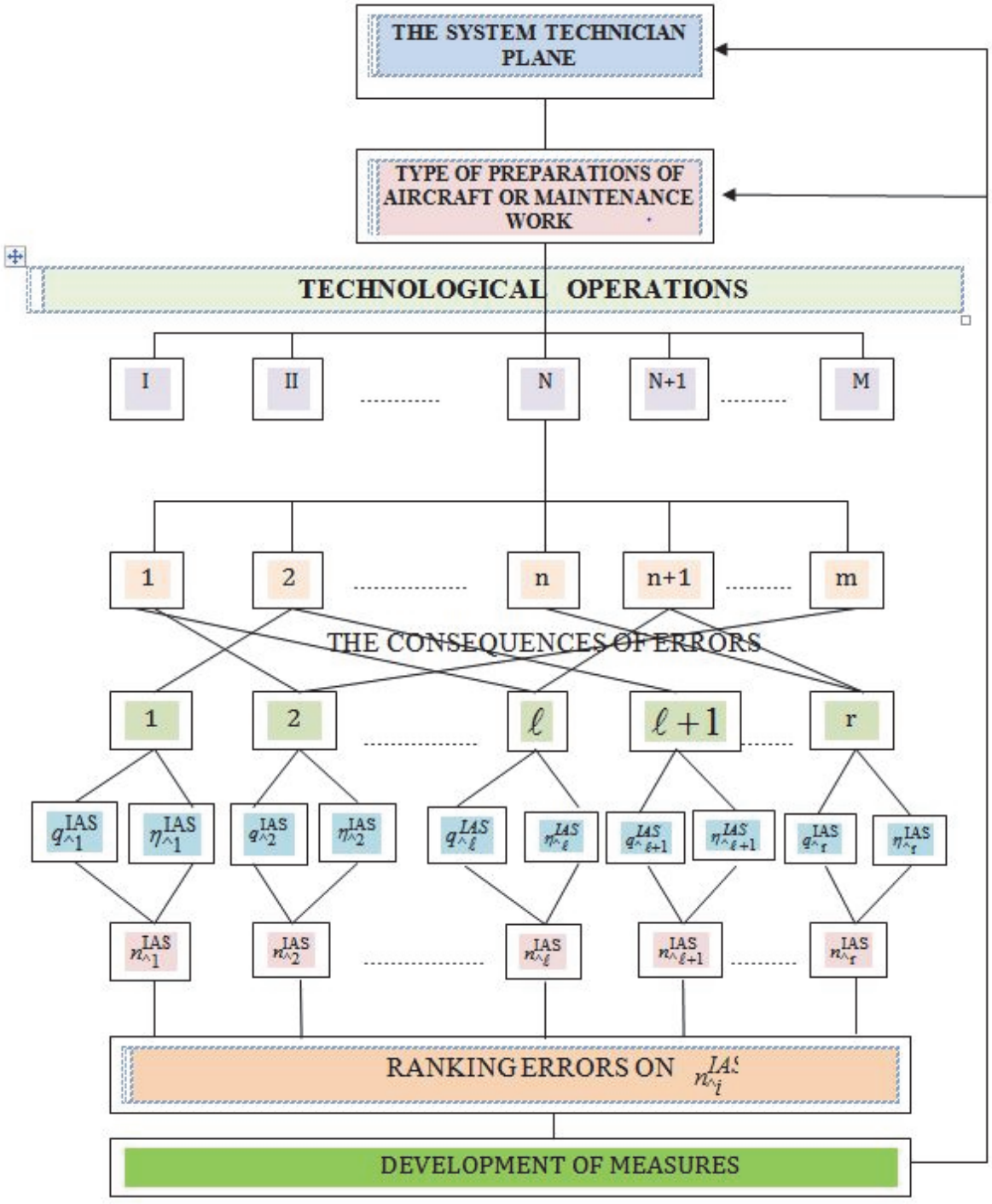

Fig. 5.2. Qualitative assessment of the impact of inconsistencies in the maintenance personnel activities.

