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INNOVATIONS IN ENGINEERING EDUCATION

Editorial board

Dear readers!

Today the job market is forwarding more serious and demanding requirements to the graduates of higher education institutions, i.e. particularly concerning their professional competencies. Employers quite often express the opinion that the level of graduates' professional competencies is unsatisfactory, especially, in the case of graduates completing academic programmes in engineering and technology. The quality of engineers training and specialists with higher education degree diplomas prepared to work in engineering positions is hardly advanced. Similarly, employers feel that graduates entering the workforce need to be taught all over again and, in most cases, a rather intensive period of adaptation is required for a young specialist at the production site. Comparing the employer's production site to university production scenario, "the cards are stacked against" the university. The employer is strongly convinced that he has received "a university product" which needs engineering following-up and supplementary costs. However, "a market-made product" is ready for fully functional service.

The reason is the policy of the specialist training system in engineering and technology, which is significantly focused on the class-lesson system itself, i.e. predominating knowledge competencies, rather than on the professional activity aspect, i.e. shaping the professional competencies of a student.

It should be noted that applying the knowledge-based approach in the education system is not counterproductive comparable to that of the activity approach. Under certain conditions (talented and/or capable students, demanding professional instructors, up-dated facilities and resources, etc.) this approach ensures training highly-qualified professionals, whose fundamental educational background would be the basis for successful professional activities for many years.

Such an outcome is essential if we are training professionals for science (research) and/or those scope of activities which do not imply dynamic changes. In the modern engineering sphere, with explosive development of technology and relentless competition, there is absolutely no time for a young specialist to "reset" himself/herself into these conditions. This is the reason why employers are looking for engineering and technical staff with well-developed key professional competencies being capable of ensuring the further success of this or that enterprise. Unfortunately, it should be noted that the number of such professionals is quite insignificant among all the "new-graduates".

Conceptually, the challenge facing higher engineering education is attributed to the contradiction between the necessity to provide training of highly-qualified staff with relevant professional competency, capable of solving engineering tasks from the very first days in this or that enterprise, on the one hand, and the educational facilities and conditions in the universities, on the other hand. This situation is prevailing in both domestic and foreign technical universities. These training conditions include such significant factors as content of academic programs, EdTech (education technology) and teaching and learning management systems. These conditions can be improved via innovative approach, i.e. innovative solutions within the framework of the education system itself. The result of such intentions and solutions resolves itself into significantly improving activity-related education components, which, in their turn, could ensure the solution of the above-mentioned contradiction and "ease" the acuteness of the problem. Today, one can observe numerous examples of different innovative approaches and solutions to improve and advance the engineer training system in both domestic and foreign technical universities. The excellent examples are CDIO Initiative, team project-based learning, interdisciplinary approaches and projects, problem-oriented and practice-oriented education, establishment of the departments at enterprises, modular training programs and other methods and techniques.

The current issue of "Engineering Education" journal (№ 19) provides the opportunity for all members and representatives of academic and engineering communities to share their experience in developing innovative solutions which involve not only the improvement of the education program content and education technology, but also the organization of the teaching and learning process system itself in order to train highly-qualified specialists within the engineering and technology domain.

The Editorial Board is grateful for all submitted papers and hopes that the published articles will be of great interest and will find a broad response among those colleagues who are "toiling" for training prospective highly-qualified engineers.

Sincerely,
Editor-in-Chief,
Prof. Yury Pokholkov

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Support for Elite Engineering Education: Student Creative Workshops

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The paper considers elite engineering education provided at the higher education institution of architecture and civil engineering. The elements of the educational process have been described. The regional employers are supposed to play an important role in setting learning outcomes, therefore, the questionnaires filled out by the representatives of civil engineering enterprises have been analyzed. The paper also describes the results of the poll held among the institution graduates. The authors of the paper have analyzed the poll data with due regard to the fact whether the respondent participated in the student creative workshop for designing and developing e-learning resources on geodetics engineering at Novosibirsk State University of Architecture and Civil Engineering (Sibstrin). The authors suggest that student professional creative workshops play a significant part in providing elite engineering education at the higher education institution of architecture and civil engineering.

Key words: engineering training, architecture and civil engineering education, student workshops, student projects, e-learning resources.

Technology-intensive manufacturing has lately led to the demand for “elite” engineers experienced in cutting-edge research and technologies, in other words, “the leaders in engineering”, who are capable of systemic, creative, and critical thinking and have “the skills necessary to make a team and manage a project” [1, p. 188].

There are different approaches to providing elite engineering education within the framework of modern education system [2]. The leading national and international higher education institutions design and implement original elite educational programmes [1]. For example, in compliance with the Regulations on elite education at Rostov State University of Civil Engineering to be found on the official website, the aim of the elite engineering education is to train highly-qualified professionals possessing fundamental knowledge, profound foreign language skills, with additional education in the spheres of economics and IT, who can work in team, conduct research, perform entrepreneurial and innovative activities under the changing conditions.

In article [1] the authors analyze the notion of elite technical education in detail based on the system of engineering education developed at Tomsk Polytechnic University (TPU). The basic attributes of elite engineering education provided at TPU are fundamental education with profound knowledge of natural sciences, mathematics, economics, and foreign languages, professionalism in intense research, creative, and project activities performed by the students, innovations based on student’s critical thinking and initiative, entrepreneurial and leadership skills [1, p. 201-202].

The system of elite architecture and civil engineering education is a pilot project implemented within the framework of complex development programme [3] by Novosibirsk State University of Architecture and Civil Engineering (Sibstrin). There will be particular student groups trained in compliance with demands specified by the employers, for example, a constructing engineer with profound knowledge of economics or a geodesist trained for road construction.

Therefore, elite engineering education can include:

- intensive engineering training courses starting from the first year of study with an emphasis on fundamental and professional disciplines;
- educational programme designed in compliance with two specializations or profiles;
- team work to perform project and innovative activities simulating production process;
- intensive foreign language study (as a rule, English as it is the language of international business communication);
- additional training in the spheres of IT, economics, and entrepreneurship.

It is impossible to train a professional in demand for civil engoineering industry without continuous monitoring of employers’ needs. According to the results of deep analysis of Russian engineering education modernization [2], to develop elite engineering education, “it is necessary for the governmental and regional education programmes to be balanced” [2, p. 18].

There are data of 15 interviews conducted over the period of January-March, 2015 with the heads of civil engineering enterprises located in Novosibirsk and Novosibirsk Oblast. There were also eight other interviews conducted via e-mail and video communication with the representatives of civil engineering enterprises in Tomsk (two interviews), Moscow (two interviews), Berdsk (three interviews), Sochi (one interview). The limitations in student training identified as a result of the interviews analysis are as follows:

- incapacity of working with a large number of engineering documents, which may involve IC technologies application;
- lack of experience in submitting documents in electronic version (reports, verification letters, etc.) to the organizations providing for municipal and federal control;
- poor skills of analyzing the structure of databases and interrelation between different documents;
- lack of negotiating and business writing skills, as well as business communication skills in general, including those for international communication;
- inability to present work outcomes and successfully defend professional projects.

Each of the above-mentioned limitations can be overcome through the application of the appropriate pedagogical techniques. For example, to improve the communicative skills of civil engineering students [4], business games and project work can be used. In case of elite engineering education there should be a complex of measures to prevent all the limitations throughout fundamental professional training.

To train elite engineering staff specialized in two profiles and capable of solving multiple tasks, it is important to use the educational potential of general professional disciplines. As for NSUACE (Sibstrin), one of the general professional disciplines taught for all civil engineering students is geodesics engineering followed by internship. Therefore, in terms of pedagogy, geodesics engineering is of great potential to improve elite engineering education.

Due to the rapid pace of technology advancement, educational and methodological support for engineering students, as a rule, lag behind and fail to meet the ever-changing requirements. Therefore, the adequate form for educational resource development is e-learning resources. Development of robust e-learning resources is labour-consuming, however, the use of e-learning resources in the education is time-saving for both students and teachers and allows releasing hours for new educational purposes, such as elite education.

To simulate work with high-tech geodetic equipment, the Department of Geodesics Engineering, NSUACE (Sibstrin), steps up efforts to develop various e-learning resources. To increase the number of developed resources, the student creative workshop "Geo-S" was established, which has been efficiently working over the past ten years. In 2014, NSUACE (Sibstrin) summarized interim outcomes of the pedagogic research on e-learning resource conducted together with Armavir State Pedagogical University to improve the quality of civil engineering education. The research revealed high efficiency of e-learning resources developed by students in cooperation with teachers at the student creative workshops [5].

The e-learning resources developed at "Geo-S" are "Electronic Notes on Geodesics Engineering", "Electronic Geodesic Glossary", animated educational resources "Setting out Levels at Pit Bottom", "Measuring Line Length", "Setting out Design Level", etc. The resources are available at geo-s.sibstrin.ru and some of them are in English.

Students involved in the creative workshop participate in exhibitions and conferences becoming laureates and winners. Recently we have had an opportunity to compare careers of alumni who, when students, participated in the creative workshop "Geo-S" with those who did not. We developed a questionnaire and held a survey, which involved 42 respondents, 27 of whom live and work in Novosibirsk, 9 – in Novosibirsk Oblast, 6 – in other areas.

The questions were as follows:

- Do you work in the sphere you have a university degree in?
- What was the position you occupied at first and what position do you occupy now (please, specify how many years have passed since you graduated the university)?
- When at university, did you participate in any student unions and activities (workshops, conferences, etc.)? If yes, please, specify what you did.
- Were the skills and abilities developed through the above-mentioned student activities contributive to your career and professional activities?
- Are you going to take any continuing professional development course?

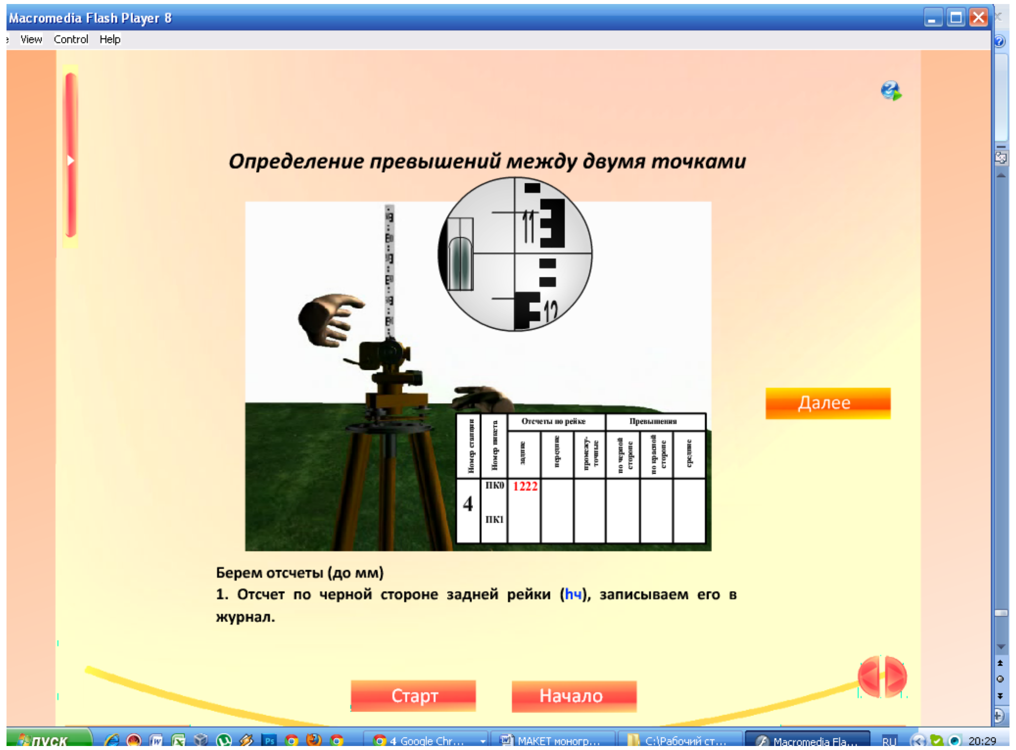
Let us summarize the answers. As for the former participants of the "Geo-S" workshop, 100% of respondents answered "Yes" for the first question (note: one of the answers was "including site engineer"). Among those who did not use to participate in the student workshop, 68% do work in the sphere they specialize in, 7% are on decree or maternity leave, 15% completely changed their specialty, and 10% work in the sphere related to their specialty (for example, he or she has got a degree in Industrial and Civil Engineering and works as a head of the laboratory for construction material production; or has a degree in Economics and works as a cost engineer at a civil engineering enterprise; etc.).

As for the second question, the former participants of the "Geo-S" workshop answered in the following ways: "master hand, site engineer in four years", "software programmer, entrepreneur in two years", "design engineer, lead professional in five years", "architectural assistant, project architect in three years", "software programmer, head of IT department in four years", "section supervisor, head of production department in five years". The answers of those who did not use to participate in the student workshop were as follows: "master hand, site engineer in five years" (12% of respondents), "master hand, the same position after five years of work", "master hand, senior master hand in five years".

Answering the third question, the former participants of the "Geo-S"

Fig. 1. E-learning resources developed at student creative workshop: a) "Setting out levels at Pit Bottom"

b) "Engineering Levelling: Filing Order"



workshop mentioned the roles of coordinator, software programmer, project web-designer of e-learning resources and the activities as follows: creating animation illustrating work with geodetic equipment, flash programming for geodetic activities, animating equipment in 3D Max, recording audio for animation and video recording, developing tests for Geodesic Glossary, designing Geodesy website, and other activities connected with e-learning resource development and implementation into professional education. Those who did not use to participate in the student workshop, as a rule, answered "No" or mentioned educational activities only.

Answering question four, more than half of respondents who used to participate in "Geo-S" workshop (55%) emphasized a significant role of the workshop for further career development, 20% said that the workshop played a minor part, 25% said that the workshop did play a certain role, 0% defined the workshop activities as irrelevant. The other respondents did not gave any full answers illustrating the effects of participating in university activities on further career development. The former participants of "Geo-S" workshop also mentioned that designing e-learning resources for geodetics engineering allowed them to acquire knowledge of IC-technologies applicable for their professional activities, improve business communication skills, and develop hand-on projects, which is particularly important for further employment even without real work experience.

As for question five, the majority of "Geo-S" workshop participants (72%) said that they would take a continuous professional development course within the next three years, 21% would like to take a course but after a certain event (for instance, project completion), 6% would take a continuous professional development course within the next five years, 1% could not say precisely, 0% would not like to take a course. The alumni who did not participate in the student workshop but worked in their degree field gave the following answers: 95% would take a continuous professional development course if the supervisor orders, 5% would like to acquire another specialty with higher salary. It is noteworthy that in both cases extrinsic motivation for professional development predominates over the inner one.

It should be noted that the activities performed at "Geo-S" workshop are supposed to fill education gaps identified by the employers in the course of the survey. For example, the workshop activities performed to improve business communication skills are expressing one's ideas using professional terminology; project discussion and group decision making; preparing supporting documentation to present or revise a project; keeping project record; presenting a project for potential customer; business communication at different levels; explaining the issue or task briefly; delegating the subordinate to present the work results for the supervisor [6, p. 194].

"Geo-S" workshop implements the components of elite engineering education: acquiring knowledge of geodetic equipment and technologies for further numerical modelling, developing and defending projects delegating responsibilities and generating efficient communication at all levels, designing e-learning resources with video- and audio-recording using IT, including those available in English.

Today, employees should meet stiff professional requirements, however, all the alumni who as students participated in "Geo-S" creative workshop are currently employed. This fact leads us to the conclusion that student creative workshop of fundamental discipline profile can provide the necessary support to efficiently implement the component of elite engineering education at civil engineering institutions and universities.

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A.V. Kozlov

UDC 378.4

Thought Process of Engineering "Elite Force": Russian Development Technologies

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The paper studies potential of Russian cognitive technologies of creative engineering thinking. The technologies are based on applied dialectics or the Theory of Inventive Problem-Solving (TRIZ) and can be applied in the elite engineering education. The author suggests using tested didactic technologies.

Key words: engineering thinking, convergent technologies, cognitive technologies, TRIZ, applied dialectics, TRIZ-education, knowledge invention, innovative projects, CAI programmes.

The task to create "engineering elite force" was first announced by A.I. Rudskoy, the Rector of Peter the Great St. Petersburg Polytechnic University, at the meeting of the Presidential Council for science and education on June 23 2014[1]. It is a crucial condition to meet prior challenges of scientific and technological development of Russia, to achieve the targets mentioned in [2]. There are a number of papers, including those issued in "Engineering education" journal devoted to this topic [3]. They underline the necessity of "jumping over some steps" to the sixth technological mode, convergent technology acquisition, interdisciplinary approach to education and science development. The authors [3] consider it very important to train specialists who would ensure such rapid progress by means of "new knowledge and cutting-edge technologies, which are currently unknown". Project-based learning and interdisciplinary approach are regarded as the way to keep up with rapidly advancing technologies, which change faster than contents of engineering degree courses.

Any goal to be achieved needs a complex set of tools. The paper reviews the capacity of the tools invented in Russia, though now being more effectively applied in other countries. These tools are of project-oriented, convergent, and interdisciplinary nature, which provides "jump over some steps" both in technology and engineering education.

First of all, it should be noted that the idea of engineering "elite force" complies significantly with the idea of innovative person, which has been often suggested recently [4]. The term "innovative person" was used in the Development strategy for science and education in the Russian Federation applicable till 2015. In particular, it is introduced in the description of approach № 5 "Knowledge-active": "...the aim is to create an "innovative person", who adheres to innovations and new knowledge regardless his/her workplace and activity area – industry, research and science, public administration, and etc.".

Part V of the Strategy project "Innovative Russia – 2020" was devoted to this notion. It says that "innovative skills development is as important as the sum of all the other tasks of the Strategy". The approved Strategy [5], however, does not contain the term "innovative person". The parts of the project related to the development of innovative person are included in Part V "Development of competencies for innovative activity". The creators of the Strategy may have considered that the development of these features will not have resulted in "innovative person" by 2020. It might be the reason for only partial development of tools to get this target.

All mentioned above makes it obvious that it is high time to develop these tools. Considering possible means, it should be noted that the tendency to innovation and new knowledge has at least two aspects. The first one is the wish and readiness to constantly perceive new knowledge and cutting-edge ideas and put them into practice. This aspect refers to "linear" engineers. In [5] it is defined as "the ability and readiness to continuous education, learning, self-development, professional development and occupational mobility, in other words, neophilia". This aspect mostly refers to engineering designers involved in development of standard projects for different technical devices and systems that differ from those designed before only in numerical parameters. The second aspect, which is becoming more and more important in innovative economy, is the wish and stable ability to solve problems in the area of technological development, to generate innovative ideas, "know-how", inventions, that is all these things that are to be perceived and acquired by the "linear" engineers. It is defined in [5] as follows: "critical thinking ability; creativity". It is obvious that an engineer of "elite force" should belong to the innovative group of the second aspect.

While analyzing the existing tools to form the qualities of an innovative person, it proves that it is a complex of tools relating to the first aspect that is now being developed in Russia. These are business accelerators, business incubators, startup incubators, technoparks, etc., including those for students and even for pre-university students. All these facilities are provided to accelerate implementation of the innovative ideas that already exist. It is thought that there are so many innovative ideas in Russia that it is impossible to implement all of them. However, we more often face the lack of constructive ideas, especially in student business incubators [6]. In all the organizations mentioned above, those who generate the innovative ideas are proposed to implement them as well, though the combination of both these activities does not always fit the psychological features of one person.

Thus, "to jump over some steps" it becomes necessary to intensify the generation of innovative ideas. Until now there has been applied only one tool to stimulate the generation of ideas, it is competitions of innovations. It is important to develop and implement instrumental methods for generating innovative ideas and to train future "engineering elite force" to apply these methods.

As it is stated in [7], other countries have the same goals; however, Russia should "jump over some steps to reach the level of these countries. Their experience shows that, first, the methods mentioned above do exist and have been developing since the ancient times. Second, it is in Russia, where the most effective methodology has been developed. It is applied dialectics or Theory of inventive problem solving (TRIZ) [8, 9], that is being more and more actively used by leading international corporations. For example, in Samsung Corporation, it is considered a good practice for an engineer to be certified by International TRIZ Association – MATRIZ [10]. To meet the education demand TRIZ course is provided in leading international universities, including the "TOP-100" universities. The authors of [7] studied the application of this methodology to form a creative class and provided its classification according to creativity level. The engineering "elite force", which definitely belongs to the creative class, take the 3rd or 4th creativity levels. They also described an innovative education system of new generation, TRIZ-pedagogics, which has a competitive advantage and meet the requirements [5] for innovative education programmes. The paper studies the potential of the system in terms of development of engineering thinking and other features of engineering "elite force".

Under present conditions of transition to innovative society and sixth technological mode, it is reasonable to classify engineering thinking in two levels [11]:

1st level: standard design of constructions similar to the existing constructions.

2nd level: innovative design of fundamentally new constructions. It is the level of engineering "elite force".

In its turn, the second level can be subdivided into the following sub-levels:

1. New ideas are found by the traditional "trial and error" method (TEM), which could be effective with several gifted and talented people. The number of such people is small. The lack of intellectually talented people in conditions of innovative society resulted in such activity as headhunting. Some philosophers and sociologists describe the innovative activity based on headhunting as "the Intellectual Paleolithic age", similar to the Paleolithic age – the age of hunter-gatherers, the difference being that now they are "hunting for heads" and "gathering ideas".