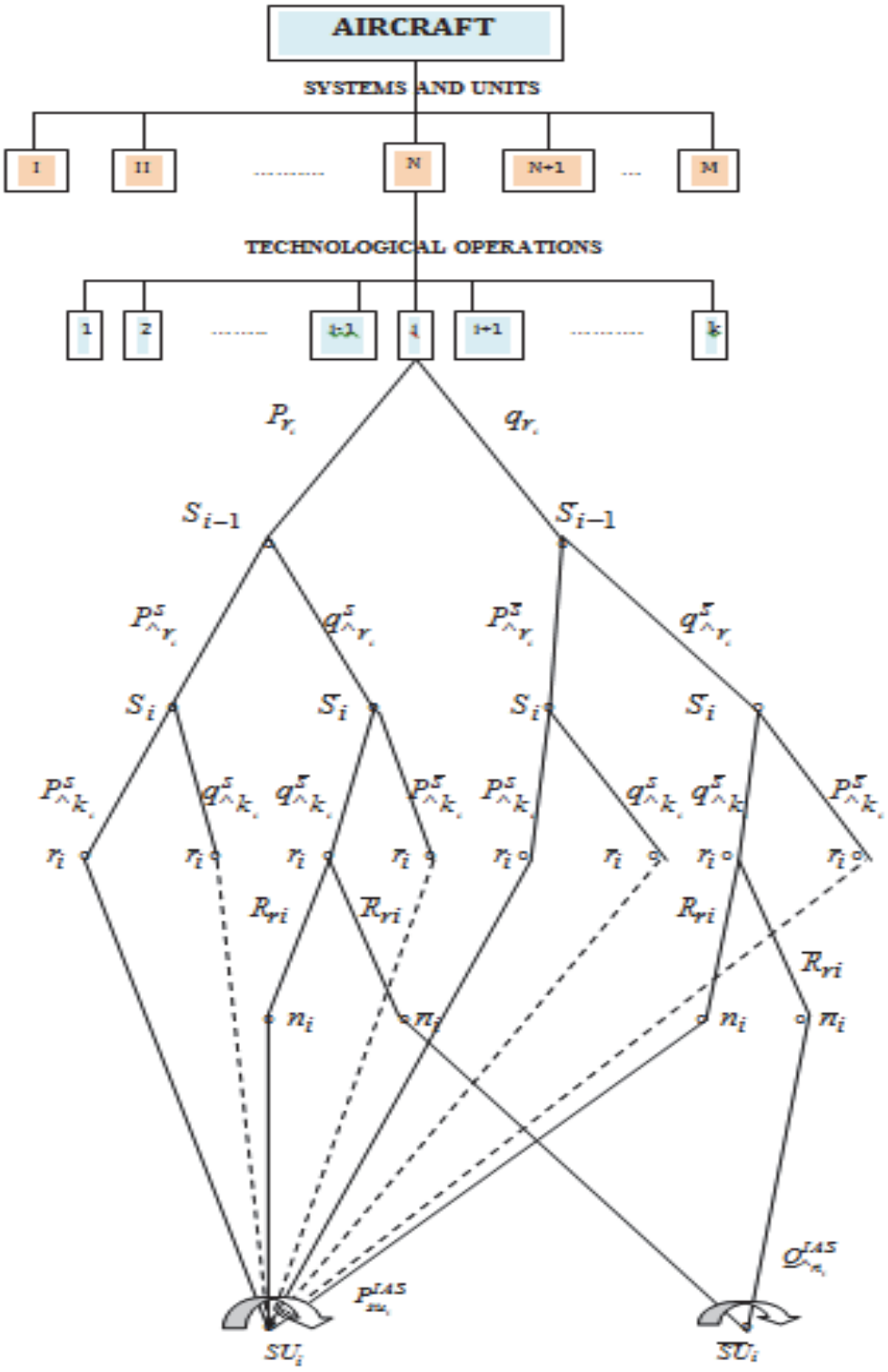

Fig. 5.3. Graph of probabilistic model.

Based on the conditions, the system of managing the risks associated with abnormalities in the airlines technical staff activity solves the problems of information at an acceptable level of their influence on safety. After identifying abnormalities, the associated risks should be evaluated and the nature of risks should be studied in terms of their “acceptability”. If the risk is “acceptable”, it is necessary to take appropriate measures, including the determination of individual guilt of specialist. The general scheme of the concept of “admissibility or inadmissibility” of risk is presented in Fig. 5.4.

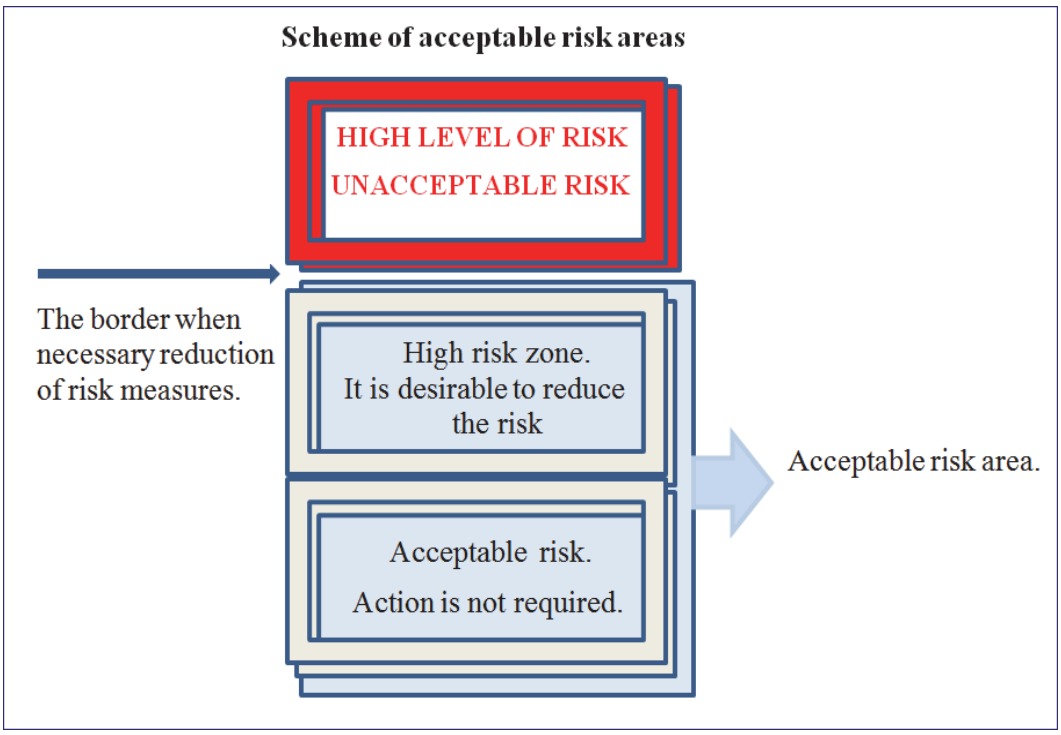

Fig. 5.4. Diagram of the concept of "acceptable or unacceptable" risk.

To assess the risk, various methods and circuits can be used. Risks can be assessed qualitatively or quantitatively. Using qualitative methods, the risk is assessed mainly subjectively. In practice, such high-quality risk assessment methods are used most frequently. The numerical or quantitative risk assessment has a number of advantages compared with the identification of potential hazards:

- provides a base of objective judgment about the degree of risk and compares it with the regulatory requirements;
- enables the risk development corresponding to the risk management system.

In many cases, these methods are based on the so-called "risk matrix". Admissibility of the risk factors for the safety-related consequences of a hazardous event or condition in terms of probability and severity is determined by the risk index (R), which is defined by the formula:

$$R = K_p * K_s, \tag{5.1}$$

where:
R – the risk index;
K_p – the degree of probability of a special situation due to the variations in the activity of the personnel;
K_s – the severity of the consequences of the implementation of a particular situation.

The result is a "risk matrix" (Table 5.1) coloured according to their degree of danger.

Table 5.1

Risk Matrix

K_p \ K_s	Degree of risk			
	16	8	4	1
4	64	32	16	4
3	48	24	12	3
2	32	16	8	2
1	16	8	4	1

In general, the risk management system, due to irregularities in the activities of the technical staff, will have the form shown in Fig. 5.5.