2. New ideas are found by purposeless methods ("divergent thinking" method of focal objects, morphological analysis, "brain storm", etc.). Similar to the previous comparison, this method can be defined as the "Intellectual Mesolithic age".

3. New ideas are found by goal-oriented methods (the combination of divergent and convergent thinking). TRIZ and applied dialectics, which refers to non-anthropogenic systems, contain these methods. This situation then can be defined as the "Intellectual Neolithic age".

The transition from the Paleolithic to the Neolithic age, from hunter-gathering to agriculture and cattle-raising finished about 10 thousand years ago. Alvin Toffler regards this transition as the beginning of the First Wave of the civilization [12]. According to A. Toffler, the present days are the time of the third wave based on intellectual product. However, the transition from "the Intellectual Paleolithic age" to the "Intellectual Neolithic age" are so similar to those that took place 10 thousand years ago, that it makes sense to discuss the assumption about the Forth wave. According to A. Toffler, the Fourth wave should start with the outer space exploration. There is no doubt that it will be a new wave, but it may be the fifth one.

When comparing all mentioned above with the widely used term "intellectual thinking" (for example, in [13] it is defined as "thinking aimed at ensuring innovative activity, it is realized at cognitive and instrumental levels and characterized as creative, socially positive, constructive, transforming and practical"), it can be concluded that the second level of engineering thinking is an essential part of the innovative thinking.

At the same time, the thought process based on goal-oriented methods can be regarded as innovative thinking as well. It is explained by two reasons. The first is that this way of thinking is scientific and technical and is based on fundamental dialectical laws of development both of anthropogenic and non-anthropogenic systems. It is based on the principle that any productive idea is the idea of anthropogenic system development according to laws of dialectics and applied dialectics. The second is that a systemic dialectical world concept is a socially positive concept that regards the world as a complex of systems developing in accordance with some laws that can be discovered and applied to create more perfect systems. Such a worldview can be defined as innovative [14].

The engineering "elite force" training based on goal-oriented methods allows developing convergent technologies by integrating sientific achievements from different field of knowledge. "The big Four technologies" are considered to be convergent technologies that include the information and communication technology (ICT), biotechnology, nanotechnology, and cognitive technology. TRIZ itself and TRIZ-pedagogics are cognitive technologies, since they develop thought process and imagination of a person. The engineering "elite force" can apply conceptually new class of CAI programmes that facilitate generation of new innovative ideas based on TRIZ that needs to be implemented in innovative sphere of Russia. The applied dialectics allows intensifying the interaction between cognitive and bio-technologies. In addition to classical bionics that uses principles of living organisms in technical structures and devices, applied dialectics allows studying natural mechanism of invention by observing the living nature evolution and designing fundamentally new biotechnical systems and biotechnologies. TRIZ has been successfully applied in molecular structure design, which shows promise of TRIZ application in nanotechnologies.

The training is interdisciplinary, since the basic TRIZ principle is its multidisciplinary application in problem-solving and idea generation. To ensure this principle, databases of physical, chemical, geometrical and other effects have been created. Biological, psychological and other databases are being in development stage.

According to the 5-level invention scale by G. Artshuler, the solutions based on interdisciplinary approach refer to the highest levels. Thus, the engineering "elite force" training should be interdisciplinary and project-based, with students of different specialties working together on a project for a company under the supervision of faculty members, which facilitates further employment of the graduates by the company. As a rule, Master's degree programmes are thought to be the most efficient for project-based learning. CDIO (Conceive – Design – Implement – Operate) system introduction allows starting to implement this method in Bachelor's degree programmes. However, the weakest chain of CDIO is the first stage – Conceive. The goal-oriented training together with TRIZ-pedagogics, method of knowledge invention and innovative projects [16, 17], allow creating constructive solutions at the "Conceive" stage, which contributes to the success of further training. Thus, it becomes possible to pass the "Conceive" and "Design" stages and to enter the "Implement" stage at the level of Bachelor's degree programme, while Master's degree programme can be focused on development and perfection of the "Implement" stage, application of virtual settings, Product Life Management (PLM) system, and simulation of the "Operate" stage.

Actually, it means transition from project-based to innovative project learning, which upgrades the model of project-based University [18] to the model of innovative project University.

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UDC 378

Project of Innovative Engineering Education

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The paper provides the analysis of engineering education and proves the necessity to develop an innovative engineering education programme. Basic principles of the innovative education programme as well as qualifications of engineering Bachelor degree programmes are suggested. Education modules of the suggested programme are described.

Key words: innovative education programme, fundamentality, automated systems, mechanics.

Reform of higher education system is continuing, although reversal of the education itself is absent. The development trends of engineering education remain the same, and, in most cases, the existing transfer from 5-year to 4-year education system reveals the fact that the professional content of most education programmemes remain practically unchanged. To implement the principle of continuing education, to integrate and apply the diversity of education programmemes, and to enhance further qualification of engineer-graduates (receiving a Master degree), a new schematic model of developing innovative education programmes has been proposed comparable to the existing programmes. An overview and brief justification including the basic principles of such programmes are being discussed further.

The market expectations of the engineering workforce within Russia revealed the fact that Russia is lagging behind the leading countries within engineering and technology domain [1]. One can observe such a factor as noncompetitive low-quality and expensive product output governed by low efficiency and weak performance (production rate). In Russia today the existing labor market requires no highly-qualified graduates due to the orientation towards resource economy. At the present moment there is a market flooding of low-demand specialists, including engineers. One of the major drawbacks of this situation is the unbalance between higher engineering education content and modern society economic development goals.

The economic development of any country is directly interlinked with the technological infrastructure and automation of present-day production, application and implementation of innovative and energy-efficient technology At this stage the development trend of global economics is determined by advancing high-quality production, promoting knowledge-intensive industry, updating materials, technology and techniques, and developing conceptually new industry sectors.

The infrastructure of any production involving technology and sophisticated techniques is impossible without qualified engineering and technical HR (human resources). The utmost task of professional education is the personnel training, oriented on the needs and demands of developing production and society. The technological modernization of economy and industry is marked by the demand for new generation engineers. Today's knowledge-intensive production requires such specialists that could develop and implement conceptually new engineering and technological approaches based on the integration of different science domains; could perform research, development, design, and engineering tasks and provide the functioning of complicated engineering systems. Consequently, the integration of innovation approaches into the education system is essential in training specialists for high-tech and knowledge-intensive industries.

All in all, the target-oriented requirements involve improving the professional engineering training system itself. At the present moment this system is based on the principle of continuous professional education. However, this system itself is being improved due to the uprising of different education system levels. One major integration stage of a sophisticated system could be considered the development and design of an engineering education and training system within the framework of technical universities under the guiding, counseling and mentoring of well-educated and highly-qualified personnel.

So, what should this innovative engineering education system be? First and foremost, it should be as dynamic as science and technology in its development; it should enhance innovative transformations within engineering and technology domains; it should provide flexible and mobile education programmes relevant to the employment market requirements; it should ensure equal opportunities of receiving qualified higher education for all social groups through flexible educational paths and alternative paths within the framework of different education system levels.

To design the innovative engineering education system, one should consider the fact that the technological modernization of the economic processes involves the acceleration of new engineering knowledge, i.e. progressively fundamental theory is being applied in practical purposes and further transformed into engineering principles. The present-day engineer should have fundamental understanding of nature of things and core phenomena, on the one hand, and possess a vivid imaginative mind in solving difficult technical and engineering production problems, on the other hand. It should be noted that only a well-educated person could be socially protected in the expanding information world. It is a person that is capable of changing his/her profile and always being involved in life-long learning. During a lifetime a person could change his/her sphere of professional activities. In the post-industrial society information, knowledge, research and development have become the basic production resources. It is the results of fundamental research that ensure high production development, prospect of new engineering sectors, as well as so-called "industry saturation", which, in itself involves instrumentation, research, monitoring, modernization and automation. Under these circumstances it becomes evident that the transfer from functional to fundamental learning is vital and could be based on both learning and practical acquisition of the basic development principles of natural, technological, and social systems [2, 3]. The emerging engineer status in this developing society should optimally meet the requirements of the new social-structure: good fundamental training base, being the major distinctive characteristic feature of university education would ensure the graduate's success not only in the professional but also in the social sphere, promoting his/her welfare due to possible professional activity orientation.

The first higher education level (Bachelor) should involve the function of developing the future specialist unique potential to select his/her profile from the far-reaching range of professional specializations. Accordingly, the Bachelor graduate (in engineering and technology) is eligible to take a Master degree programme in any university. In this case basic engineering discipline invariance is required. Growing extent of information, updated IT occurrence, access to knowledge database, electronic manuals, journals and guidelines, and possible e-learning necessitate modification of not only the education content but also learning technology itself.

Based on the above-mentioned aspects the major developing innovative education system principles are the following:

1. continuity;
2. multiple-level system;
3. fundamentality;
4. proactive training;
5. flexibility and diversity;
6. development of economically in-demand engineering education profiles.

Based on the described analysis it is possible to specify and distinguish the dominating functioning engineering education system concept which includes a diversity of education programmes. The proposed innovative education programme would be one of the most important components in this system, focusing on improving the engineering training quality.

The economic analysis of developed countries revealed the fact that there are all possible alternatives in future automated and robot-based engineering-production process development growth. In the environment of the North more or less competitive productions could exist only by using limited manpower energy-efficient technology and backyard production. Many branches of production are mechanized, however, their productivity is rather low since they are not modernized to the existing local climatic conditions. For example, in the construction and mining sectors mechanization is popular, but only involving transportation, drilling, and other similar processes. Predominately, technologically continuous linked systems are not so widely used in production. These technological system are not automated and each is managed separately. There are no robot-based systems. To implement sophisticated industrial (technological) processes, new generation trained engineers are necessary, i.e. specialists in design & development and automated system production & operations. Training such specialists is a multi-stage process which requires an advanced fundamental base to assimilate knowledge-based technology.

Thus, designing innovative education programmes is closely connected with the future-oriented development of advanced economic areas, such as automated and/or limited manpower productions which involve a wide application spectrum of mechanized, automated, robot-based production systems emerging as a module of different mechanisms. The most appropriate education programme (curriculum) within the framework of the Bachelor level is "Applied Mechanics" as it fully accommodates to the above-mentioned principles. The programme project was designed within the context of education modernization principles involving the transfer from functional learning to universal fundamental training. The new project model based on the "Applied Mechanics" programme includes disciplines in mechanics relevant to machinery design. However, it is elaborated, specifically pertaining to fundamentalization of professionally-oriented disciplines. The basic disciplines in the curriculum include basic engineering disciplines in mechanics, which involve an intensive education programme. A student could obtain basic knowledge in mechanics, kinematics, dynamics, interaction of different linking mechanisms and preliminary skills in computation and modeling. The major objective is training students for further Master degree programmes in Russian and foreign universities. In view of this fact the core (professional) module in the education programme also includes basic engineering disciplines. This approach ensures basic fundamental education, which, in its turn, offers an opportunity to continue one's professional learning in different in-demand engineering profiles. Within the framework of such a programme the students also learn the essentials of

IT, principles of automation, including computer programmeming skills – this is the third discipline module. Another important aspect of this programme is developing competencies, i.e. in-depth understanding of technical knowledge, domestic and/or foreign experience pertinent to the engineering discipline through courseware, science literature and journals. To accomplish this, integrated methodology and English language learning are included – fourth education module. **Integrated methodology includes three English learning levels- basic (1-2 courses), university component (3 course) and teaching engineering disciplines in English (3-4 courses).** After completing the Bachelor degree programme students would have the opportunity to continue their education in Master degree engineering programmes in any university abroad.

Thus, innovative engineering education programme includes four professional-oriented modules: **mechanics, fundamental-profes-sional, modeling and programmeming, and communicative.**

The implementation of the proposed innovative programme enables a student to enter any engineering Master degree programme after completing the Bachelor degree programme. The basic innovative education programme provides universal, diverse, fundamental and basic engineering education in effective modeling of different linking system mechanisms. This advanced education major would boost the development of innovative engineering education within North Eastern Federal University in Yakutsk.

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Humanities and Social Technologies to Develop Engineer's Personal Potential in Self-Developing University Environment

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Techno-humanitarian balance conditions the prospects of human survival as well as competitiveness of Russian industry on the global market. This balance depends strongly on such engineers' qualities as way of thinking, ethical priorities and reflexive positioning. The paper describes a practice-oriented approach to study personal potential of modern engineers, development of their personal qualities by means of socio-humanitarian technologies and reflexive approach used in educational process.

Key words: socio-humanitarian technologies, engineer's personal potential, reflexive management, self-developing environment of higher education institution.

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The engineer of the 21st century is a key figure in social and economic space of modern Russia headed for technical and technological breakthrough in science and industry, import substitution, upgrade of engineering education. The vector of thinking, ethical priorities, reflexive position of a future engineer influence today the choice of techno and humanitarian balance both as a condition of survival and prospects of mankind, and as a solution of the local problem of competitiveness of the Russian industry in the world market. The dialogue of natural-science, technical and technological, and humanitarian thinking, logic of interrelation of professional and socio-humanistic knowledge and experience, personal potential of the engineer, their implementation in engineering practice is set by the order and nature of the acquired knowledge to meet challenges of fast transformation in social and technological practices and actual trends of an engineering profession; they serve as prerequisites of the solution of this fundamental problem. Today highly specialized training of the engineer with a dominant of engineering intelligence under «laboratory conditions» of acquiring knowledge and experience becomes insufficient for adaptability to new types of knowledge, change of the purposes and means, ethical priorities, activities in professional practice.

Professionalizing and personal qualities of a modern specialist in general depend on methodology and effective technologies of his education and transfer of professional knowledge in engineering practice. The relevance of research in personal potential formation modality of the engineer of the 21st century and opportunities of its reflexive provision in modern Russian higher education is caused by a block of theoretical and practical factors. The first one is the essence of reasons, certificates of theoretical knowledge as a development of socio-humanistic technology in the self-developing environment of higher education institution, formation of personal potential of the engineer, relevant to modern social and economic requirements with a high level of creative engineering thinking, presenting professional socialization, a set of professional abilities, personal resources, values. The second block considers a problem of transfer, implantation of educational experience of the 21st century engineer personal potential formation to the interval of innovative processes in current and future professional practices. Fast aging of engineering personnel, change of its quality structure, outflow of young qualified specialists from the specified areas to other spheres of social activities are observed. This circumstance does not allow meeting social and technical and technological challenges of the present time – competitiveness of an engineering product in the sphere of high technologies, systemically reproducing and hiring the engineering personnel with the adequate complex of competences that are transformed due to social and economic practices and allows performing engineering, research, socially important functions in the mode of «society of knowledge», «heuristically» (reflexively) and taking professional decisions. Therefore, the problem solving of young engineering and research personnel deficit prepared for effective professional activity under the conditions of constant practices transformation in the sector of production, science and higher education becomes a priority task of the Russian science, education, and industry.

The methodology of professional training of the future engineer has to be guided by basics of modern philosophy of science and technology, principles of post-nonclassical rationality and interdisciplinarity [3, p. 20-25] correlated with the environmental paradigm of the human self-developing systems [1, p. 7-13], ethics of self-developing reflexive and active environments [2, p. 46-50]. Such a methodology of training demands personal potential formation by means of socio-humanistic technologies in the self-developing environment of higher education institution.

The tools of post-nonclassical methodology are for the first time approved in our practice-project approach to preparation of engineering personnel; the key components of personal potential of the engineer are commensurated with the self-developing environment of higher education institution, reflexive activity at the three stages of higher education (a bachelor degree, master course, postgraduate study) and engineering practice. Theoretically, the research serves for expansion of socio-humanistic paradigm in professional engineering education, a concept of «the personal potential of the engineer», and also for determination of constellation features of prepotent personal qualities of the engineer, relevant to the self-developing environment of higher education institution. Scientific knowledge growth implies development of engineering personnel training model by means of the socio-humanistic reflexive technology converging personal, professional competences and ethical priorities of the engineer which corresponds to the role of engineering education, modern trends of engineering practice development, tasks of global competitiveness of the Russian industry. The scientific and applied project results in development and implementation of information model of the self-developing environment of higher education institution with disclosure of the purpose of all the subjects of engineering personnel training, designing of «subjects assembly» and implementation of the project practices in the three-stage educational space of technical higher education institution and engineering practice to develop of personal and professional resources, unite engineering mentality of the 21st century.

Our project of engineering personnel training is initiated due to the following problem. The issues of the law of techno and humanitarian balance violation of the anthropogenous crisis which is initiated by technical and technological intervention at the beginning of the 21st century are widely discussed in the sphere of humanitarian knowledge and science today. The current situation with the consequences, unpredictable for mankind, may be partly overcome by solving the fundamental problem of natural-science and humanitarian paradigms dialogue via understanding the prospects of mankind survival, harmonization of technically oriented engineering intelligence and humanitarian and reflexive mentality based on anthropological, social, and ecological values. The solution of these problems is strongly connected with the issue of engineering personnel training meeting the purposes and standards of domestic engineering product competitiveness in world economy and industry. In its turn, it actualizes the research of methodological tools for analysis of the engineer of the 21st century, constellation of personal and professionally important qualities of the engineer, diagnostics of special knowledge measure and socio-humanistic, reflexive experience in the self-developing environment of higher education institution. The self-developing environment of higher education institution means interaction of all subjects of the engineer professional training (higher education institution, engineering practice (enterprises, business community) on the basis of consistency in the purposes of engineering ethics, reflexivity and all subjects assembly, organization of communicative space, which initiate project identification of engineering mission. The construct of personal potential developed in domestic philosophy, socio-humanistic science by means of reflexive technologies can be helpful to explain the «basket» and dynamics of the professional personality characteristics commensurability of engineering competences and engineering practice challenges [4, p. 8]. The personal potential of the engineer is considered as a generalized (personal, subject, cognitive) opportunity for self-determination, self-development, self-management in the professional and social environment [5, p. 32-36]. Such interdependent variables as the developed reflexive activity, autonomy (self-determination), creative activity, project identification, responsibility, trust, communicative capabilities, which are most brightly demonstrated in the «nonlinear» professional situations are implicit for the construct of personal potential.

Professional activity of the engineer in modern life is accompanied by fast transformation of social and technological practices. This circumstance initiates cognitive flexibility and accelerated adaptability to new types of knowledge, change in the purposes and means, ethical priorities of activities, and also meets the two complementary purposes of education: first, orientation of training process to extremely broad development of the person and formation of personal qualities, secondly, discovery of individual opportunities for permanent cognitive search and maintenance of high level professionalism. Achievement of the specified purposes seems probable in case of reproduction of such educational and cultural invariants in training process of the engineer, which provide world outlook and methodological depth for the ordered process of fast and high-quality learning (through reflexive and critical review) of the most different cultural and technological innovations, and also initiate a synergy of natural-science, technical and humanitarian mentality, priorities of engineering ethics. This reproduction is set by the tools of post-nonclassical rationality, interdisciplinary paradigm by means of the reflexive technologies creating a fundamental basis for perception and translation of any sociocultural and professional models, values of world cultural development.

As a result, the main objective of the project is to develop a socio-humanistic technology of personal potential formation of the engineer in the self-developing environment of higher education institution, to study systematically the main components of the engineer personal potential, features of its constellation in the educational process and engineering practice with complementary definition of possible mechanisms of reflexive impact on this process. Aggregation of the «basket» of competences of the future Russian engineers, determination of knowledge priority will be directed to development of the model of engineers' professional training converging personal and professional competences, professional identification in the self-developing environment of higher education institution. The self-developing environment of higher education institution may be identified as creation of its information model with disclosure of all subjects of engineering personnel training, project of «subjects assembly».

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Issues of Fostering Students' Artistic Taste in the Process of Engineering Education

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The article justifies the need to develop such personal skills of future engineers, as the artistic taste, the sense of beauty, and the inner personal culture. The basic requirements towards mechanical components, connection joints and structures are addressed allowing the creation of not only technically ingenious, but also eye-catching products that would be notable for their harmonic configuration and beauty. Special emphases are put on the phenomenon of golden ratio, inherent to the most attractive and beautiful items created by nature or by human.

Key words: artistic taste, aesthetic culture, visual appeal, expression, beauty, golden ratio.

Owing to the modern rapid development of science and technology there is a possibility of an occurring tendency towards lower requirements for the artistic taste of an engineer with respect to his/her engineering decisions. This may lead to the decrease of the aesthetic qualities of developed items. Finding successful solutions to modern issues of new technical systems' design is only possible in the case of increasing inner aesthetic culture of engineers.

It may seem at the first glance that issues of aesthetics, that need to be solved by a technical specialist, could be handed over to designers or application-oriented artists. However the practice indicates that these specialists, who lack basic engineering knowledge and engineering support, are not capable of creating aesthetically ingenious technical systems [1]. On the other hand, in case if such specialists do not have an opportunity to get direct involvement in the design and development of technical products, engineers are required to take over their functions. Therefore, an engineer has to be specifically trained to conduct these tasks, as well as to be ready to cooperate with professional designers.

As a result higher education institutions have an arising need for sufficient enhancement of engineers' aesthetic culture.

In order to enhance aesthetic education of mechanical engineering students it is necessary to emphasize and demonstrate the most relevant, highly ingenious and beautiful technical decisions within the teaching process of basic engineering and specific professional courses. Such demonstration of technical items' beauty standards with relevant comments would form and foster students' taste and sense of beauty in the field of technology. Besides, this would assure the most efficient and solid understanding and acquisition of study material, since it would be obtained via two channels simultaneously – through the thoughts and logical thinking and through the feelings.

Thus, when designing new mechanical products it is necessary to ensure not only the technical excellence (that is the main indicator of product's quality), but also the coinciding appearance, its visual attractiveness. Advertised technical excellence of a product would be acknowledged only in the process of its exploitation, but the external appeal of a product, reflected in a showpiece or on a picture in the company's catalog would, in no doubt, affect the customer's decision on purchasing a particular type of mechanical product. Therefore, the focus on aesthetic excellence of products may spike their competitiveness.

The key components of the external appeal of a technical product that need to be taken into account by engineers when creating new mechanical products are, first of all, predefined by:

- The material of the product, the choice of which is usually strictly limited by the functional attributes. However when choosing the form and method for item production it is necessary to strive for exploiting the natural beauty and the texture of the metal.
- The structure of the surface that depends, in most cases, on the tooling method, and in some cases – on the texture of the design or hard-wearing surfaces.
- The overall dimensions, their correlation, and the correlation of dimensions of the product's parts. These parameters are usually defined by the functional purpose. However, in any case, it is necessary to strive for a maximum correlation of product's dimensions with the dimensions of the space, where this product will be exploited.
- The spatial outline that represents a mix of spatial "hard-lined" (cube, prism, pyramid, etc.) and "soft-lined" (cylinder, cone, solid sphere, etc.) geometrical forms [2]. Designers usually tend to "soften" the edges and corners by rounding them; that, except for its external expression, contributes to decrease in stress concentration, increase of fatigue endurance, preservation of the surface, and allows to keep the product's surface clean easier.
- The contour (silhouette) of the product, which is designed to be balanced and beautiful. It should be taken into account that horizontal lines on the product leave an impression of its stableness and sustainability, whereas the vertical lines – an impression of slenderness.
- The existence of small cymatium on the main surfaces of the product that may serve for different functional purposes. They tincture decorative value and have a positive aesthetic effect on human.
- The color scheme. The use of a few different and at the same time harmonic colors strengthens the aesthetic impression and significance. Besides the aesthetic criteria of color, it is worth to take into account the corrosion resistance requirements, durability of paints and surfaces, as well as the technology and economy of the color decorations.
- The combination of light and shades on the product's surface that should consider the character and the intensiveness of the light needed for product's exploitation.
- The inscriptions, symbols and digital data imposed on the front sides of the product. A well-done inscription makes a positive emotional impact.

Besides ensuring external attractiveness of product's elements, product design engineer should keep track of the product indicators' originality in order to create the sense of its dissimilarity and uniqueness, its individuality, recognizability, and specific historical novelty. At this, the appearance of the product should create an impression of harmony and consistency with the surrounding equipment elements and other hardware.

It is worth noting that most of the previously outlined components of technical items' external attractiveness should consider an opportunity to exploit such distinguished psychological phenomenon influencing human's perception of the product's appearance, as the "golden ratio".

It has been since the Ancient times that people have noticed a certain quantity responsible for the ratio of overall dimensions and dimensions of particular parts of the most ingenious and beautiful creations of construction workers, architects, sculptors and artists. This ratio was named the "golden ratio". It is common that such "beauty" had appeared accidently, so to say, intuitively in the works of the creators; and the latter analysis discovered the existence of the "golden ratio" in their works.

The history of material and spiritual cultures of the humanity accounts a few of irrational numbers that take up a special place, since they reflect some ratios that are universal and occur in the most unexpected phenomena and processes of the material and biological worlds. These numbers include: the number π, the ratio of a circle's circumference to its diameter, the Euler's number e that is the base of the natural logarithm, and also the one known from the ancient science – the number d – the "golden ratio" or the "golden section", according to Leonardo Da Vinci.

Since the "golden ratio" phenomenon occurs and is used in many spheres of exact sciences, biology and art, there are many studies devoted to it [3]. At the same time, it should be admitted that an insufficient time is spent on exploitation of the "golden ratio" in new product design and engineers' training in terms of the art of creating technically ingenious and beautiful structures.

The principle of finding "golden ratio" is the following: divide the AB line segment with a point C so that the ratio of line segments $\frac{AB}{AC}$ and $\frac{AC}{AB}$ is equal. When transforming this setting to the mathematical format, the following quadratic equation is true:

$$d^2 - d - 1 = 0,$$

where the positive root is

$$d = 1.61803...$$

which is called the golden ratio.

Its derivatives are also widely used. Thus, its ascending series is the following:

$d^0, d^1, d^2, ..., d^n = 1, 1.618, 2.618, 4.236, ..., 1.618^n$;

and the descending series is:

$d^0, d^{-1}, d^{-2}, ..., d^{-n} = 1, 0.618, 0.382, 0.236, ..., 1.618^{-n}$.

In the context of training future mechanical design engineers it is worth noting that the design of new products in all cases has to, first of all, encompass an analysis of a possibility for the dimensions' ratio to be the "golden ratio" without decreasing products' workability.

It should be mentioned that an externally attractive product is not particularly required to have the overall dimensions' ratio precisely equal to the number stated above: unlike the π and e constants, the golden ratio may differ within a certain range and not be exactly equal to the d number or its derivatives. At this, the psychological influence of such products would still be significant.

Overall, when training engineers, who will be involved in the creation of new mechanical engineering products, it is necessary to foster their will to take into account the "golden ratio" phenomenon indicators as often as possible when designing new products.

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UDC 378

Preparation and Conduct of WorldSkills Competitions as an Innovative Method of Technical Student Training in Vocational Education System

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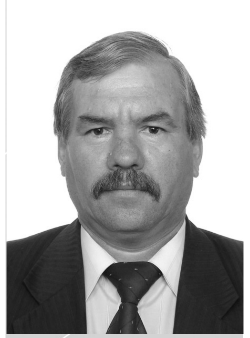

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The paper examines the issues concerning preparation and holding of professional skill competitions between experts in automotive repair. It also provides the assessment of auto mechanic training in terms of its conformity with the global requirements to technical specialists of the automotive service industry.

Key words: WSI; technical training; innovations in education, professional skill competition, vocational education.

The design of cars is constantly becoming more complicated that demands improved training of car service professionals – mechanics. Development of car design is possible to trace by the example of VAZ cars: from VAZ-2101 model of 1970 (Fig. 1) to Lada Kalina II of 2014 (Fig. 2).

While analyzing the design of these cars, it may be noted how configuration, engine, fuel system, transmission, and suspender have changed. Besides, the esthetic side of expectations and requirements of the car owner has increased. The electronics was used in all systems of the car; compactness of units and mounts has increased. However, meanwhile the system of mechanics training has not changed, which is obviously connected with the 'left-over principle' of financing educational institutions of the vocational education (SPE).

In the system of AVTOVAZ technical support service which preceded a modern dealer network of the Volga automobile factory, the level of training could be estimated by results of the professional skill competition. Now traditional professional skill competitions were changed by the competitions under the auspices of the movement WorldSkills.

WorldSkills International (WSI) – an international noncommercial association aimed at increasing the status and standards

Fig. 1. VAZ-2101, 1970

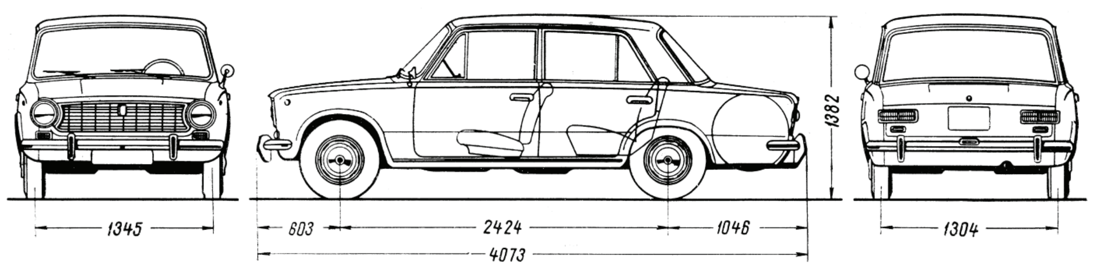

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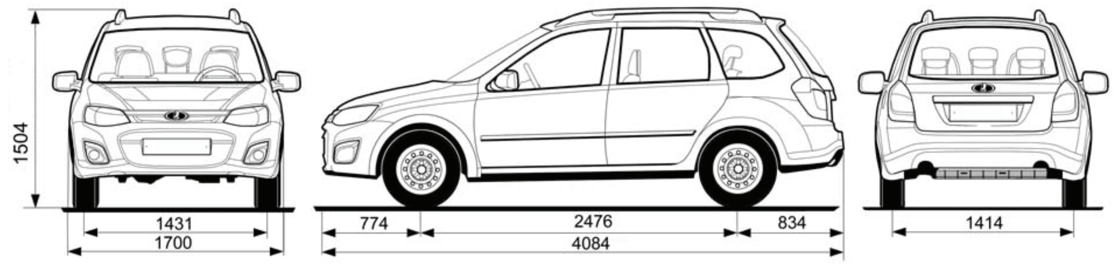
Fig. 2. VAZ-2194 Kalina II, 2014



of vocational training and promoting working jobs through international competitions. The association was created in 1946, the first championship was held in 1947 between Spain and Portugal. Now WorldSkills is the world's largest competition of professional skills. The primary activity of WSI is holding the Skill World Cups WorldSkills for young people aged from 16 till 25 years; it happens every two years. These competitions are figuratively called «The Olympic Games among those who can work with hands».

This movement is now developed in Russia replacing domestic competitions of professional skill. The first All-Russian competition of professional skill «The national WorldSkills Russia championship – 2013» took place in the spring of 2013 in Togliatty. More than three hundred participants aged from 18 till 22 years – students of vocational education establishments, winners of regional competitions – participated in the championship. At the beginning of 2015, Russia submitted the application for holding the World Cup of 2019 in Kazan.

Three WSI competences on car repairs are actual for domestic specialists of car service:

- «Automobile Technology» (according to the WorldSkills International № 33 classification) [2],
- «Auto body Repair» (№ 13) [1],
- «Car Painting» (№ 36) [3].

The lists of works which these experts have to be able to do are as follows:

1. Automobile Technology (auto-mechanic) – service, repair of mechanical and electric part of the engine, transmission, and running gear of the car including electronic and hydraulic systems.

2. Auto body Repair (auto body repair technician) – replacement, recovery of the bearing and hinged elements of the car body including preparation for coloring and replacement of electronic security system elements.

3. Car Painting (car painter) – coloring, recovery of the paint coating and drawings on the body details of the car, including plastic ones.

The most widespread and demanded of the listed professions is No. 33 «Automobile Technology». The WorldSkills competitions in competence «Automechanic» involve the following modules:

A. Diagnostics and repair of the control system of the gasoline or diesel engine.

B. Diagnostics, repair and adjustment of the steering system and suspender.

C. Fault tracing and repair of electrical and electronic onboard systems.

D. Repair of the mechanical systems of the head and engine block.

E. Diagnostics and repair of the braking systems and road-holding ability.

G. Repair of the main units and auxiliary systems of transmission.

In the Auto body Repair competitions (auto body repair technician) the participant of the competition has to show a range of abilities in the field of body repair. The WorldSkills competitions in competence «Auto Body Repair Technician» include the following competitive modules:

A. Check of geometry and repair of the bearing components of the crashed car body.

B. Replacement of the detail of the bearing body framework using welding, deseaming, and preparation for coloring.

C. Replacement of the external detail of the body using welding, deseaming, and preparation for coloring.

D. Repair of the crashed external detail of the body and preparation for coloring.

E. Diagnostics and replacement of the elements of passive safety systems (pillows and safety belts).

In the Car Painting competitions (car painter) the participant of the competition has to show a range of abilities in the field of body repair. The WorldSkills competitions in competence «Car painter» involve the following competitive modules:

A. Preparation and coloring of a new body detail.

B. Fault clearing of the paint coating with local coloring.

C. Repair of the painted detail with masking and coloring inside and outside.

D. Selection of color and color matching including determination of the color code and preparation of the test plate.

E. Preparation and coloring of the nonmetallic (plastic) detail.

F. Drawing on the body details with polishing.

It is interesting to note that in the description of the competitive tasks for competence «Automechanic», there is a list of modules which cannot be included there: such as works with the fuel atomizers and high pressure pumps, conditioner filling up, replacement of oil etc. By the way, the unskilled official translation of the technical specifications into Russian strikes; it causes bewilderment of domestic professionals, and it can provoke some mistakes of competition participants. As an example, it is possible to list new terms formed by literal translation of phrases «compressionnoe zazhiganie» or «structurnye/nestructurnye elementy» though these concepts are well known and clear for many years in the Russian technical language.

The regulations of the international competitions are rather accurately and scrupulously registered (here the official-English version of the documents is already meant) including the course of the competition, observance of safety requirements, and even the ethical moments [4]. The point-based system using objective and subjective evaluation criteria is applied for assessment of the performed works at the WorldSkills competitions, the subjective criteria are not applied for automechanics among the three considered competences.

The key figures at the WorldSkills competitions are the contestant (participant) and expert. The pupils of initial, average, and highest professional establishments, and also the young working professionals who have achieved good results in work may be contestants according to the regulations of the competitions [5]. The expert is a person possessing experience in any specialty, profession or technology representing the participant at the professional competition. It is necessary to call a problem of expert training who, speaking the language of sports, connect the function of the trainer and judge in the field.

My personal experience of participation as an expert in the regional competitions in competence «Automechanic», allow me to note two moments: first, the contestant's victory is unambiguously defined by his extensive practice (trainings), and secondly, the choice of the representing expert is important for successful performance of the contestant. The requirements to the expert are practical work in this domain, theoretical knowledge, pedagogical (trainer's) abilities, and physical endurance (it is desirable, if the person is young). The simulators for practical skills training [6] are perspective.

The problems which were revealed due to the first participation of the Russian team on WorldSkills International World Cup final are noteworthy. In 2013 the winners of the national championship in Togliatty went to Leipzig. According to the results of the competitions in Leipzig, the Russian team had the 41-st place with Chile, Estonia, Iceland, Kuwait, Oman, and Saudi Arabia.

After the analysis of the results it turned out that our participants have conceded slightly in the quality of works, but they could not compete in the speed as some tasks were performed for the first time. Moreover, even the experts who had arrived with the participants were not familiar with them. Besides, the tools of our participants technologically lagged behind the tools of their competitors. Some long-competing contestants even brought the tools constructed and manufactured by special orders; it allowed them to do work more efficiently.

The teams of experts from other countries, unlike Russia, were mostly specialists of industrial enterprises. It was attributed to the fact that they better knew the equipment and technological processes. The Russian team of the experts for WorldSkills-2013 comprised academic staff of educational institutions, but not specialists from enterprises. The training content of the current vocational education could not ensure the victory in the championship; and it proves again the fact that the production workers should be directly involved in qualified personnel training. To compare, there is a system of dual education where study means not only theoretical, but also practical preparation work, and business actively participates in financing such education in the three of the winner countries in the championship of 2013 (Switzerland, Austria, and Germany).

It should be noted that WorldSkills not only develops professional skills and competences, but also determines professional standards in the areas of production presented in the championship. Domestic FGOS SPO in the specialty 23.02.03 «Maintenance and repair of motor transport» fails to meet the international standards of WSI in terms of the requirements for modern car service [7]. The excellent student of our SPE will not be able to perform a half of competitive WorldSkills modules without additional training.

The Ministries of Labor and Social Protection of the Russian Federation published a list of 50 new, perspective, and most demanded jobs in 2015 [8]. There were only two professions of car service in Top-50: «Mechanic» and «Specialist in service and repair of automobile engines». Unfortunately, car painters and auto body repair technicians were not supported by the Ministry of Labor.

Conclusion

Holding the WorldSkills Olympic Games in Russia leads to positive tendencies now; it increases the training quality level of car service technical specialists and stimulates development of the system of vocational education.

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Electronic Presentation as a Factor to Improve Learning Outcomes in Mathematics: the Case of Elite Engineering Education

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The paper describes the dependence of the quality of mathematics education on the methods applied at lectures delivered for elite engineering students. Two approaches to giving lectures, conventional and presentation-based, are compared. The academic progress performed by students within the frameworks of these two approaches is assessed. The assessment is based on the comparative analysis of the results achieved by students doing theoretical tasks in different sections of the course.

Key words: electronic presentation, mathematics education, lectures, elite engineering education.

Tomsk Polytechnic University (TPU) is one of the leading higher education institutions in Russia: it ranks fifth among national engineering universities. Since 2008, TPU has had the status of national research university, which implies that the university graduates, besides having a bulk of knowledge, have developed the abilities to analyze and summarize the information obtained, integrate the knowledge acquired through studying different sciences, conduct research, and create new products. Therefore, the most important of university's objectives is to train highly-qualified professionals, who are aware of modern trends in science and manufacturing, have an ability to reflect on their work, and are in demand on the labor market [1]. There should also be graduates with the potential to conduct scientific research.

Starting with the first years of professional activities, the educator should be focused on achieving the major objectives, even if facing challenges. One of the difficulties to be overcome when teaching first year students is different levels of student's background knowledge. Some students acquired profound knowledge at school while the others failed to obtain sufficient knowledge even in the disciplines which are majors at technical universities (mathematics and physics).

Diverse levels of student's background knowledge result in different numbers of academic hours necessary to study new material: some students comprehend new information quickly and easily, while the others lacking sufficient basic knowledge need much more time. To solve this problem, TPU has implemented the system of three pathways for studying mathematics and physics: basic, adaptive, and profound.

Compared to the basic pathway, the adaptive one implies more academic hours and is designed to fill in the gaps in school knowledge, which hinder comprehension of new material.

The profound pathway for studying mathematics is implemented as elite engineering education (EEE) [2]. One of the EEE project targets is to distinguish students eager to solve original research tasks and to create special conditions for nurturing student's research potential.

The type of pathway is determined via entry testing which is held for first year students over the first days of studies. The unified state exam (USE) results do not always reflect the level of knowledge, which is attributed to the fact that USE tasks are typical and applicants are simply trained to solve the tasks of a particular pattern. The tests for students are also developed to check the knowledge within the scope of school programme, however, they are diverse and, as a result, are more efficient in identifying the level of background knowledge. The students who get less than 50% of points then follow the adaptive pathway and the rest of the students follow the basic pathway. The students who get more than 90% can take an additional test and be selected for EEE. As a result, EEE is for students with profound background knowledge who find the educational process within the basic pathway tiresome since they need less time to understand theoretical issues and develop practical skills. Therefore, compared to the basic pathway, the EEE programme is more sophisticated.

The EEE programme is more than 10 years. In compliance with the programme, over the first four semesters, the student acquires profound knowledge in mathematics and physics. In general, the blocks within the disciplines are the same as those within the basic pathway programme, but they are taught in detail and the tasks are more complicated. Moreover, there are some topics that go beyond the scope of higher mathematics programme developed for the majority of specialties (mathematical statistics, partial differential equations, etc.).

At higher education institutions, the educational course on mathematics includes lectures and practical tasks, with lectures being particularly important component at Russian universities [3]. As a rule, lectures take 50% of discipline academic hours. The lecturer plays a major part as he/she presents the developed educational material with the emphasis on theory. It is at the lectures where students learn to conduct a logical argument, which is an essential skill for a prospective engineer.

Over the first two years of the EEE programme implementation, students were taught in compliance with a classical scheme, i.e. the lectures were given in the form of the lecturer's monologue on basic concepts, theorems and their proving. The lectures served as foundation for solving practical tasks. At the end of each semester, there was a final test to assess the knowledge obtained by students following the basic and the profound educational pathways (the results are given in Fig. 1).

As seen in the diagram, the outcomes of the basic education and the EEE programmes are similar, with better results of EEE students being attributed to successful performance in solving practical tasks. The level of theoretical knowledge was approximately the same, however, the potential of EEE students was higher and they were supposed to achieve better results. To identify the reason for such unexpected performance, we conducted a survey among EEE students. The questionnaire was developed to identify the challenges students face during the lectures. None of the students answered that they faced no challenges and the difficulties specified were as follows:

1. Difficulties in making notes due to the lecturer's fast speech (34%).

2. No visual aids for concepts presented (38%).

3. Difficulties in understanding theoretical material and following the lecturer's logics without any visual aids (69%).

4. Difficulties in formulating clear questions to the lecturer (32%).

5. Insufficient number of examples to illustrate the theoretical material studied (67%).

6. No time to reflect on new material (64%).

Based on student's answers analysis,

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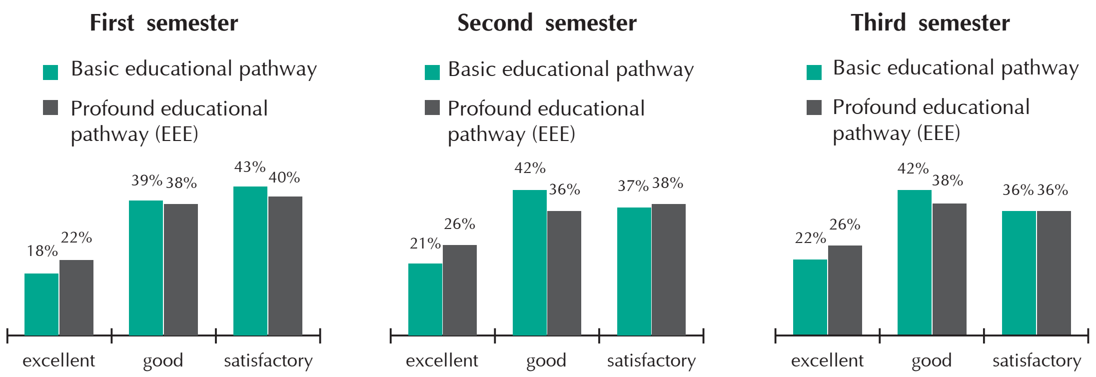
Fig. 1. Learning outcomes of students following basic and profound educational pathways over the first two years of EEE programme implementation.



we identified the disadvantages of lectures given in the form of the lecturer's monologue:

1) passive perception of information provided;

2) while lecturing, the lecturer fails to adjust the pace to student's individual needs: some students have enough time to reflect on the information while the others can only make notes;

3) the lecturer does not get any feedback from students and cannot monitor the educational process;

4) educational forms and methods at school and university are different: at school, the emphasis is put on practical skills and students often have poor knowledge of theory, which causes challenges for first year students.