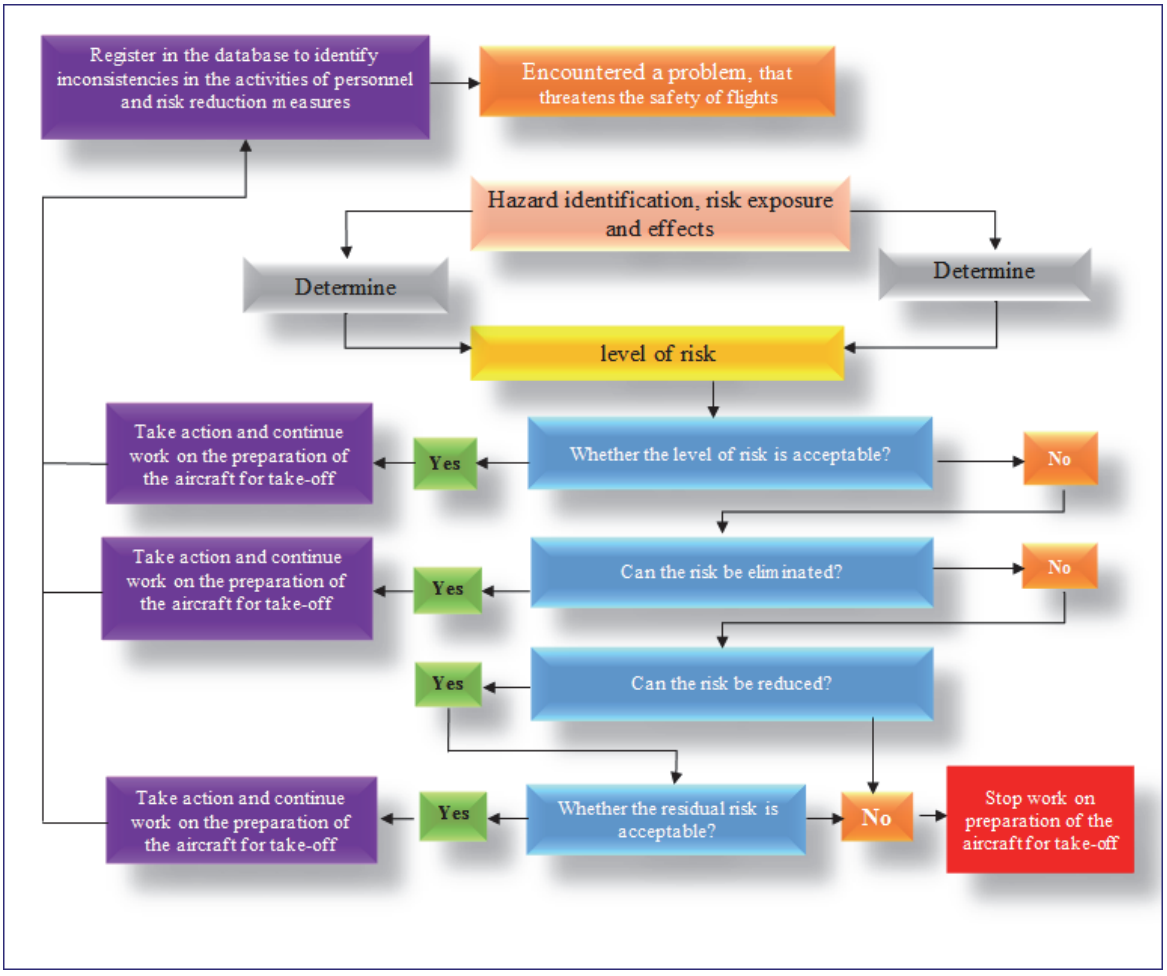

Fig. 5.5. The risk management system due to variations n the technical staff activity.

To compare the quality of the organisational and technical department of preventive work, criteria can be used on the basis of point system evaluation. To assess the quality of individual technicians to ensure the flights, private or basic criterion was used:

$$K_i = \frac{\Sigma B_i}{nB_{\max}}, \tag{5.2}$$

where

B_i – the number of points received by a specialist in the maintenance of the quality of the work performed;

B_{max} – the maximum value of the scoring;
n – the number of estimates received by a maintenance specialist over the period (week, month, quarter, year).

The total number of errors made, depending on the severity of their consequences, is taken into account as a factor reducing the quality of service:

$$\xi_{\Sigma} = \prod_{i=1}^{m} \xi_i^{m_i} \quad , \tag{5.3}$$

where
m_i – the number of ξ_i estimates received by a specialist in the period under review. The conversion factor of maintenance personal qualifications is taken into account by K_s.

Detection and timely elimination of the mistakes made by other specialists or equipment failures, depending on the severity of the possible consequences during the flight, are taken into account by the coefficient k_{η}.

Taking into account the conversion factors, as well as negative and positive factors, a general criterion for the comparative evaluation of the quality of organisational and preventive measures to ensure that safety is of the form:

- For an individual service technician:

$$G_{k_i} = k_i \times \xi_{\Sigma_i} \times k_{\tau_i} \times k_{s_i} \times k_{\eta_i} \tag{5.4}$$

- For crew, a group or team consisting of *«n»* specialists the quality criterion is defined as the weighted average of the criteria received by all experts, taking into account the scope of the execution of each of these works (the number of serviced sorties, the number of completed forms of preparations, the volume of executed routine operations, etc.):

$$G_r = \frac{\sum_{i=1}^{n} G_{k_i} \times r_i}{\sum_{i=1}^{n} r_i} \quad , \tag{5.5}$$

where
r_i – the work volume of *"i"* specialist during the reporting period;

- For airlines maintenance organisation:

$$W_k = \frac{\sum_{i=1}^{N} T_j \times \frac{G_{r_j}}{G^o_{r_j}}}{\sum_{i=1}^{N} T_j} \quad , \tag{5.6}$$

where
T_j – the number of aircraft flight hours in *"j"* group.
N – the number of groups in the airline.
G_{rj} – the value of the quality evaluation criteria in *"j"* group;
$G^o_{r_j}$ – baseline (initial) value of quality assessment criterion *of "j"* group.