The disadvantages identified, it is necessary to eliminate them and improve educational process to obtain the expected learning outcomes.

The lecture can be enhanced via introduction of active learning forms and methods [4]. The lecture should not be a monologue but a conversation with students. The lecturer should address students with questions, involve them in discussion. When answering a question, the student reflects on the information obtained and changes his role of passive listener for the active participant of education process. This allows making shift from transmitting information to developing cognitive skills and elaborating scientific methods of information processing.

At the end of the lecture, it is also important to ask a number of questions on the studied material so that the students can identify the key points.

Another tool to improve the lecture efficiency is to make historical references when giving a definition or explaining a theorem. This is due to the fact that students lose concentration when processing a bulk of theoretical information, while historical facts and practical examples allow deviating from the main topic for a while and then concentrating on the studied material again.

Technology advances and modern devices (computers, projectors, etc.) the classrooms are equipped with can also improve the lecture performance.

In our opinion, one of the effective tools is electronic presentation [5]. Over three years we were experimenting with different types of presentations on different mathematical topics. The aim was to determine what kind of material should be put on slides and identify the best way to present the material. Having analyzed the experience obtained [6], we made a conclusion that the adequate information to be put on slides is definitions, theorems, and figures. As for theorem proof and examples, they are to be given on the

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board. The reasons for this way of material presentation are as follows:

1) The definition and theorems are given on slides using quantifiers and contractions, therefore, the information is conveyed concisely and can be easily comprehended. Moreover, this concise information is perceived as a figure visualizing the knowledge obtained.

2) Electronic presentation allows avoiding lecturing heavily with a fast pace: the lecturer has enough time to comment the definitions and theorem given on the slides since he/she need no time for writing.

3) There are opportunities to emphasize key ideas and new terms via changing font and colour.

4) When there is a bulk of information to be processed, the student inevitably loses concentration and stops following the lecturer's logics. Electronic presentation conveys information concisely, and this creates an illusion that there is less information to be comprehended, which results in more efficient cognition.

5) The lecturer has more time for giving examples and discussing new topic with the audience. The dialogue between the lecturer and student clarifies how well the material is comprehended, which information should be revised or added, and what attention should be paid to when doing practical tasks.

6) Electronic presentations are available and students can look through them in advance, think of the questions to be asked, which significantly improves student's cognitive skills.

Results

The experiment was conducted over two years and involved two groups comprising 48 and 43 students, respectively. For these groups, the lectures on mathematics were given with and without electronic presentations. In the first semester, the first group had lectures on Linear Algebra and Analytical Geometry (LAAG) supported with slides and lectures on Differential Calculus (DC) given without presentations. In the second semester, the same group had lectures on Integral Calculus (IC) presented with the supportive slides and the course on Differential Equations (DE) given without. The second group had lectures on Differential Calculus (DC) and Differential Equations (DE) supported with slides and lectures on Linear Algebra and Integral Calculus (IC) without presentations. The aim was to identify the best way to comprehend the theory, therefore, the final exam comprised the tasks of two types. The fist type was developed to check the knowledge of theory: the students had to give a definition or formulate and prove the theorem previously explained by the lecturer. The other type was theoretical task developed to determine the level of theoretical knowledge: the students had to prove the statement based on the theoretical knowledge obtained. The exam results are given in Fig. 2.

As seen in the diagram, the numbers of students giving answers for theoretical questions slightly differ in two groups. However, the number of students coping with tasks is higher in the group which attended lectures supported with electronic presentations. This proves the idea that electronic presentations used as visual aids for lectures lead to more efficient cognition: the students can not only give answers to the question on theory (since they learned some definitions and theorems), but are able to reflect on the information obtained and can use it appropriately, which proves a high level of theoretical knowledge.

The experiment results indicate that electronic presentations are very contributive to improve lecture performance. Over the past five years, we supplied all the lectures on mathematics with visual aids (electronic presentations) and assessed the efficiency of lecture performance via developed theoretical tasks. Fig. 3 presents the results of these innovations.

These data prove the idea that electronic presentation significantly improves student's knowledge of theory.

Conclusion.

All TPU classrooms are equipped with multimedia devices, which allows supplying lectures with visual aids, i.e. electronic presentations, which improves the education provided.

Based on the experience obtained, we can say that electronic presentation used to provide visual aids for lectures allow students:

1) to better understand the information due to its being conveyed concisely;

2) to spend more time on reflecting of the information since there is no need to make notes on definitions and theorems;

3) to prepare for lectures in advance since all presentations are available;

4) to perform efficiently at practical classes as electronic presentation facilitates information processing, which is important for solving practical tasks.

Electronic presentations used in educational process improve lecture performance. As the lecturer need not write down definitions and theorems, he/she can focus on explaining new material, giving comments and examples. Since the presentations are available and students can look through them in advance, they can participate in discussion, which makes student's work at lecture more effective and ensures profound comprehension.

Therefore, electronic presentation is a tool to visualize education content. It improves interaction between lecturer and students and lead to more efficient acquisition of theoretical knowledge.

Fig. 2. Lectures with and without electronic presentations and final exam results

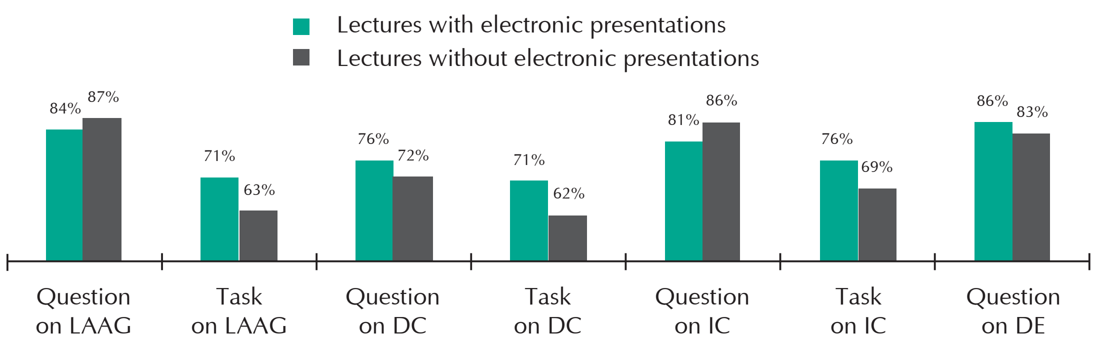
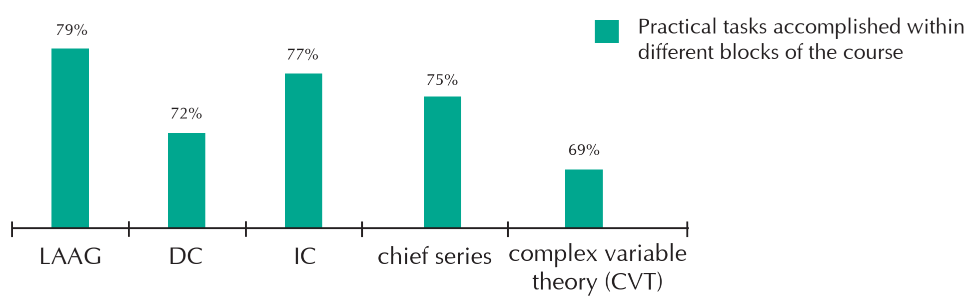


Fig. 3. Practical tasks accomplished within different blocks of the course



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Unification of Engineering Education Programmes

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The article deals with the unification of engineering academic programmes. It provides a professional functional map and generalized analysis of the competencies included in FSES in engineering. The author suggests a unified engineering education model developed in terms of the structure of basic competencies and including competency-based modules.

Key words: unification, engineering education, functional map, competency, credit-modular structure, education programme.

The concept of improving the Russian higher education system, involving the transition to FSES (Federal State Education Standards) HE (Higher Education), multitiered-level education and integrating the competency-based approach were defined in the strategic objective itself: **"the development of fundamentally-oriented, practice-oriented and innovative higher education".** This also includes the industrial-innovative strategy, i.e. uniting the development strategies of education and science with the development strategies of different economic sectors.

The three above-mentioned strategic aspects could be defined as:

- **fundamentally-oriented** – unifying the programmes within the framework of sciences and developing the basic education modules (units) for fundamental student training in terms of the best Russian education traditions;
- **practice-oriented** – developing industry-functional models of professional activities as formalized requirements in organizing the educational process with in-depth practical dominance instrument;
- **innovative** – competency-based model for future specialist based on the principle of productive competency to shape professional skills and further professional experience.

Professional engineering education is technically – oriented, based on the fundamental principles of natural sciences, theory of human activities and interpersonal relations, knowledge of project management methods and active communicative skills. This predetermines the unification factors of basic engineering education system, its cognition and fundamental orientation.

Universality of numerous engineering activity functions promote the application of the integrative approach in the education process for training engineering Bachelors. The aim in this case is to **develop a unified teaching-learning model, determining the standard engineering education requirements, regardless of this or that programme and to recommend a body of relevant activities (actions) in developing integrated academic programmes.**

Instructional research in shaping the conceptual framework for unified engineering education programmes has been conducted in Cherepovets State University. The experimental base involved four Bachelor programme tracks: 08.03.01. Civil engineering [1],13.03.02 Power and electrical engineering [2], 15.03.01 Mechanical engineering [3] 22.03.02 Metallurgical engineering [4].

The following tasks were solved: development of universally functional map; classification of competencies and development of universally functional engineer's map; credit-modular structure design of the education process.

The development of the universally functional engineer's map was based on the qualification requirement generalization of industrial-occupation standards, job profile diagram (system of attributes describing this or that type of engineering activity), recommendations of internationally-recognized engineering certification system (for example, APEC Engineer). The results of obtained generalization are illustrated in Tab. 1.

Table 1. Basic universal functions of specialists in the domain of engineering and technology (functional map)

Universal functions	Content
1. Non-technical and professional ethics	Associated with informative, civil-social, social-labor, cultural-leisure and communal activities.
2. Standard technical knowledge	Representing the science-based foundation to perform research assessment and technological forecasting, systematic R&D and conceptual technological product management.
3. Assessment and technological forecasting	Focused on identifying the technological contradictions and production requirements.
4. Engineering activity research	Involves the identification of the process flow diagram, strategy method of "inscribing" the planned task in the frame of natural and engineering science laws.
5. Engineering development	A body of well-known engineering techniques and elements which embrace newly high-quality functional attributes.
6. Engineering design	Technological concept attains its final form as a contractor drawing which completes the engineering planning production.
7. Technological (engineering)	Associated with the interaction of technical- work processes, which, in its turn, minimizes time and material consumption due to the interaction of human resources and technologies, and, furthering a more effective operation of the engineering systems.
8. Production management	On-the-spot organization of employee-employee teamwork and subordinating one specific engineering problem-solving to on team.
9. Operation and maintenance	Debugging and maintenance services of machines, automatons and production lines; monitoring operation regimes.
10. Economic-investment	Constant assessment and planning of the economic results; improving production efficiency and gaining a foothold in the market.

In engineering educational programme tracks (FSES HE) the professional functions are described in the section – "Professional activity characteristics" (Tab. 2).

Generally speaking, the functional map should be designed within the framework of the professional domain standards, which, in its turn, would assign a system of indicators establishing the conformance extent of a worker's professional activity relevant to the existing employment market requirements. This includes a set of typical professional functions of this or that professional activity which a person preforms in one specific profession (job). Performing the professional functions would promote the acquisition and development of those competencies which shape the professional competency of this or that employee.

A set of competencies is a group of related behavior indicators incorporated into several units, and, depending on the conceptual content, form a definite structure of integrated group of basic competencies. Based on the stated competencies in FSES HE, the basic competency groups were unified and structured in analogue to professional functions (Tab. 3). It is evident that some are industrial-based

Table 2. Professional activity characteristics of Bachelor in Engineering and Technology (FSES HE)

№	Engineering educational program track (FSES HE)				Integrated characteristics
	08.03.01. Civil engineering	13.03.02 Power and electrical engineering*	15.03.01 Mechanical engineering *	22.03.02 Metallurgical engineering *	
1	non-technical and professional ethics	non-technical and professional ethics	non-technical and professional ethics	non-technical and professional ethics	intellectual-corporate
2	experimental research	research	research	research	research; experimental-analytical
3	research and development (R&D)	research and development	research and development	R&D and analytical	R&D
4	technological production	technological production	technological production	technological production	technological production
5	production management	production management	production management	production management	production management
6	installation-set-up and operation-service	operation and maintenance			operation and maintenance
7	entrepreneur-ship				economic-investment

* it should be noted that no business activity type has been established in FSES HE

competencies, however, they are practically identical to the mentioned competencies in the system model.

The proposed functional map simply lists the practical-oriented tasks which the engineer association and employers set for the engineer training of higher education institutions.

Table 3. Structured competencies for Bachelor in Engineering and Technology in the education program tracks: 08.03.01, 13.03.02, 15.03.01, 22.03.02 (competency – based map)

Basic competencies	Competencies
1. Intellectual-corporate	**(BCC-1)** Ability to apply knowledge of fundamentals of philosophy in developing one's worldview approach. **(BCC-2)** Ability to analyze the basic stages and principles of society historical development to enhance active citizenship. **(BCC-3)** ability to apply basic economic knowledge in different social spheres. **(BCC-4)** Ability to apply basic legal knowledge in different life-sustaining activities. **(BCC-5)** Ability to communicate effectively and to use written / oral communication in Russian and English to solve interpersonal and intercultural problems. **(BBC-6)** Ability to function effectively as an individual and as a member or leader of a team in multi-disciplinary settings (social, ethic and diverse cultural). **(BCC-7)** Ability to recognize the need for, and have the ability to be engaged in independent and life-long learning. **(BCC-8)** Ability to apply the methods and techniques of physical training to ensure full social and professional activities. **(BCC-9)** Ability to apply first aid and protection methods in case of emergency situations.
2. Research	**(BPC-1)** Understanding the underpinning natural and physical sciences applicable to the engineering discipline; applying mathematical analysis methods and design, theoretical and experimental research. **(BPC--2)** Conceptual understanding of information in the development of a society; fluently applying relevant investigation analysis, interpretation, assessment, measurement and knowledge management of information from different sources and database and presenting it in relevant format via computer and network technology. **(BPC-3)** In-depth understanding of technical knowledge , domestic and/or foreign experience pertinent to the engineering discipline.
3. Experimental-analytical	**(BPC-4)** Fluent application of measurement methods relevant to performance conditions; ability to design and conduct experiments, analyze and interpret result data and formulate reliable conclusions. **(BPC-5)** Sbility to interpret and ensure compliance with relevant meteorological regulations and rules; to meet the requirements of national and international standards; to conduct patent research. **(BPC-6)** Ability to prepare high quality engineering documents as progress and project reports; implement results of investigations and feasibility studies.
4. R&D	**(PC-1)** Ability to contribute and manage engineering project activity relevant to technical specifications and technical standard documents; be aware of different technological and ecological requirements. **(PC-2)** Proficiently apply industry-standard software to the planning and execution of project work. **(PC-3)** Ability to plan and quantify performance over the full life-cycle of a project relevant to technical documentation, conditions and other regulatory documents; to conduct preliminary technical and economic assessment of sustainable outcomes in all facets of the engineering project work.
5. Technological production	**(PC-4)** Ability to plan technical and production documentation via updated instrumentation; to determine the technological parameters and performance regime of engineering activity facilities. **(PC- 5)** Ability to ensure required regimes and specified parameters of the technological process; address broad contextual constraints as environment, human factor as well as health and safety and sustainability as an integral part of the process. **(PC-6)** Ability to understand the need for monitoring process specification, quality management of technological regime parameters, service and performance of technological equipment; to apply quality control management in engineering activity and prepare all documents for quality management. **(PC-7)** Ability to perform the engineering development and implementation of technological processes into new product line; to monitor the quality of installation and set up during testing and commission of new samples and facilities.
6. Production management	**(PC-8)** Should competently address all problems in the organization and work standardization, apply process approach, develop core planning of primary production departments, analyze the cost benefit of these departments, design technical documentation, as well as prepare registered form of reports. **(PC-9)** Should operate all basic protection methods from all possible accidents and natural disasters **(PC-10)** Should function as an effective member or leader of engineering team and apply the principles of production management and human resource management. **(PC-11)** Should design technological documents (employment schedules, instructions, budget, plans, estimate requirements for materials and equipment) and prepare registered form of reports. **(PC-12)** Should understand the need to perform standard programs, certification of engineering software tools, systems, processes, equipment and materials; organize metrological provision of technological processes by using standard quality monitoring.

Basic competencies	Competencies
7. Operation and maintenance	**(PC-13)** Ensure per-commissioning activities, provide technological workplace with relevant equipment; utilize introduce facilities. **(PC-14)** Monitor the technical condition and limited life performance of processing facilities; organize preventive maintenance inspection and current repairs and maintenance of equipment. **(PC-15)** Understand the need for systematic management of the acquisition, commissioning, operation, upgrade, monitoring and maintenance of engineering plant, facilities, equipment, and systems.
8. Economic-investment	**(PC-16)** Conduct preliminary feasibility studies of project solutions; develop measures in improving enterprise technological and economic efficiency. **(PC-17)** Enhance the investment potential of engineering projects; to analyze and evaluate the activity results of different production departments. **(PC-18)** Apply the legal organization principles in management and entrepreneurial activities, plan human resources and salary budget.

* BCC- basic cultural competencies; ** BPC- basic professional competencies;
*** PC- professional competencies.

Solving these tasks involves shaping professional thinking of the future engineer based on the acquisition of the basic competencies, while the decision-making mechanism itself is implemented through education programmes and curriculum modules developed by a university.

Universal engineering education is often based on the logical sequence of the achievement levels [5], which provide conditions in attaining the potential abilities as initial competencies to develop a student's professional thinking. During the learning process the student's thinking transforms from basic educational, i.e. "ability to assess one's learning process" to professional-oriented, i.e. "ability to solve applied problems in a specialized professional domain" (Tab. 4). However, it should be noted that student competency acquisition is a cyclic, integrated and accumulating process, which involves not only education content (standards) but also cognitive learning technology; and, only after the completion of an educational programme the student's success could be evaluated.

Teaching credit-modular system is the basis in designing engineering education programmes. The curricula include a combination of academic courses (subjects), practicum (practical training), assessment, courseware, etc. Based on basic competencies they are divided into basic courses (non-technical, compulsory technical) and elective courses (professional-oriented, professional-applied).

An important factor of module technology is the graphic, understandable and applicable content presentation. The structure of a programme module should be relevant to the professional activity of a specialist; reveal the scope of professional functions and reinforce in-depth understanding of these functions through

Table 4. Flowchart of transformation of engineering student abilities in the learning process

Bachelor				Master
1-course Presentation level	2-course Acquisition level	3-course Reproduction level	4-course Level of knowledge & skills	1-2- courses Level of enhanced specialized knowledge & skills
Shaping professional thinking →				
1. Ability to assess one's selection of the professional learning domain	2. Ability to generalize scientific principles in the structured subject model	3. Ability to solve experimental-theoretical problems in the industrial-oriented domain	4. Ability to select the conceptual industrial solutions	5. Ability to solve applied problems in specialized-industrial domain
Fundamentals of education		**Fundamentals of industrial-based education**		**Fundamentals of professional-oriented education**

the acquisition of professional competencies. In this case the name of the module and successive learning performance should further distinct understanding of a student's future job. Thus, this results in distinct knowledge orientation within the framework of education programmes based on the generalized engineering functional-competency model [6].

Accordingly, the author has proposed a list of academic modules of basic and elective courses within the framework of academic programmes and relevant to the specialization training domain (Tab. 5).

The structure overview of an academic programme and successive learning acquisition of these courses is illustrated in Fig. 1.

The characteristic feature of the proposed credit-modular structure for Bachelor engineering programmes is that it is comparable with the basic courses of fundamental higher technical education level in general, as well as the elective courses developing the fundamental professional-oriented education. All in all, this provides the conditions for the unification of education programmes which not only embrace the selection of the basic academic disciplines, but also involves the didactic acquisition techniques for professional-oriented disciplines. A student choosing an engineering education path develops the possible social-professional mobility in terms of his/her personal interests and according to the existing regional market demand.

Within the framework of the education programme credit-modular structure student ability development flowchart considered as a mechanism of successive accumulation of acquired competencies reveals the cause-effect relation of three engineering education components: abilities, basic competencies, and academic modules

(Fig. 2), which, in their turn, shape the universal competency modular model of engineering education.

Conclusion

Based on the research it is possible to consider the unification of engineering education programmes. The major unification involves the following: development of a universal functional-competency map; integrated credit-modular structure design project of education programmes; enhancement of in-depth understanding that the competency model of a future specialist is defined by the scientific knowledge-based structure of learning technology, while competency acquisition is an integrated accumulating process.

Table 5. Unification of education modules

Basic courses		Elective courses	
Non-technical	Compulsory-technical	Professional-oriented	Professional-applied
Module 1. Theory of Health and Safety & Interpersonal Relations	**Module 3.** Theory of Informative-mathematical Thinking	**Module 6.** Design Theory of Professional Activity Objects	**Module 12.** Fundamentals of Engineering Specialization (elective courses)
		Module 7. Fundamentals of Energy Conservation	
	Module 4. Mass Theory	**Module 8.** Technology Background of Industrial Processes	
Module 2. Fundamentals of Engineering	**Module 5.** Theoretical Basics of Engineering	**Module 9.** Practical Aspects of Organization and Management in Business	
		Module 10. Fundamentals of Performance Reliability	
		Module 11. Theory of Economy, Innovation and Investment	
1–4 semesters		**5–8 semesters**	

Fig. 1. Credit-modular structure project for Bachelor engineering programme

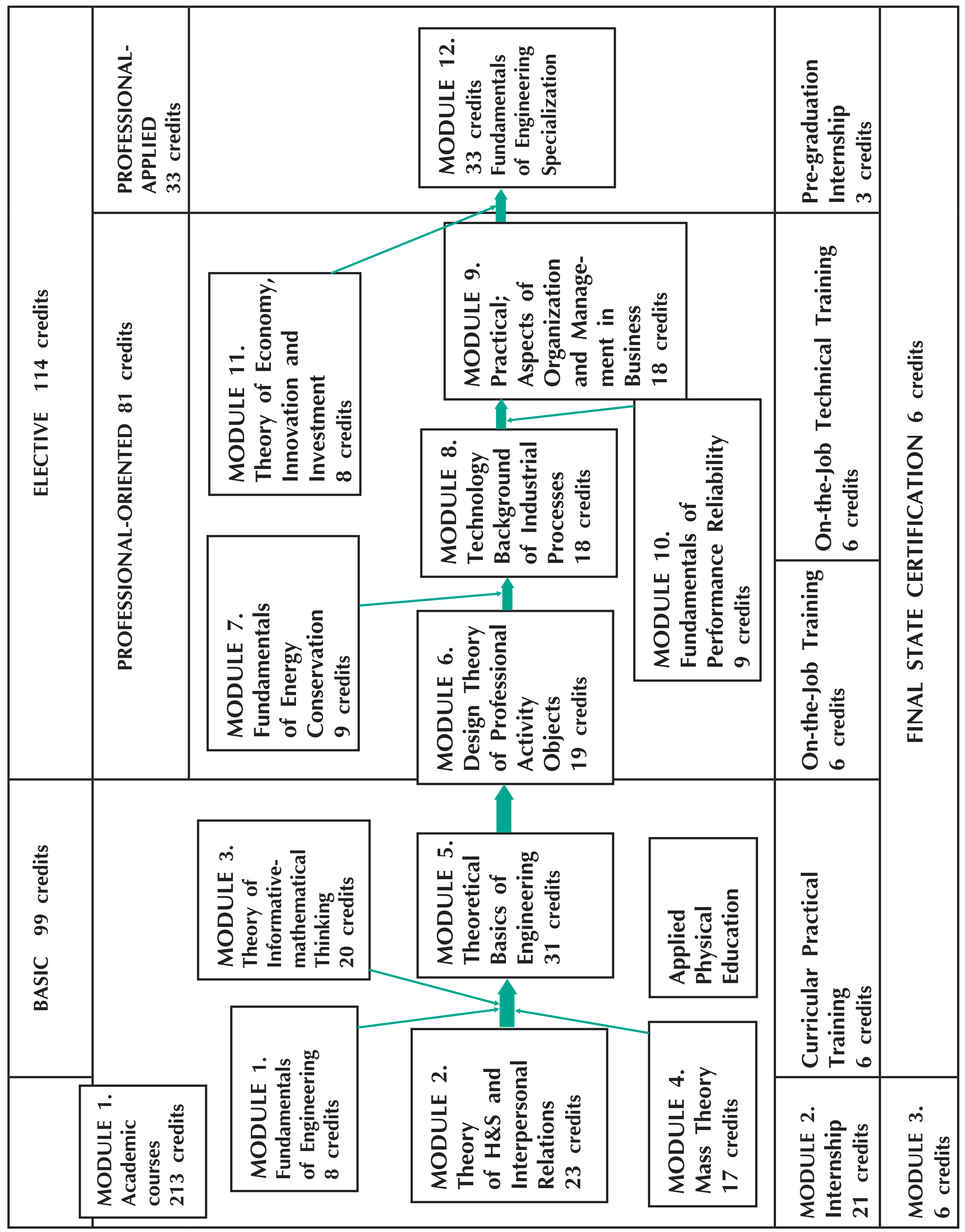
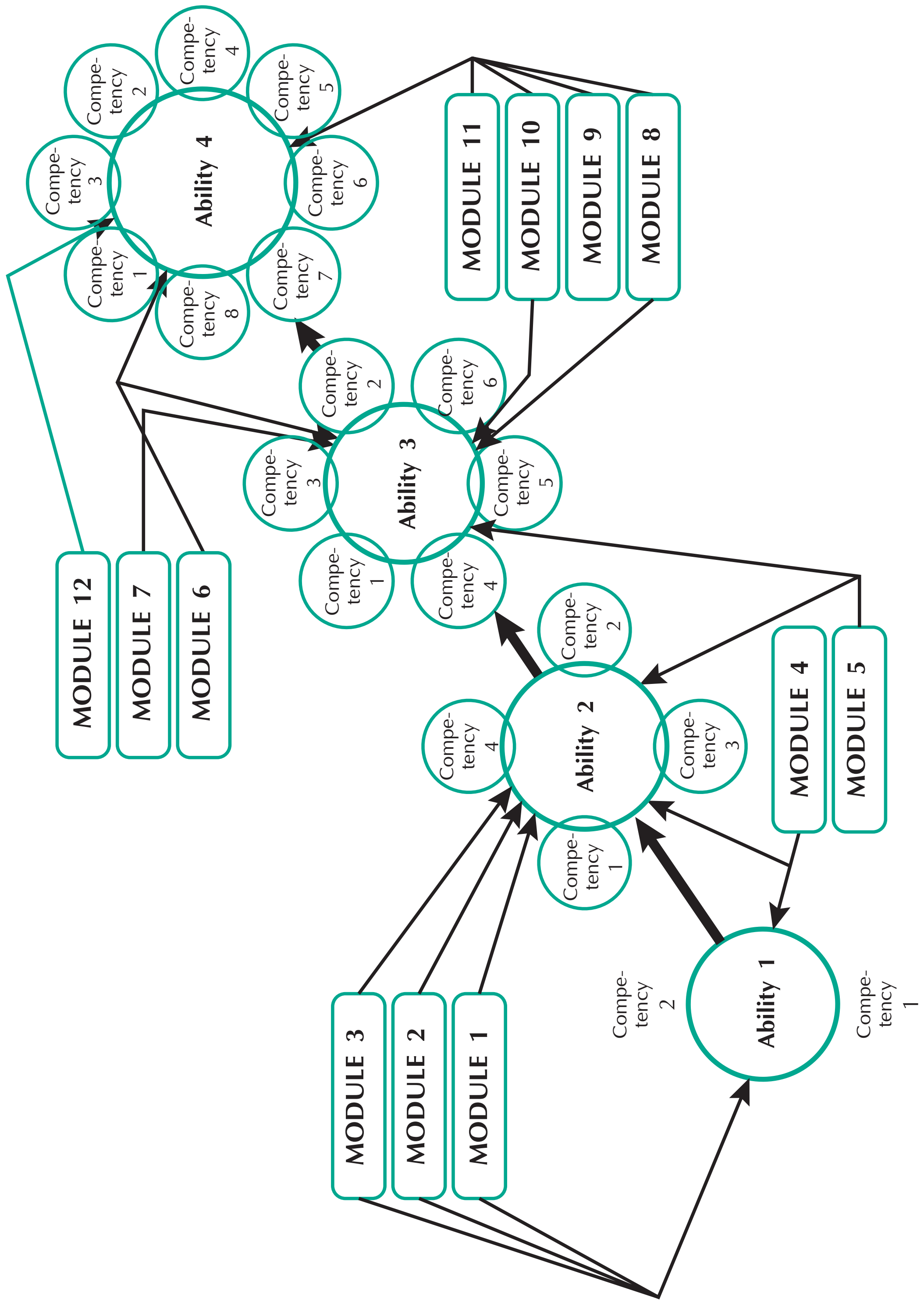


Fig. 2. Cause-effect relation flowchart of competency modular model of engineering education



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Competency-Based Approach to Education Programme Development: the Case of Technology and Engineering Teacher Qualification (Technology of Light Industry)

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The article is devoted to development of competency-based education programme to train technology and engineering teachers with regard to prospects of light industry development. The developed model includes general and professional competences. The general competences comprise instrumental, interpersonal, systemic, informational, communicative, and legal ones. Professional competences include professional, pedagogical and special competences: engineering and production technology.

Key words: competency, technology and engineering teacher, vocational education, light industry, industry forecast.

Problem statement. Development of competency-based education programmes in the frame of Bologna process is one of the challenges for the contemporary higher education in Ukraine. Competency-based approach allows reaching general understanding of qualification requirements and learning outcomes for a particular professional activity, as well as ensuring consistency, comparability and transparency of European education programmes. To obtain a license for educational activity, a project group of an educational institution should develop a number of documents, with a curriculum being a key one. The curriculum development should include some stages. First of all, it is necessary to make a list of competencies and learning outcomes the graduates are to acquire and show as a result of education. The second stage implies determining the subjects (internships) that should form the curriculum with regards to the developed list of competencies.

Specialty 015.17 "Professional education. Technology of light industry" in Kirovohrad State Pedagogical University is being under way for being licensed. The faculty staff has the task to develop a model of a graduate's competency taking into account the prospects of the industry development and employers' requirements. Thus, to determine a set of competencies required for a Bachelor of vocational education and training (B.V.E.T.) is a topical task of pedagogical design.

Analysis of modern research and publications. Competency-based approach to engineering education standard development is in focus of Ukrainian and Russian educators. The article [1] determines competences for Master's programmes in standardization, metrology and certification as cultural and professional. The cultural competences involve personal and professional development, communicative competences, the competence of thought process and information culture, and systems thinking.

Participants of TUNING project [2, p. 8] identified 30 general competencies of higher education graduates, which were classified in 3 categories: instrumental, interpersonal and system. In addition to the general competencies, there are special ones that are unique for each professional area. In particular, the Bachelor should "know the basis and history of the basic subject, implement the methods and technologies typical for the professional area", and be able to understand and implement the methods of scientific analysis and theory [2, p. 9-10].

We acknowledge undeniable theoretical and practical values of the publications mentioned above, and consider them a theoretical foundation in meeting our challenge. However, there is a difference between two notions "competency" and "competence". In this paper we use the following definitions [3]: Competency is a set of skills and abilities that ensure effective professional behavior (or rights to take decisions). Competence is an integrated personal quality resulted from development of a number of competencies (professional integrity).

According to [4], the basic competencies of educators and scientists are: professional, informational, communicative, and legislative. Communicative competency is apparently distinguished due to the specific features of pedagogical activity. However, the competency list of TUNING project regards informational and communicative competencies as constituents of the instrumental one.

The paper [5] presents a competence model of a vocational training teacher (specialty- Hospitality management) based on the analysis of competencies of Bachelor in hospitality management and teacher of vocational education. The model incorporates general and professional competencies. The latter, in its turn, are divided into pedagogical and specialty-oriented. We consider such competence model to be the optimal one for the specialties combining pedagogical and engineering activities.

Thus, the review of publications proved that the issue on competence model development (for B.V.E.T. in light industry) has not been fully studied yet and needs theoretical development.

The aim of the article is to justify the use of learning outcomes as a list of competencies of B.V.E.T. (specialty 015.17 "Professional education. Technology of light industry").

The qualification of teaching engineer refers to the sphere of "education", though it implies skills and knowledge of engineering activity. Bachelors of vocational education should be able to perform the following activities: technological, technical, training, predictive, research, project, management etc. in vocational colleges and at light industry enterprises.

A B.V.E.T. (specialty 015.1) can take the following positions: at a vocational school – teacher of professional training, training technologist, master of vocational training, senior master; at an enterprise – production supervisor, technology technician, laboratory technician, design technician, safety engineer, and clothing manufacturer.

The education programme of specialty 015.17 is intended for training specialists both for vocational schools (teaching activity) and enterprises of light industry (design, management, production, technological and research activities).

A competence model of vocational teacher (hospitality management) [5] was taken as a base for developing the competence model of vocational teacher (specialty "light industry") so far as it relates to general competencies and teacher's professional competencies. To identify the specialized professional competencies related to light industry we take into account the forecast of changes in content of education of clothing industry specialists [6]. In particular, the basic scenario of clothing industry development predicts preproduction automation and automation of separate production areas as well as development of online custom tailoring. It requires developed informational skills, using professional software, internet surfing for new important job-related data and its processing. Thus, it is not enough for a prospective teaching engineer to have only basic computer skills as described in [2]. The content of informational competency is enlarged for the Bachelors to be able to apply informational technologies in light industry, in particular, CAD system. The competence model for a teaching engineer is shown in Tab. 1 and includes a list of competencies (Column 1) and learning outcomes (Column 2).

Apart from the competencies mentioned in Tab. 1, some scientists also identify the following competencies: axiological, socio-economic, life- and health protective, polytechnic, managerial, etc. We do not distinguish them as the basic ones in the

Table 1. Basic competence constituents of teaching engineer (specialty – light industry)

Competency	Learning outcomes
	General competencies
Instrumental (cognitive, methodological, and technological)	– ability to analyze, synthesize, organize and plan; – basic knowledge in humanities and social science, fundamental and natural science, and economy; – fundamentals of professional knowledge; – problem-solving and decision-making.
Interpersonal	– ability to criticize and self-reflect; – ability to work in a team including interdisciplinary and international ones; – skills of interpersonal relations; – ability to perceive cultural diversity; – commitment to humanistic, democratic and ethic values.
System	– ability to apply theory to practice; – research skills; – learning ability; – ability to rapidly adapt to new conditions or environment; – ability to generate new ideas (creativity); – leadership; – understanding culture and traditions of other countries; – ability to work and learn independently; – project development and management; – self-starter quality and entrepreneurial skill; – focus on quality; – need for achievement.
Information	– effective information search and structuring, data adaptation to training or production process conditions; – skills to use information resources, and software packages; – skills to use automated workplace of the teacher, designer, or production manager; – skills to conduct distance educational and project activities; – skills to apply computer and multimedia technology, as well as digital educational resources in educational and production process; – maintenance of engineering and design documentation and documentation relevant to education process on an electronic data carrier; – skills to apply CAD system in light industry product design.

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Competency	Learning outcomes
Communicative	– ability to ensure effective relations and feedback from students of different ages and their parents; – ability to develop communicative strategies, methods and techniques to ensure effective interaction between team members; – ability to persuade and defend its own position; – official language skills, elocution, professional etiquette, skills of public presentation of work results; – native language written and oral communication; – second language skills.
Legal	– skills to apply legislative and regulatory documents related to professional activity.
	Professional competencies
Pedagogical	– effective solving of typical professional pedagogical problems; – application of educational technologies, techniques of pedagogical diagnostics, and correctional psychology; – constant improvement and implementation of new pedagogical and education ideas into educational process; – implementation of reflective practice.
	Special professional competencies
Engineering	– general technical and technological knowledge, engineering graphics; – efficient application of special knowledge and skills to complete educational, design, technical and creative professional tasks; – ability to develop technical and design documentation for products of light industry taking into account the development prospects of the industry; – good knowledge of basic technology and history of a costume; – understanding and ability to implement methods of scientific analysis, predict technology of light industry.
Production technology	– good knowledge of methods of professional activity and their adequate choice; – ability to choose and use modern equipment in accordance with their characteristics and production aims; – ability to choose and treat modern tissues and materials taking into account available range, characteristics and market development prospects; – ability to plan the production technology in light industry; – ability to implement design methods and production technologies in light industry using modern equipment and technologies, to ensure quality control, meet health and fire- and electric safety requirements; – ability to identify and improve technical and economic indexes of products, to improve economic efficiency, and to promote the products on the market.

paper; however, some of their elements are incorporated in the competencies described above.

Conclusion. The research resulted in a new competence model of a teaching engineer in the sphere of light industry technology. The model is distinguished from other similar models by introducing such new parameters as prospects of innovative development of light industry. The model takes into account the review of publications related to competence-based approach, and meets the Ukraine education regulations and standards. It includes general and professional competencies. The general ones embrace instrumental, interpersonal, system, information, communicative, and legislative. Professional competencies are subdivided into pedagogical and those related to professional activity: engineering and production and technological. Further research will be focused on the competency development model for a teaching engineer in light industry.

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UDC 378

Analysis of the Curriculum Subjects Correlation

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The methodological foundation for the analysis of courses dependencies within the university curriculum has been studied. To build an effective curriculum, a model of disciplines correlation analysis based on Spearman's rank correlation using students' assessment as input information was proposed.

Key words: curriculum, discipline, correlation, model, analysis, prerequisites, co-requisites.

Introduction

One of the main goals of University control automation is to develop a curriculum. It provides initial data for dean's offices.

While implementing the new federal state educational standards of higher education (FSES HE) in the education system, it is necessary to take into account the relations between studied subjects to develop new curricula. These relations are reflected in the terms of "prerequisites" and "post-requisites".

Prerequisites are subjects that are required to be studied beforehand.

Post-requisites (co-requisites) are the subjects that should be studied after a particular subject.

In most cases, prerequisites and post-requisites are chosen by a faculty member without taking into consideration the interrelations between these disciplines. Thus, the curriculum can only partially reflect the relations between the subjects, which leads to inconsistent assessment and auditors' claims in the framework of education quality management system.

1. Approaches to curriculum development with regard to logical coordination and consistency of subjects

Let us consider some approaches to effective development of curriculum in higher education institutions with regard to logical coordination between subjects.

The aim of curriculum enhancement is to choose the most essential content for a particular professional activity and distribute it throughout the academic terms in an optimal manner.

It should be noted that curricula can be presented as directed graphs, tables, or matrix, which conditions the variety of approaches to curriculum design [1, pp. 16-28].

Works [2, pp. 90-97, 3, pp. 111-116, 4, pp. 134-143, 5, pp. 179-185] offer algorithms of curriculum design with regard to interrelations between studied subjects and developed competencies. While developing curricula, the value of a subject, faculty qualification, and sequence of subjects are taken into consideration. However, it is a user who determines the dependency between the subjects. Thus, the issue of adequacy of such relations remains open.

Mathematical models offered in [6, pp. 66-71] are based on automation of curriculum development by using a semantic net to arrange the sequence of the subjects. In this case, relation-associations reflect the subject dependency, which reveals all non-realized dependencies in the curriculum.

Studying the issues of material

preparation for study packs [7, pp. 35-38], the researcher suggests keeping the balance between the amount of training content and academic hours of a subject by defining the priority of each subject and choosing the content in descending order of priority. The priority is determined by attributing particular value to a subject, content material or task. The values are determined basing on students' skills and knowledge (entry test).

The authors of paper [8, pp. 136-143] offer a decision-making model for curriculum synthesis. It takes into consideration the subjects interaction in curriculum, since some knowledge is based on the content studied beforehand [9, pp. 14-17]. The intensity of the relations between the subjects was evaluated by the expert evaluation method based on the binary Cartesian product. Importance index of a training module is calculated by expert ranking method according to Saati's method (Method of analytic hierarchy) [10, pp. 80-83]. The importance indexes of secondary subjects are calculated through estimating the importance index of the major discipline in regard to the other subjects within the same course. It takes into account the contribution of a subject not only on related subjects but also on the subjects studied afterwards. To determine the importance index of a subject, a DxD matrix is made, with each element being equal to the intensity coefficient of relations between subjects i and j. The necessary coefficients are calculated by experts. It depends on what is more important for professional training: either logic and learning outcomes or summarized total significance of the training content.

In works [11, pp. 1013-1020, 12, pp. 203-215], the authors compare algorithms of curriculum formation: KBS, LS-Plan and IWT, a distance learning system taken as an example. One of the main adaptation methods is sequence of training programmes (curriculum). The curriculum implies the way to help students to find an optimal way "through the training content" [13, pp. 1-7]. The curriculum in this case is an algorithm or graph. The research showed that LS-Plan has the longest educational trajectory and the biggest number of errors, while IWT creates the shortest educational pathway. The correlation of the subjects was not studied in the research.