The value can be taken as $G^{o}_{r_j}$ unity, or the value $G^{o}_{r_j}$ obtained during the first or previous assessment of the quality of maintenance personnel in the airline.

If $G^{o}_{r_j} = 1{,}0$ (conditional – ideal process maintenance),

G_{r_j} – general criterion for assessing the quality of the organisational and preventive work organisation for airline maintenance will be the following:

$$W^{o}_{k} = \frac{\sum_{i=1}^{N} G_{r_j} \times T_j}{\sum_{i=1}^{N} T_j} \quad . \tag{5.7}$$

For assessing the quality of technical personnel to ensure the safety, you can:

- Enter into the work a single system of evaluating the performance of staff in aircraft maintenance of the airlines technical departments;
- To conduct at the airlines a comparative assessment of the quality of individual service specialists, groups and teams;
- To assess not only the quality of maintenance personnel, but also its effectiveness through a comparative analysis of the criteria values;
- To take into account virtually all factors affecting the quality of work performed by the introduction of new criteria for conversion rates.

In addition, the use of the proposed system for evaluating the performance of staff in maintenance in conjunction with other events held in the airlines will increase the level of professionally important qualities of employees. It will foster a sense of high personal responsibility of all professionals for safety, the desire to increase their level of training, work discipline, initiative, alertness, sense of duty, etc. Ultimately, this will lead to the improvement of the entire organisational and preventive work for aircraft maintenance, for the prevention of accidents and flight prerequisites due to human errors in maintenance and reduction of aircraft failures.

CONCLUSIONS

Within the framework of the Doctoral Thesis, the following tasks have been performed:

- On the basis of a questionnaire, a basic list of professionally important qualities of aviation technical personnel, which includes eligibility criteria and elements of the future work of the expert, has been developed.
- The methodology has been developed for identifying professionally important qualities of aviation specialists in aircraft maintenance in the course of training at an educational institution.

On the basis of a questionnaire, the dynamics of awareness of students enrolled in various courses of engineering schools, professionally important qualities of aviation technical specialist as well as motivation for studying aerospace engineering have been examined. By analysing the obtained data, it has been found that initial expectations of many students fail. The decrease rate of contentment by professional orientation course according to the latest data is demonstrated by the values of satisfaction with the chosen profession. The maximum number of students expressing satisfaction with the profession is decreasing from 78 % by 1st year students to 35 % by 4th year students and the number of students with an undefined and neutral attitude to the profession rises from 6.5 % by 1st year students up to 13 % by the 3rd year students. Perhaps one of the reasons for the decline of professional orientation of students is insufficient guidance.

- The evaluation methods have been developed and tested for compliance with the actual professionally important qualities of aviation technicians working at aviation enterprises after graduation, basic professional qualities important in view of their positions, seniority, types of training, etc.

Professionally important qualities have been determined and classified, by performing the survey of the technical personnel of various airlines and aviation services, as well as engineering managers.

The research has confirmed:

- The accuracy of the proposed basic professionally important qualities of the aviation technical personnel.
- Correlation of the professionally important qualities formed in the period of study and practised by specialists in the process of practical activities in the airlines.
- The results of the analysis can be used to improve the study process and speed up input of specialists at operating enterprises of civil aviation.

The proposals have been developed to improve the processes of essential training and teaching qualities of aviation maintenance professionals for further professional activities in the airlines.

- Based on mathematical modeling, the model has been developed for assessing the risks associated with abnormalities in the activity of aviation technical personnel and guilt of a single expert, affecting the safety and regularity of flights of aircraft.
- Under the actual conditions of operation of the aircraft, the model of the risk management system has been developed; the risks are associated with abnormalities in the activity of the technical centre staff that reduce their effect on the safety and regularity of flights of aircraft.

RESUME

The author is an employee of the Civil Aviation Agency of Latvia at the department of certification of aviation technical personnel, which in recent years has accumulated a huge statistical data related to testing and examination, which has great potential for improving the professionally important qualities of aviation technical personnel. The practical application of these techniques for the purpose of knowledge evaluation of candidates for certificates of modules Part-66, as well as the evaluation of professionally important characteristics of the technical staff of airlines based on length of service, the different types of improvement of professional knowledge and skills require solutions to many legal and organisational issues, as well as the consent of various organisations and institutions. These are the issues the author intends to deal with in the future.

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