Interaction between curriculum modules was studied in [14, pp. 28-34]. A frame is regarded as a basic information unit of a training system. The paper describes main possibilities of frame combinations. To connect the training content between different frames, it is necessary to introduce information relation between them. The frame content is not mathematically formalized, however, each frame can be connected with its describer that distinguishes the main concepts and relations between the frames within one subject. The frame describer has a logical form, but it allows keeping order only on the highlighted subset of frames.

Analyzing the existing approaches to curriculum design with regard to logical sequence of subjects, it is possible to conclude that it is mostly experts who set the correlation between subjects in curriculum while determining the sequence of prerequisites and co-requisites. In other words, it is faculty staff's decision. There is no module analyzing subject correlation within a curriculum in the most modules. Thus, we took a decision to develop a model to analyze correlation between curriculum subjects based on Spearman's rank correlation coefficients.

2. Analysis of correlation between curriculum subjects based on Spearman's rank correlation coefficients

The results of course final assessment (in scores) are taken as input data to analyze the interaction between the subjects of the curriculum. However, it should be taken into consideration that a traditional mark, which is registered in the exam record list, depends on a particular scale chosen by a particular University.

We calculate nonparametric correlation coefficient since students marks are subjected to non-normal distribution, i.e., they are multimodal distribution. To fulfill it, it is necessary to rank the characteristic values (in our case these are students' scores of final exam in a subject) in descending or ascending order.

To evaluate the intensity of relations between different subjects of a course, let us use Spearman rank correlation [15, pp. 626-628]. It is calculated as follows:

$$\rho = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)},$$

where d_i^2 – difference square of ranks;
n – number of observations (number of rank pairs).
The result will always be between 1 and minus1.
Student's T-test is used to test the significance of the coefficient. T-statistic is calculated while testing the hypothesis:

$$t_{pac} = \sqrt{\frac{\rho^2(n-2)}{1-\rho^2}}.$$

The calculated value is compared to the tabulated one $t_q(n-2)$. If the calculated value is bigger that the tabulated one, it indicates the significance of the correlation coefficient, and thus, it proves statistical significance of relations between sampling data. The task can be done with any mathematical software (for example, Mathcad).

3. Research results

Academic achievements of students of Urga State Technological Institute, National Research Tomsk Polytechnic University (USI TPU) were the base for the correlation research. The academic office provided sampling of final students' marks in all the curriculum subjects over three recent years (2013, 2014 and 2015), a Bachelor's degree course in "Applied Information Technology".

The structure of the main education programme was developed at the Department of Information Systems, USI TPU. There are prerequisites for each studied subject.

Basing on the model, a correlation matrix of interdisciplinary relation between the subjects was suggested. It has the size NxN, where N is the number of subjects, provided by the course. In this case, N = 55. The correlation coefficients with t-statistic less than t_q (28) = 2,05 can be considered to equal zero, since the correlation is insignificant.

While analyzing the general matrix of correlation coefficients, it can be concluded that:

a) Most subjects of the first academic term (Computer Science and Programming, History, Mathematics, Economics, Foreign language, Discrete Mathematics, Fundamentals of Information Society Development, Physics) are strongly correlated. It is explained by the fact that prerequisites for all these subjects are provided by the school education programme. Successful school study ensures good academic performance during the first term.

b) The subjects of the last (the 8th) term (Graphics in Information Systems, Production and Engineering Training, Information Systems Management, Research Work, Information System in Accounting and Audit) are also closely correlated. It accounts for the fact that all these subjects should ensure successful Bachelor's thesis defense or state examination pass. The content of these subjects are supposed to be applied in further professional activities of the graduates.

c) The prerequisites are not always correlated with the subject they are supposed to relate to. The reason for that was mentioned above: the faculty members responsible for the curriculum choose the prerequisites and co-requisites without studying interrelations between them.

d) Most of the subjects have a significant correlation with the English language, which is a characteristic feature of the specialty. Most programming languages are written in English. Thus, a good English level facilitates student's progress in computer programming.

Table 1. Intensity of relations between the subjects

Subject	Prerequisites according to the curriculum	Prerequisites revealed by the analysis
B3. Professional cycle (102 credits ECTS)		
Computer systems, nets and telecommunications	Computer science and programming; Discrete mathematics	*Computer Science and Programming; Discrete Mathematics;* Mathematics; English; Physics; Practical Course; Numerical Methods; Probability and Mathematics Statistics; Data Base; Management; Algorithm Theory; System Theory and System Analysis; Philosophy
Information systems and technologies	Fundamentals of information society development; Computer science and programming; Data base	*Fundamentals of Information Society Development;* English; Discrete Mathematics; Practical Course; Probability and Mathematics Statistics; Management; System Theory and System Analysis; Philosophy

The data obtained via analyzing the interrelations between some subjects are presented in Tab. 1.

Thus, the method described above reveals that faculty's or experts' choice of prerequisites in curriculum fail to correspond or at least only partially reflects the real correlation between the subjects.

4. Prospects for research and applications

The results obtained from the analysis of correlation between curriculum subjects based on Spearman's rank correlation coefficients can be applied in developing both basic curriculum and individual one that takes into account student's interests and abilities.

Study of correlation between curriculum subjects can be useful not only for general curriculum but also for individual education pathway development.

Petrova S.Yu., Gudzovskii A.A. and Kuz'min A.V. [16, pp. 39-50] offer an object-oriented model of individual curriculum development. It implies implementing a supporting system that provides optimal educational vectors basing on student's academic achievements. A student should have a choice of elective subjects that are closely related to the subjects that the student is good at. In most cases, a set of elective subjects is formed either basing on the Education Standard or on a set of available subjects related to a course. Such model contains neither an algorithm to select interrelated subjects, nor a mathematical model to analyze the intensity of correlation between curriculum subjects.

In earlier publications we developed a dynamic model to manage an individual education pathway of a student [17, pp. 77-81, 18, pp. 245-257]. The sequence of subjects, which is conditioned by the curriculum, is determined with the help of coefficients of correlation between the subjects (prerequisites and co-requisites). It is possible to overcome the restriction related to the sequence of subjects within an academic term and a whole course by using the results of correlation between curriculum subjects based on Spearman's rank correlation coefficients.

Conclusion

While analyzing the existing approaches to curriculum development we investigated the methodological base to study the intensity of relations between curriculum subjects.

We developed a model to analyze the subjects interaction for a particular course based on Spearman's rank correlation coefficients, using final scores of graduates for some previous years as input data.

The task can be completed by means of any Mathematical software (for example, Mathcad). The suggested model was tested on academic achievements of USI TPU students.

The method to calculate the coefficient intensity of relations between curriculum subjects (prerequisites and co-requisites) will be applied in the dynamic model related to management of student's individual education pathway. It can also be applied to develop an effective basic curriculum.

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Innovativeness in Future Engineers: Value and Motivational Characteristics

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The article presents the results of research concerning the peculiarities of value-motivational structure of engineering students with different levels of innovativeness manifestation. The obtained data allow introducing new practical technologies aiming at future engineers' motivational activity and innovativeness development.

Key words: innovativeness, innovative potential, value-motivational structure, engineering education.

Rapid changes in public consciousness developed under the influence of social-political and social-economic deformations are a problem sphere for modern psychology from the standpoint of theory and practice. Society is a community of people and if we want to build an advanced civilization, one has to start with a person's bringing-up and education.

One of the key factors of modern society's development and well-being is innovation. To support innovations, special financial and technical resources are allocated by the society and some organizations, since innovations are an important condition for viability, activity, and competitiveness of any company. Innovation provides intensive development of both economy and society, in particular. It contributes to the efficient solution of the problems faced by the government. However, when analyzing the problems of innovation support, they are, as a rule, considered in economic and managerial aspects, whereas psychological bases of developing personal innovational potential have not been adequately investigated

The issue of research in peculiarities of innovativeness development in modern society is conditioned by the necessity to develop new forms of personal development management. Searching for the boundaries among personal success, efficiency, and performance, new generations can apply their activity for boon or bane both for themselves and society. The perspectives of psychological trends in innovativeness are connected with not only revealing peculiarities of the quality in the activity, but also implementing the efficient social-psychological and psychological-pedagogical techniques of managing personal characteristics to develop social creativity.

Based on the analysis and generalization of numerous theoretical investigations dealing with analysis of personal potential of professional development and psychology-acmeologic potential of professional activity, one can suggest that personal innovative potential is an integral complex of activity resulting from involvement in innovative process and consisting of interconnected and interdependent components: creativity (cognitive-prognostic component), innovativeness (dynamic-managerial component), and constructiveness (value-motivational component) [2; 5].

In foreign research the interest in innovativeness as a personal quality is presented in different concepts and approaches that are concerned with innovative behaviour, innovative potential of management, and cognitive styles responsible for a person's inclination for innovation (R.A. Bruce, T. Amabile, R.M. Kanter, M. West, M. Basadur, E.Hagen, M. Kirton, J. Farr, J.P.J. De Jong, etc.).

In contemporary psychology the term has two versions of pronunciation and spelling 1) innovativnost' (derived from English 'innovativeness') is directly borrowed from the English literature; 2) innovatsionnost' (derived from French innovation; Latin innovātio 'renovation', 'change'). The term «innovative» means 'relating to innovations'. From the semantic point of view the most appropriate version to denote personal quality is the term «innovativeness» [1; 4].

Innovativeness is a set of personal qualities relating to perception, evaluation, processing, efficient practical implementation of ingenious ideas developed in activity [3]. Innovativeness is connected with other personal characteristics, but fundamentally differs from creativity and enterprise. Creativity conveyed as intellectual activity is an integral part of an individual innovative potential. If creativity is considered as a set of qualities developing a new idea, innovativeness is a set of personal qualities implementing a creative idea into the reality [3].

As follows from the analysis of diversity in interpretation of enterprise it should be underlined that a result of enterprise is economic success expressed in money, whereas a result of innovativeness is professional success expressed in the form of new professional results. It is just innovativeness rather than enterprise is necessary to be developed in future specialists who are motivated for creative labour and activity [3].

The relevance of the research consists in the fact that at the moment there is an acute need for study in the value-motivational peculiarities of personal innovativeness, since individual and social values of a person as well as extrinsic and intrinsic motivations play an important part in innovativeness manifestation.

Despite a number of studies in characteristics of labour value-motivational aspects performed in Russia (V.N. Myasishchev, K.A. Abul'khanova-Slavskaya, A.N. Leontiev, A.G. Kovalev, V.D. Shadrikov, Ye.P. Il'in, V.G. Aseev and others) and abroad (A. Maslow, F. Herzberg, V. Vroom, J. Adams, L. Porter, E. Lawler, H. Hechhausen and others), the novelty of our research consists in study of future engineers' value-motivational structure with different level of innovativeness manifestation.

To study the value-motivational characteristics of innovativeness we used the following techniques: 1) test of diagnostics in real personal value system developed by S.S. Buybnova; 2) questionnaire "Diagnostics of personal motivation structure"; 3) Self-esteem scale of personal innovative qualities developed by N.M. Lebedeva and A.N. Tatarko.

The research was performed at the Engineering department of Peoples' Friendship University of Russia. On the whole, the research involved 88 fourth-year Bachelor students aged 20-25, 58 boys and 25 girls.

Based on interpretation of the data obtained, the following levels of future engineers' innovativeness manifestation were established: the first group consisted of tested students with low level of innovativeness – 16 students; the second group included the students with the average level – 52 students; the third group was presented by the students with high level of innovativeness – 20 students. Then, the descriptive statistics of the innovativeness parameters was carried out in the reference set shown in Tab. 1.

The summary innovativeness index in the reference set varies from low level of innovativeness manifestation (1.5) to high one (4.58), on the creativity scale – 1.5-4.75, "risk for success" scale – 1.25-4.75, but on "looking for the future" scale – 1.75-5. On the whole, the average level of future engineers' innovativeness manifestation was revealed.

As a result of mathematical-statistical analysis using H-Kruskull-Wallis test, the

Table 1. Descriptive statistics of innovativeness parameters in reference set (N = 88)

Variables	Minimum	Maximum	Mean	Median
Creativity	2	5	3,75	3,5
Risk for success	1,5	5	3,1	3,25
Looking to the future	1,5	4,8	3,41	3,75
Summary index	2,25	4,92	3,42	3,58

statistical differences in future engineers' personal motivational structure were established in groups with different level of innovativeness manifestation (Tab. 2).

The significant differences of three groups with different innovativeness level were determined using the scales of «Life-support» ($H = 22.662$, $p < 0.01$), «Comfort» ($H = 6.891$, $p < 0.05$), «Communication» ($H = 18.572$, $p < 0.01$), «General activity» ($H=8.135$, $p<0.01$), «Creativity» ($H=6.57$, $p < 0.05$), «Social activity» ($H = 11.966$, $p < 0.01$). No significant differences were revealed regarding the scale of "Social status".

Correlation analysis of variable values and motivation in students' groups with different innovativeness level has shown that students possessing low innovativeness level highly value help and mercy to other people. A significant aspect for the given group is learning new things in the world, but they also attach great importance to other people's recognition and respect and influence on others. Besides, a distinguishing feature of the group with low innovativeness level is a trend to achieve high social status and communicate with other people.

Based on the significant correlations obtained one can suggest that future engineers having low innovativeness level strive to exhibit their activity to influence positively the society. Communication is of significant value for the students of the given group.

Negative correlations between the value of *"help and mercy to other people"* and such an innovativeness parameter as *creativity* allow concluding that the higher respondents' level of creativity is, the lower importance they attain to mercy and help to those who need them. Presumably, the reason for this is the fact that the world of their own ideas is of prime importance for them, but the surrounding world takes the back seat.

Future engineers having average level of innovativeness attain importance to communication with others and learning new things. They value recognition and respect as well as their influence on the other people, lay emphasis on help and mercy, but they have a pronounced trend to material well-being and social status as attributes of prestige.

As a result of correlation analysis, the relationships between creativity and motif of creative activity were established in the group with average innovativeness level. It may be suggested that the students of this group develop something new for the sake of creative process itself that drives their activity.

Table 2. Statistical analysis of differences in expressing motivation types in three groups

variables	Average values in groups			Kruskall-Wallis H-test	Significance level
	1 (N = 16)	2 (N = 52)	3 (N = 20)		
Life-support	19,83	50,06	44,85	20,662	0,001*
Comfort	43,89	47,34	31,46	6,891	0,032*
Social status	42,47	38,38	47,83	2,395	0,302
Communication	59,89	42,27	28,13	18,572	0,001*
General activity	42,14	48,39	30,98	8,135	0,017*
Creativity	42,14	36,17	51,85	6,57	0,037*
Social usefulness	31,14	38,99	55,29	11,966	0,003*

For the future engineers with high innovativeness level to learn something new as well as to be respected by the others and to influence other people are of great significance (Tab. 3).

The key motifs of the group with high innovativeness level are drive for creative activity, achievement of desired social status, and life-support to achieve the necessary living standards. Social status as a value has a positive correlation with such a motif as *past-time and rest*. Engineering students attain great importance to social status, as achieving definite level of professional development will allow them to have enough past-time in future. At the same time, negative correlations between social status and the motifs: *"help and mercy to other people"* and *"love"* show that future engineers with high innovativeness level regard compassion, help, and love for other people as factors impeding the achievement of desired social status.

The students with high innovativeness level consider the value of *social usefulness* with *health,* which is necessary to become a good specialist. However, future engineers striving for success do not assign importance to their health, past-time, and rest, possibly, because the expected success is more significant for them. Such values as *high social status and management of people* correlate with *risk for success* scale. The students with high innovativeness level are ready for risk to achieve high social status and gain some power.

To improve psychological-pedagogical training of future engineers with different innovativeness level it is important to apply various interactive teaching techniques in learning process of higher school. For the students with low innovativeness level who have inclination to show their social usefulness and altruism, it is necessary to increase the innovativeness level by means of developing the motifs of social

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Table 3. Correlation coefficients of value variables with motivation structure parameters (managers with high innovativeness level (N = 20))

Values \ Motifs	Life-support	Comfort	Social status	Commu-nication	General activity	Creativity	Social usefulness
Past-time, rest	0,227	0,373	0,427*	0,086	0,321	-0,199	-0,244
High living standards	0,356	0,235	-0,036	0,042	0,231	-0,127	-0,371
Search for and delight of beauty	0,126	-0,045	0,04	0,01	0,223	0,11	0,123
Help and mercy to other people	-0,054	-0,221	-0,449*	-0,225	0,066	0,045	-0,049
Love	-0,054	-0,404	-0,478*	-0,361	-0,222	-0,299	0,062
Learning new things in nature, world, and human beings	0,268	0,151	0,152	-0,244	-0,213	0,288	-0,041
High social status and management of people	0,393	0,01	0,055	-0,117	0,267	0,009	-0,045
Recognition and respect, influencing other people	0,215	0,23	0,257	0,139	-0,043	-0,08	-0,315
Social activity to gain positive changes in society	-0,074	-0,068	0,093	-0,017	-0,033	0,088	0,144
Commu-nication	0,27	-0,035	-0,233	-0,13	0,087	0,351	-0,096
Health	0,086	-0,349	-0,278	-0,059	0,055	0,379	0,408*

activity. The future engineers with average innovativeness level should participate in training developing personal innovative qualities as well as be involved in creative, and innovative activities.

The students with high innovativeness level need the professional activities to develop value-motivational structure as they are focused on social activity and responsibility. The motivational structure of the given group is known to be expressed in creative activity only without strong motivation for self-actualization in definite activity in which one can apply his/her creativity. For the given group it is necessary to arrange training focused on understanding social usefulness of professional activity and help to other people.

The development of strategies of future engineers' education is to include a set of psychological courses focused on formation of value-motivation bases of their success. Psychological model of innovativeness development in future engineers' training consists of stages corresponding to the competence levels including different methods (diagnostics, interview, training) focused on developing a student's personal quality.

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Nanotechnology Education Programmes: Experience in Accreditation

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The paper presents the results of pilot accreditation of nanotechnology education programmes. The analysis performed allowed revealing a number of challenges in engineering education of Russia and suggesting solutions ensuring its future development and competitive growth of Russian economy in general and professionals, in particular.

Key words: professional and social accountability accreditation, education programme, criteria.

Introduction

Against the backdrop of the sixth wave of innovations and when the national economy growth is associated with implementation of breakthrough technologies, there is an urgent need in professionals possessing new type of competencies. Lack of qualified personnel is one of the major challenges for the development of national priority industries significantly invested over the past ten years. **Nano systems** are one of the priority areas the RF is currently focused at [1].

One of the factors which facilitates the development of nanotechnologies in the RF is improvements in staff training since it is the personnel who develop and operate nanotechnologies and whose high qualification is attributed to the successful development of the national engineering education system. High quality of education is secured by professional and social accountability accreditation (PSAA) of education programmes (EP) implemented by higher education institutions (HEI). Professional and social accountability accreditation is an approve of quality and level of education provided by higher education institution in compliance with the programme accredited; PSAA confirms that the education provided meets all professional standards in effect and labour market requirements to professionals, workers, and officials [2].

PSAA experts are representatives of the industry (employers), universities, and scientific centres. PSAA is a tool to secure the interests of all parties (stakeholders): applicants and their parents, students, employers, government, and the society in general can be sure that the HEI and the provided education meet their expectations and requirements.

In 2014, Association of Engineering Education of Russia (AEER) and the Fund for Infrastructure and Educational Programmes

(RUSNANO Group) signed a contract aimed to **develop methodological and organizational basis, put together a team of experts, and accredit higher education programmes provided in the sphere of nanotechnology.**

In the course of the project (2014-2015), PSAA methodology was developed, which prescribes the procedure and criteria of accreditation, includes a set of documents describing the programme and provides a guideline for education programme estimation. Based on this methodology, a pilot accreditation has been conducted. Within the project, 20 education programmes in metrology and nanoelectronics provided at 9 HEIs and 15 education programmes in nanophotonics and nanomaterials provided at 8 HEIs of Russia have been accredited. The experts participating in the accreditation were trained in the course of the project implementation.

Criteria for professional and social accountability accreditation

To estimate education programme quality and relevance to nanotechnology sector, a system of global and local criteria was developed. The global criteria, which reflect the requirements of FIEP RUSNANO, are focused on real economy demands, reveal whether the graduates will be in demand, and elicits if the programme content and education outcomes meet the professional standards in effect. As for the local criteria, they allow giving integrated consideration to the educational prosess and specifying if the programme meets the international standards of Washington Accord (WA) [3] and European Network for Accreditation of Engineering Education (ENAEE) [4]. Conformance to the standards of WA and ENAEE means that the education degree obtained in the accredited programme is equivalent to that in the signatories (the USA, Canada, the Great Britain, Japan, etc. – 17 countries in total) and that the programme can be marked by EUR-ACE® Label, certifying conformance to EUR-ACE® Framework Standards and Guidelines (EAFSG) [5].

The global and local criteria developed and used for accreditation within the project by FIEP RUSNANO and AEER are as follows:

Global (integral) criteria:

- Criterion 1. Education programme objectives and outcomes. Programme content.
- Criterion 2. Resources.
- Criterion 3. Programme efficiency in terms of labour market demand and graduates' relevance, graduate positioning and promotion.

Each global criterion comprises a number of local criteria (see Tab. 1).

Table 1. Global and Local Criteria

Global criteria (FIEP RUSNANO)	Local criteria (AEER)
Criterion 1. Education programme objectives and outcomes. Programme content	1.1. Programme objectives 1.2. Programme content and outcomes 1.3. Professional training
Criterion 2. Resources	2.1. Students and educational process 2.2. Academic staff 2.3. Programme resources
Criterion 3. Programme efficiency in terms of labour market demand and graduates' relevance, graduate positioning and promotion	3.1. Graduates

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PSAA procedure is held in the established standard form and includes: submission and pendency of application, execution of contract with an accrediting organization (AO), internal audit, analysis of internal audit results, establishment of expert commission, audit, Accreditation Council (AC) Session for audit results analysis, confirmation of AC decision by the AEER Administrative Board and/ or the Accreditation Council of Russian Nanoindustry Association (RNA) [6].

The analysis of global and local criteria [5, 7-9] showed that they are interrelated. Moreover, the suggested system of criteria, if there is an agreement signed by both parties, makes it possible for the education programme that have been through PSAA process to be awarded with three certificates: certificate awarded by Russian Nanoindustry Association, national and international certificates by AEER (EUR-ACE label/ certificate of significant conformity to WA standards).

Pilot accreditation of nanotechnology education programmes

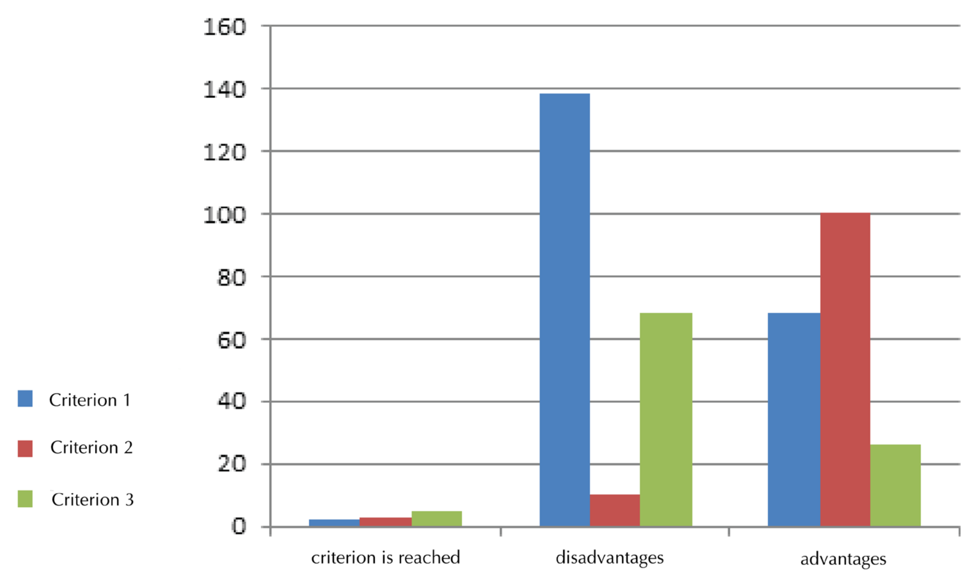
This paragraph describes the result obtained via application of the developed methodology and criteria. Within the scope of the project, 35 Master's degree programmes were accredited, including 16 programmes in Electronics and Nanoelectronics (11.04.02, 11.014.04, 12.04.01, 28.04.01), 4 programmes in Standardization and Metrology (27.04.01), 9 programmes in Nanomaterials (22.04.01, 22.04.02, 03.04.02, 150100.68, 270800.68), and 6 programmes in Nanophotonics (12.04.03, 200400.68). The programmes are implemented in 17 leading national universities, including one federal and six national research ones.

As mentioned above, the programme was estimated in terms of three criteria, and each criterion was analyzed relating to three categories: programme advantages, criterion is reached (no comments), programme disadvantages. Estimation results are given in fig. 1 – 3.

As seen in the graph, all criteria are estimated in terms of three categories: there were 410 estimates with comments and 10 estimates without ("criterion is reached").

In the course of accreditation, 216 advantages and 194 disadvantages were identified. Most disadvantages are generated within criterion 1 "Education programme objectives and outcomes. Programme content" and advantage – within criterion 2 "Resources" (fig. 2).

Fig. 1. Criteria estimated in terms of three categories



The estimates indicate modern resource base and highly-qualified academic staff at leading national universities, which is attributed to universities' participation in national priority and international projects. Low estimate of criterion 1 indicates that academic departments lack knowledge in developing education programmes: firstly, there should be correlation between programme objectives and outcomes, and secondly, programme content should meet employer's requirements and conform to professional standards in the sphere of nanotechnology.

However, it is difficult enough to answer the question whether this or that disadvantage is attributed to a particular programme or a particular university in general. This is due to the fact that within the pilot project there was only one programme accredited at 9 universities (50% of experiment participants), i.e. about 25% of the accredited programmes. Therefore, we identified advantages and disadvantages, which characterize a particular programme or a particular university (Fig.3).

The disadvantages are low rate of academic mobility of both students and staff, poorly developed system of graduate's employment and career support. To some extent, these disadvantages result from intrinsic reasons, such as development of a new social and economic pattern, economic crisis, higher education reforms, etc. However, the experience of national leading universities (National University of Science and Technology MISIS; Higher School of Economics, National Research University; ITMO University (Saint-Petersburg National Research University of Information Technologies, Mechanics and Optics); TPU (National Research Tomsk Polytechnic University) and other participants of Global Universities Association) shows that these challenges can be overcome.

Conclusion

Based on the accreditation results, the suggested methodology proved to be efficient for education programs in nanotechnology and this conclusion is supported by the representatives of companies operating within technology-intensive industry. PSAA appeared to be

Fig. 2. Criteria estimation

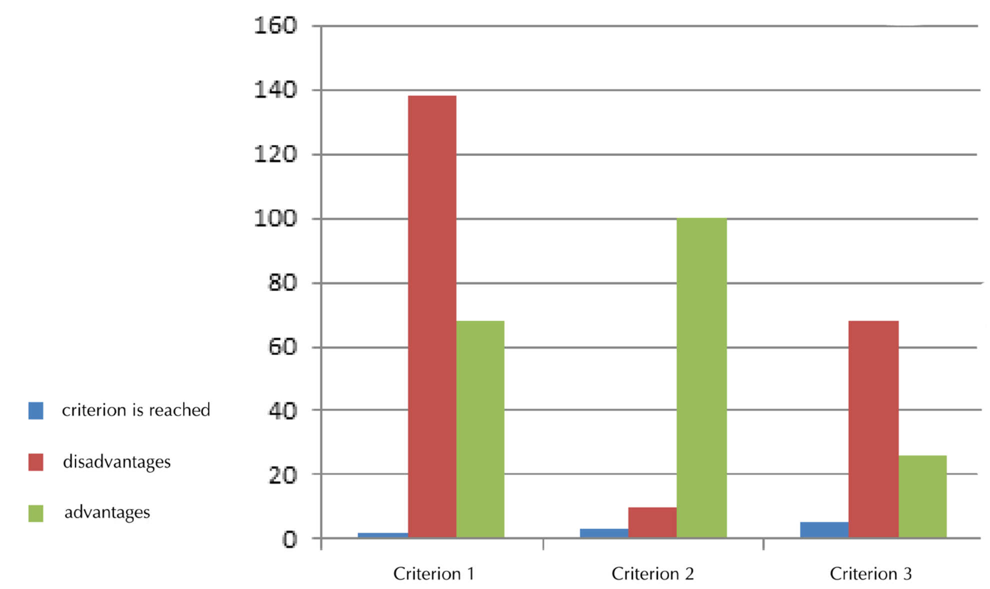
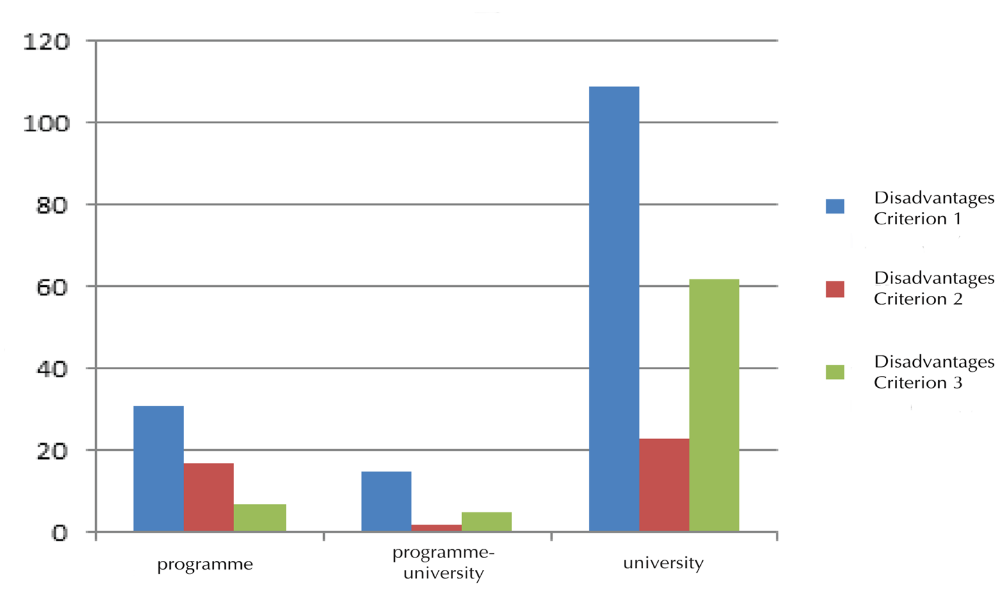


Fig. 3 Criteria estimated regarding university or programme



an important issue for real economy and the experience can be disseminated within the cluster including RUSNANO, JSC Academician M.F. Reshetnev Information Satellite Systems and other high-tech companies of the RF, as well as higher education institutions training professionals for the companies.

The analysis performed allowed revealing a number of challenges in engineering education of Russia and suggesting solutions ensuring its future development and competitive growth of Russian economy in general and professionals, in particular.

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Accreditation of Applied Bachelor's Programmes in Lithuania

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This article is to some extent a sequel to the notes on organization of accreditation process of Study Programmes in the field of technology in Lithuania [1]. In 2015 one of the article's authors took part in conducting independent external evaluation of 5 Study Programmes of Applied Bachelor level in 4 universities of Lithuania. Together with the earlier publications this material allows to assess the level of development of the system for Study Programmes' (SPs) accreditation and the specifics of its execution in the country.

Key words: accreditation, educational program, nanotechnology, criteria.

Organization of the SP Accreditation Process

According to the Law on Higher Education and Scientific Research [2], Lithuanian HEIs can only carry out Study Programmes of higher professional education that had been successfully accredited. Starting from 1999 the SP accreditation process has been based on external evaluation of SPs.

Accreditation of Study Programmes conducted by Lithuanian universities is organized by a governmental agency – Lithuanian Center for Quality Assurance in Higher Education – SKVC[1] that was founded by the Ministry of Education and Science of the Republic of Lithuania and is a state-financed organization. HEIs seeking for Study Programmes' accreditation have an opportunity to choose: either execute Programme evaluation process by efforts of the SKVC expert teams or exploit services of some other (foreign) accreditation agency, but only from amongst those registered in the European Quality Assurance Register - EQAR[2].

In the first case it is the SKVC agency that comprises the international team of experts. Based on the author's experience, only one of the experts is a representative of a Lithuanian university; all the rest are invited experts from different European countries. In the latter case the chosen agency leads the expert team selection process. In both cases this, inevitably, minimizes the probability of influencing the accreditation result by personal or professional ties and experts' preferences. Obviously, in both cases the working language is English – self-evaluation materials, SKVC and Ministry's standards, specifications and guidelines, expert team reports – all is written and presented in English. English is also the language for expert team communication when visiting HEIs and holding meetings with administration, SP managers, students, teaching staff, graduates. That still causes certain troubles to the HEIs members – process participants.

It should be taken into account that expert teams present solely an explicit conclusion on the results of independent external evaluation of Study Programmes, but the final decision on the accreditation of an SP is taken by SKVC based on the expert team's reports.

Programmes can be accredited for 3 years (partial time period) or 6 years. At this, all new SPs, proposed by HEIs, can get accreditation only for 3 years. Negative result is also possible, i.e. the rejection to accredit an SP.

The technology of decision-taking is the following. When conducting independent external evaluation of an SP six criteria are used:

- Programme Aims and Learning Outcomes.
- Curriculum Design.
- Teaching Staff.
- Facilities and Learning Resources.
- Study Process and Student Assessment.
- Programme Management.

Each criterion is assessed with a grade/point:

- 4 (very good) – the requirements of the criterion are met explicitly.
- 3 (good) – this sphere is being constantly developed, in some aspects it is assessed as excellent.
- 2 (satisfactory) – minimal requirements are met, enhancement is needed.
- 1 (dissatisfactory) – substantial drawbacks that need to be eliminated.

Accreditation for the full period (6 years) is given in case if the total sum of points is 18 or more, while there is no criterion with a grade lower than 3. Accreditation for the partial time period (3 years) is given if the total sum is no less than 12 points and there is no criterion with a grade lower than 2. A negative decision (rejection to accredit an SP) is taken if the total sum is lower than 12 points and there is at least one criterion with a grade lower than 2.

The external evaluation procedure of SPs in Lithuanian HEIs is regulated by a special document – "Procedure for the External Evaluation and Accreditation of Study Programmes", enacted by an order of the Ministry of Education and Science [3]. As noted in the introduction to this document, the accreditation procedure of SPs is developed in line with the ENQA European Standards and Guidelines[3]. The process itself is well-structured and reasonably regulated. There are some supporting materials developed for experts (for instance, standard questionnaires for meetings with HEI managers, students, etc.). Besides, it is notable that SPs are evaluated by a "package" method – one expert team is assessing a set of similar SPs in different universities. This allows exploiting professional expertise of team members in their field of pedagogical and scientific competency to a maximum extent, although it requires relocations to different cities in order for experts to visit different universities[4]. However this does not cause sufficient problems since transfer from Vilnius to another cities (Kaunas, Šiauliai, Utena) on a minibus takes only 2-3 hours.

Requirements towards Study Programmes of Applied Bachelor Degree

Study Programmes of Applied Bachelor Degree are executed in Lithuania at universities of applied sciences (for instance, Utena University of Applied Sciences) or colleges (for instance, Vilnius College of Technologies and Design, Siauliai State College) – these are, in their essence, two similar types of educational organizations aiming at training applied bachelors. Starting from June, 2010, the Ministry has set the following requirements towards such Programmes of the first cycle (according to the classification given in the Bologna Process documentation):

- Programme volume – no less than 210 and no more than 240 ECTS.
- Number of disciplines per one semester – no more than 7, including internships.

[1] http://www.skvc.lt/en/?id=0
[2] http://www.eqar.eu/
[3] http://www.enqa.eu/
[4] In contrast to accreditation held by one team of experts to accredit several education programmes within one university (for example, AEER (Russia) and CEAB (Canada)

- Total volume of general courses – no less than 15 ECTS.
- Total volume of general professional and specific professional courses – no less than 165 ECTS.
- Workload for thesis preparation (including its defense and final exam, if outlined) – no less than 12 ECTS.
- Total volume of specific courses (including elective courses) – no less than 60 ECTS.
- Total volume of internships within the study period – no less than 15 ECTS.
- At least half of teaching staff should hold an academic degree.

Programme Evaluation According to the Accreditation Criteria

What are the requirements of each accreditation criterion and how are they executed in real life?

Criterion 1. The aims and learning outcomes of the Study Programme. In the context of this criterion the following requirements are set for SPs of Applied Bachelor Degree.

1. The programme aims and learning outcomes are well defined, clear and publicly accessible. Study Programme's aims should be achieved, possibly not by all students, in some time after finishing the study of the programme. On the other hand, the achievement of learning outcomes should be assessed at the end of study period, and the learning outcomes should be achieved by all the graduates.

Lithuanian HEIs preset 5 general aims for each Programme of Applied Bachelor Degree that characterize typical types of graduates' activities. For instance, for a Programme in the field of Power Engineering such aims could be:

- Ability to design electrical distribution networks and networks for distribution of power supply to machinery.
- Ability to conduct assembling of power grids, power stations and substations.
- Ability to maintain power grids, stations and substations for power distribution and power supply to machinery.
- Ability to organize teamwork in the field of design, assembling and maintenance of distribution tools for power and power supply to machinery.

Each aim of a Study Programme clearly defines what and under which conditions Programme's graduate should be able to do. Such description of aims should help prospective students to choose a Study Programme most compatible with their life's interests.

Intended learning outcomes, in their turn, have a more precise meaning. There are about 13-15 of them. Outcomes of a Study Programme describe those particular knowledge and skills in the field of study, both of professional and personal character, that have to be achieved by all students by the end of the study period.

Obviously, both aims and learning outcomes of certain Study Programmes are formed in line with the labor market requirements. Most of Lithuanian HEIs have a so-called "Programme Committee" for each Study Programme (Study Programme Committee) that mandatorily includes a representative of employer enterprises among its members. It is worth mentioning here, that such committee necessarily has a representative of students studying on a particular Programme.

It is interesting that information on each Programme's aims and learning outcomes is disseminated not only through HEI's website, but also on the website of the Ministry of Education, which makes it easier for enrollees to choose a Programme (in Lithuania, like in Russia, prospective students are allowed to submit applications for admission to several HEIs at a time).

2. The programme aims and learning outcomes are based on the academic and/or professional requirements, public needs and the needs of the labor market. First of all, it should be noted that formulation of Study Programme's aims and learning outcomes in Lithuania is necessarily based on the European norms and regulations – those are the Bologna Process documents on the structure of educational system in Europe, the results of the Tuning Project [4], Dublin Descriptors [5] for all cycles of higher education, EUR-ACE Framework Standards and Guidelines for accreditation of engineering education programmes [6] – and are compatible with them. Of course, the norms and recommendations of the national Ministry of Education and Science in a particular field are also taken into account [7]. It is interesting to note that some of the Programmes in the field of Power Engineering, that were assessed during the last visit, presented aims and learning outcomes closely tied with both the National Energy (Energy Independence) Strategy of the Republic of Lithuania and the regional development plans for 2014-2020.

3. The programme aims and learning outcomes are consistent with the type and level of studies and the level of qualifications offered. In our case, the chosen Programmes were of Applied Bachelor Degree, and that has resulted in the evident orientation of SP's graduates on managing and maintaining power facilities on regional and local levels, i.e. on very specific types of professional activities.

4. The name of the Programme, its learning outcomes, content and the qualifications offered are compatible with each other. Undoubtedly, this universal requirement is suitable for Programmes of any type and any cycle. It can only be noted that Lithuanian HEIs are indeed "fighting" for prospective students; and for the Programmes in the field of Power Engineering (which are not among the most prestige or most demanded Programmes in this country) HEI administration is doing its best to assure that enrollees get the most precise (and at the same time attractive) information on a Programme, where he/she is planning to study. Therefore, there is a well-adjusted compliance of the name of the Programme, its intended learning outcomes, content of study and qualification that will be given to the graduates.

Criterion 2. The Curriculum Design. This criterion sets the following requirements for the Programmes of Applied Bachelor Degree:

1. The curriculum design meets legal requirements. Main requirements towards the curriculum design set by legal documents of the national governing bodies in the field of education have been mentioned above. It should only be added that the volume of SP's courses should be equal for both intramural and extramural forms of study.

As can be seen from these requirements, most of them are similar to the requirements set by the AEER accreditation criteria. However, it is prominent that there is a restriction "from above" for the volume of specific professional courses – Programme developers should not get too involved in "narrowing" Bachelor's education to a very precise professional field.

2. Study courses and/or modules are spread evenly, their themes are not repetitive. It is a good and a very practical requirement allowing to even students' workload. Expert teams traditionally ask students during the accreditation visits, whether their workload is evenly spread between semesters (and the answer is usually positive). At the same time, the practice of visiting Russian HEIs shows that it is common to have certain courses of the final year of study repeat the material of first years' courses in order to "refresh what had been learned a long time ago to better understand new material". That has never been the case for Lithuanian HEIs.

3. The content of the courses and/or modules is consistent with the type and level of studies. It seems to be a very logical requirement since it is a frequent finding that developers of Master Programmes promise in preset learning outcomes to ensure knowledge and skills based on the latest achievements of science and technology, however the content of particular disciplines does not rely on these achievements; and for Bachelor Programmes it is common for them to get carried away with the theoretical aspects of study material at the expense of achieving practical knowledge and skills.

4. The content and methods of teaching specific courses/modules are appropriate for the achievement of the intended learning outcomes. Introduction of practice-oriented learning approaches, based on the CDIO ideas [8], which have become widespread over the past years, recommends, on the one side, to implement active teaching and learning forms and methods, and on the other side, to assure teachers' knowledge based on their practical experience, which should be reflected in the contents of the courses taught. In the case of Applied Bachelor Degree and the orientation of training students for their professional activity, this requirement seems to be an essential one.

5. The content and methods of teaching SP courses facilitates the achievement of the intended learning outcomes. This requirement to a great extent strengthens and develops the previous requirement.

6. The scope of the Programme is sufficient to ensure learning outcomes. As can be noticed, this requirement corresponds to the requirement 3 of this criterion. The content of the Programme should not be too wide, but it also should not be too specific and narrow. In the authors' opinion, successful fulfilment of these requirements allows to develop a Programme that would be explicitly focused on a particular segment of labor market and its demands.

7. The content of the Programme reflects the latest achievements in science, art and technologies. It is essential for a graduate of an Applied Bachelor Degree to walk out of the university and be acquainted with what is happening in his field of economy and/or business. Master level of study may require some volume of new theoretical knowledge (any theory needs time to get validated on practice), but the Applied Bachelor Degree intends that graduate's practical knowledge and skills are as similar as possible to the ones he would need at his future workplace. During the visits to Lithuania it had been noticed that accreditation experts criticized laboratory supplies of Bachelor Programmes due to their outdated equipment – any graduate of an Applied Bachelor Programme, who is thought to be maintaining and managing complex equipment, has to be familiar with modern un-to-date tools, devices and mechanisms. Undoubtedly, an HEI can only solve such a problem if it has a close-tie partnership with industry and with potential employers of the Programme's graduates.

Criterion 3. The teaching staff.

1. The study Programme is provided by the staff meeting legal requirements. The core requirement towards the teaching staff for Applied Bachelor Programmes is that at least half of the faculty holds scientific degrees or scientific titles [9]. A Study Programme is considered sustainable if most of the teaching staff works at the university full-time.

2. The qualifications of the teaching staff are adequate to ensure learning outcomes. In order to meet this requirement Lithuanian HEIs pay great attention to the professional development programmes for teaching staff (mobility to foreign HEIs, participation in executing research and development projects, etc.).

3. The number of the teaching staff involved in SP realization is adequate to ensure learning outcomes. It is a natural requirement allowing, on the one side, to assure sustainability of the Programme, and on the other side, to prevent teachers' overload.

4. Teaching staff turnover is able to ensure an adequate provision of the Programme. It should be noted that a similar requirement in a stricter form (no more than 40% turnover during the period analyzed) exists in the AEER accreditation criteria [10]. In comparison with Russian universities, teaching staff turnover in Lithuania is a bit higher, which can be explained, in the authors' opinion, by more open selection procedures for vacant staff positions in this country.

5. The higher education institution creates conditions for the professional development of the teaching staff necessary for the provision of the Programme. It is again a very natural requirement. It should only be noted that Lithuania's inclusion in the European Union gives teaching staff an opportunity to participate in various staff mobility programmes. One of the constraints here is the level of proficiency of "main" European languages. However open borders of the European Union will inevitably lead to dissolving this constraint.

6. The teaching staff of the Programme is involved in research (art) directly related to the Study Programme being reviewed. As of today it is hardly possible to state that all of the teaching staff of the examined Programmes is actually taking part in research and development projects and activities. State funding of scientific research so far is quite limited. At the same time, a certain percentage of staff takes active part in executing projects financed by European resources (for instance, the EU Framework Programme), and this makes a positive impact on the development of their HEIs.

Criterion 4. Facilities and learning resources for the educational process:

1. The premises for studies are adequate both in their size and quality. It is an apparent requirement. The authors are not familiar with the process of funding premises' maintenance, however in all 5 HEIs that authors were able to visit during the 2015 audit in Lithuania universities pay sufficient attention to the maintenance process. This issue concerns not only the premises used for the educational process of the accredited Programmes.

2. The teaching and learning equipment (laboratory and computer equipment, consumables) are adequate both in size and quality. First of all, it should be mentioned that many Lithuanian HEIs receive special funding for the enhancement of technical equipment used for the educational process. This, to a great extent, concerns the equipment for laboratories utilized for natural sciences (physics, chemistry, etc.). Conspicuous is the noticeable number of breadboard specimen and equipment for these courses made in China – authors have not had an occasion to see such equipment in Russian HEIs. At the same time, the equipment for courses of specialty is not always up-to-date. This has been mostly brought to attention by the recent graduates, who participated in the audit meetings for all of the accredited Programmes. As a solution to this problem a number of universities have a practice of using production equipment of industrial companies for conducting lab research. It is important that outdated laboratory equipment and passive position of the management of two Study Programmes in two different universities have resulted in a negative decision on their accreditation in 2012.

3. The higher education institution has adequate arrangements for students' practice. As has been previously noted, students' internships have to have a total volume of no less than 15 ECTS for the Programmes of Applied Bachelor's. Universities frequently face problems with signing agreements for students' practices, the same as in Russia. And for Lithuania, where the production industry mostly consists of small and medium enterprises, this problem is especially vexed. It is common that an enterprise is ready to invite for internships only a limited number of students, whom it is planning to employ later. All of these require SP managers to invest a lot of efforts, especially since students' opinions on the quality of educational process (including students' practices) are collected and analyzed mandatorily and on a regular basis by the Programme Committees and the administration of HEIs. Besides, such an attention to organizing students' practices for Programmes of Applied Bachelor Degree is, obviously, necessary.

4. Teaching materials (textbooks, books, periodical publications, databases) are adequate and accessible. Perhaps, it is quite hard today to amaze someone with just an existence of a university library – most universities have accessible and well-equipped libraries. It is a different story if an HEI has a policy on library fulfillment in the interest of the study process and particular Study Programmes. At least half of library collections in Lithuanian HEIs consists of technical literature in Russian language (it has a reason behind it – a number of Programmes have "Technical Russian Language" as a mandatory course). Another 25% of the collections are the publications in English. Study books in Lithuanian mostly support the general university courses on science and economics. Providing students with an access to the electronic sources (data bases of full-text periodicals, educational portals' materials) under these conditions gains particular significance. It had been a pleasure to notice that practically each Lithuanian university has its own educational portal; that teaching staff pays a lot of attention to filling the portal with study materials. As a result of the accreditation visits to Lithuania there have been no complaints about HEI libraries on this criterion.

Criterion 5. Study process and students' performance assessment:

1. The admission requirements are well-founded. The rules for admission to Bachelor Programmes in Lithuania are quite similar to the Russian ones – standard framework requirements set by the Ministry of Education and Science and their certain specification set by HEI's Council (Senate). In order to enroll as a state-funded student, the enrollee has to have a certain total of grades received at high school final exams, which are similar to the Russian Unified State Exam. The minimal amount of these grades differs from Programme to Programme according to its popularity. Besides, an HEI may enroll a number of fee-funded students, who pay for their education themselves. It is interesting to mention that on some Programmes average grades of fee-funded students during their education are higher than those of the state-funded students.

2. The organization of the study process ensures an adequate provision of the Programme and the achievement of the learning outcomes. First of all, it should be noted that a number of Lithuanian HEIs run a special 10-hour course "Introduction to Studies" prior to the Bachelor Programmes. The aim of such course is to get the new-coming students acquainted with the structure of an HEI, the core study materials, the Code of Conduct and Students Code of Ethics, library, e-learning services, and various other student services.

As a rule, a student may request to form an individual Study Plan for his whole Study Programme or for its part (semester). Students have a vast choice of elective courses, and this, in its turn, allows students to choose whichever specialty within a certain Study Programme.

Some HEIs offer an opportunity for students to receive two Diplomas within their Bachelor's education – a major specialty and a minor specialty (in Economics or Management). Such an opportunity is provided by means of increasing their study period of the Applied Bachelor Degree.

3. Students are encouraged to participate in research, artistic and applied research activities. It is rather unfair to state that Applied Bachelor's students are massively involved in research activities. However, during the visits to the Lithuanian HEIs good practices of such involvement had been seen, majorly, the involvement in applied research conduction and development projects demanded by industry.

4. Students have opportunities to participate in student mobility Programmes. As known, the EU HEIs have a certain standard set for them – it is recommended to have 15% of students taking part in the programmes of academic mobility, as a rule, in the Erasmus Programme. Most of the HEIs of this country are registered as Erasmus Programme's participants and have a sufficient number of partners for the academic mobility. Overall, in Lithuania and in Applied Bachelor Programmes in particular, the number of Programmes' participants is by far lower than the recommended number. Of course, students are well-informed on their opportunities; the system for organization of their mobility is well-functioning, but, according to the feedback from students their participation is limited due to the economic reasons – many of them align studying with part-time work and simply cannot afford to quit their job.

5. The HEI ensures an adequate level of academic and social support. There are various forms of such support in Lithuania – these are the traditional introductory courses, group tutoring, individual consultations, catch-up classes for low-performing students, and also granting loans to students for covering the tuition fees and living costs. Students' active participation in research, sports, and social events may also be financially supported. As a rule, any student in need is provided with a room in a dormitory. Specific helping devices for students with disabilities are the law, not just a pleasant exception. At the same time some SPs (for instance, in the field of Electrical Engineering) a number of students receiving state tuition is quite low due to their low grades for previous semester.

6. The assessment system of students' performance is clear, adequate and publicly available. As a rule, HEIs use a common system for all the courses to accumulate grades for various types of course tasks within a semester. The methodology for applying such system is approved by the HEI's Scientific Council and an order within an HEI. At the beginning of each course the professor has to explain students the rules for their academic progress evaluation relevant to the particular course. In case a student disagrees with the grade received, he/she has a right to file an appeal to the Faculty Dean, who should then make an order to appoint a board to evaluate student's academic progress.

7. Professional activities of the majority of graduates meet the Programme providers' expectations. As in Russian HEIs, students get acquainted with their future profession and possible workplaces long before the end of their studying. Both Russian and Lithuanian HEIs necessarily organize "Career fairs" and companies' presentations. Special departments of HEIs conduct monitoring of graduates' professional careers. Achieving an 80% level of graduates employed in line with their major and qualification is considered an indicator of SP's successfulness and relevance.

Criterion 6. Programme management.

1. Responsibilities for decisions and monitoring of the implementation of the Programme are clearly allocated. As has been stated previously, the core department responsible for SP realization is the Programme Committee. All decisions relevant to many or even all of the SPs are taken by the Scientific Council and top management of an HEI, and all decisions concerning a certain SP are taken by its Committee. However, critical decisions, concerning a Programme, have to receive an approval of the Faculty Council, and then an approval of the HEI Scientific Council. As noted, the Programme Committee includes representatives of the Faculty and Department, one or two representatives of the students studying on the SP, and one or two representatives of the employers. A system of decision-taking on Programmes' realization and their contents is usually approved by an HEI order.

2. Information and data on the implementation of the Programme are regularly collected and analyzed. It is a common thing for Lithuanian HEIs to have a system of regular surveys for students and teaching staff to collect their opinions on the quality and the conditions of SP execution. Obviously, the working party for analyzing this data and taking decisions based on it is the Programme Committee. At the same time, as seen from the meetings with students and teaching staff, it has been far from always when the information on taken decisions reached the respondents. This situation seems to be quite similar to the one in Russian HEIs.

3. The outcomes of internal and external evaluations of the Programme are used for the improvement of the Programme. It should be noted that most Lithuanian HEIs, with which the authors had a chance to get acquainted with during the accreditation visits, do have a closed cycle of feedback from all interested parties, discussion of the received data, decision-taking on SP modernization and execution. In this context, it is worth for Russian HEIs to apply Lithuanian best practices.

4. The evaluation and improvement processes involve stakeholders. As has been noted previously, all stakeholders (students, teaching staff, and employers) are involved in the process of SP modernization in Lithuanian HEIs – they are involved in the feedback system and take part in the discussion of the outcomes, as well as in the decision-taking within the Programme Committee. There can be found some examples of such mechanisms for constant SP modernization in Russian HEIs; however it is hardly a large-scale process so far.

5. The internal quality assurance measures are effective and efficient. It is probably one of the hardest requirements in terms of its examination. What should be taken as a measure of effectiveness and efficiency? It is likely that the evaluation depends on the expert's expertize – and experts taking part in the audit process are invited from different countries with different backgrounds, techniques and cultures of the educational process. On the other hand, the applied grading scale "good – satisfactory – unsatisfactory" and the evaluation procedure by a consensus of Committee members' opinions ease the procedure to some extent. In the authors' opinion, the existence of such criterion allows to set a high bar of international (all-European) requirements towards the quality of SP management.

Speaking of the criteria and their evaluation, it is necessary to mention one more aspect of the expert team work in Lithuanian HEIs. The teams have to note in their reports the examples of the outstanding compliance of the SP execution with one or another criterion (Examples of Excellence), that are then recommended for dissemination within the system of higher education as best practices. This, in its turn, works for the reputation of HEIs and the attractiveness of their SPs.

Technological Aspects of Expert Team Work at Lithuanian HEIs

First of all, the audit process is built to use both experts' and HEIs' time in the most efficient way. The self-evaluation reports on SPs are prepared beforehand and are sent to the experts no less than one month prior to their visit. The Chair of the expert team usually appoints a primary expert on each Study Programme and two secondary experts. The main aim for these experts is to thoroughly analyze self-evaluation reports, address questions to the SKVC and, after all, prepare first draft of the Study Programme evaluation report. Besides, these three team members prepare and coordinate approval of the list of follow-up questions to be asked during the visit. It should be taken into account that each expert team member plays the role of primary expert for one Study Programme and the role of secondary expert for one or two more Programmes. Thus, during the monthly visit there is a very active exchange of expert opinions.

The expert visit to an HEI lasts only one day – it has a very busy schedule in comparison to the audit procedure realized by the AEER at an HEI, although during this visit the same amount of meetings and events is held. Of course, this requires an HEI to prepare the self-evaluation report very thoroughly and to follow the audit schedule precisely.

Preparation of the final report of an expert team on each Study Programme is a very time-consuming and intensive process. A very exhaustive description of the state-of-art on each criterion has to be provided on the evaluated Study Programme. All the conclusions and recommendations of the expert team have to be thoroughly justified and be based on facts collected by the team members from self-evaluation reports and during the visit to an HEI. A special technical coordinator of the Lithuanian Center for Quality Assurance in Higher Education conducts a thorough reading of the draft report and expert team conclusions from the point of the justification of the conclusions. The formation of the final report may end up in multiple iterations. In case of a negative review the Center committee revising the results of Study Programmes' evaluation may return it for altering.

Conclusion

By getting acquainted with the system for accreditation of educational programmes in Lithuania it is possible to conclude that the system works in full compliance with the approaches designed by the Bologna Process documents and the ENQA. The system is focused on talking into account the opinions and roles of all stakeholders, and is acknowledged by both teaching staff and students of Lithuanian HEIs. At the same time, the system is quite strict – the approval of this statement is that there is a big number of Programmes that receive accreditation only for a partial time period. It is quite natural, since the higher education system of the Republic of Lithuania is aiming to become an equal partner of the European Higher Education Area and pays specific attention to the issue of engineering education quality.

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UDC 378

Scientometric Research Results for Educational Trajectory Development in Electronic Educational Environment

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The higher education system keeps changing; therefore, development of new training methods is currently urgent. Control algorithm designed for the most effective individual educational trajectory is a rather important task. Results of scientometric research allow transformations of the variable part of the curriculum on the basis of modular approach taking into account demands of the most intensively-developing industries. Model formalization of information streams in development of educational trajectories is suggested to choose an optimal option of network interaction.

Key words: e-learning, scientometric research, individual educational trajectory, module of an educatio program, electronic educational environment.

The first projects of electronic (on-line) learning emerged in the world under the term "e-learning" as early as the 1990-s, but they became really popular only in the middle of the 2000-s. Nowadays, the volume of electronic learning global market is evaluated of $90 billion, its growth rate exceeding 25% per year.

The demand for a new pattern of training is conditioned by the fact that it should provide the high level of education accessibility and, at the same time, its high quality.

The possibility to master training courses regardless of student's location and simultaneous decrease in teachers' labour efforts per one student allow solving complex problems of enrolment in qualitative training over the entire territory of the country and special category of students.

To implement the mechanism of crediting curriculum modules developed by the teachers of different universities, it is necessary to perform continuous monitoring of designed training modules and select the best ones on the basis of scientometric analysis.

Selection of optimal credit mechanism for curricula modules in the course of network cooperation between professional education institutions includes solving the problem of arranging constantly updated database of such modules.

The results of scientometric research will permit building-up effective teams of university teachers to develop particular electronic educational resources (EER).

It is well known that the major problem of contemporary professional education is the low level of graduates' practical professional training.

The analysis of literature in this sphere [1] has shown that individual educational trajectories (IET) include three components: content (individual educational path), training (including interactive techniques), and management of academic process. In work [2] there is a conclusion that IET effectiveness is defined by student's intention to self-actualize in the surrounding community.

There appears a question: how to transform the training model in modern conditions? How to manage development of IET effectively?

Intensive implementation of electronic learning into academic process allows a way of solving this problem due to implementing practice-oriented training modules. However, it should be noted that such an approach can hardly be implemented without using module training.

Traditional module training is a way of arranging academic process in which instructional content is presented using block-module design. In this case the content of training is structured into autonomous organizational-methodical blocks – modules, with content and volume varying depending on didactic objectives, students' profiles and levels, students' choice of individual trajectories.

The analysis performed has shown that the most optimal module duration in learning process using distance learning techniques (DLT) is 9-hours, which was revealed from multiplicity of curriculum or professional development programmes duration to credits.

A module of educational programme is a relatively autonomous, logically concluded, structured part of the educational programme providing and evaluating the learning outcomes. 'Module' is used as a term synonymous to 'discipline' (a set of discipline parts) or 'discipline cycle' (a set of disciplines within a definite logical framework) of the curriculum.

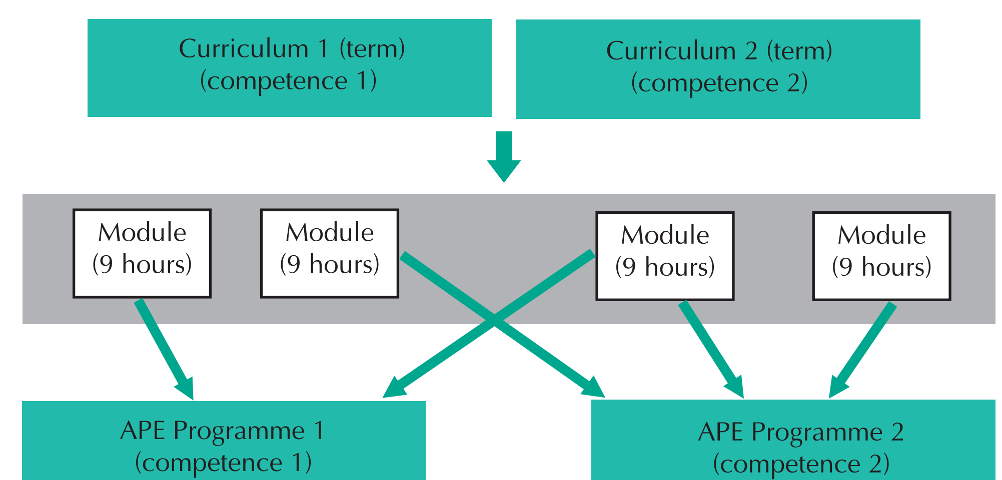
Apart from compulsory modules, curriculum may include the so-called mobility modules, i.e. "a link" of non-profile disciplines that completes student's educational trajectory and provides additional competences, for instance, of the other profile.

Every module ends in test (if necessary, it is accompanied with proctoring procedure). Proctoring is monitoring performed remotely with student's identification and control during the test. Every module is sure to contain the list of competences (competence designators are taken in accordance with FSES requirements).

Modules can be designed in two different ways. One of them is module design based on curriculum. In this case the curriculum is broken into modules. The other way is development of independent modules, which are united into curriculum.

For example, Additional Professional Educational (APE) curricula (APEC) with required competences are composed of different modules (Fig. 1). Each module is described with definite parameters. APE programme is also described with a definite number of parameters. To design

Fig. 1. Module design and APE curricula



the programme effectively, the algorithm of module selection is schematically shown in Fig. 2.

In the suggested project the innovative development of electronic learning environment resulted from using database of discipline modules in learning process.

Modulus approach allows transferring to individual learning process. Individual educational trajectory includes student's individual syllabus consisting of compulsory (invariant) modules (disciplines) and modules (disciplines) chosen by student from proposed disciplines, and individual timetable. Due to student individual syllabuses it is possible to take into account different levels of students' preparation from the first term and make necessary adjustments in their individual syllabuses. Students showing insufficient preparation in the placement test may choose modules, for example, on physics, mathematics of "zero level" (in terms of curricula of the school programme), whereas advanced students may exclude from the syllabus modules that they have mastered at school or studied at colleges.

Individual planning permits including disciplines by choice, mobility modules not only from the individual syllabus, but also from the syllabuses of the related profiles, as well as other university programmes. Using modules in the form of on-line courses these, modules may be recommended to study in the local document.

On the whole, the educational trajectory consists of modules united in a steady set formed by the programme and completely mastered by the students to achieve general learning outcomes corresponding to the particular type, sphere, and professional activity.

To manage the formation of students' individual educational trajectories, a mathematical model was developed. It includes: determination of managed and unmanaged variables of the model, determination of optimization function shape; establishment of the model content and structure; calculation of its parts dependence.

The developed model can use functional, information, resource, and managerial elements. The project is focused on information (learning and research aspects) and managerial elements (interaction in university hierarchical structure).

The innovative development of electronic learning environment is more effective under the condition of managing all its elements online by means of different automated control systems. These systems suggest revealing intersection nodes (points) of information flows followed by management of the information flows just in those points. To control the information flows, the points' location should be adjusted to the university organization structure. It has to be underlined that targeted management control of the information intersection points changes their parameters.

Formalization of information flow model includes conceptual model production followed by mathematical modelling. Let us put:

S – information flows of "university – Ministry of Education" system;

$x_i \in X$, $i = 1, 2, ..., n_x$ – a set of input flows;

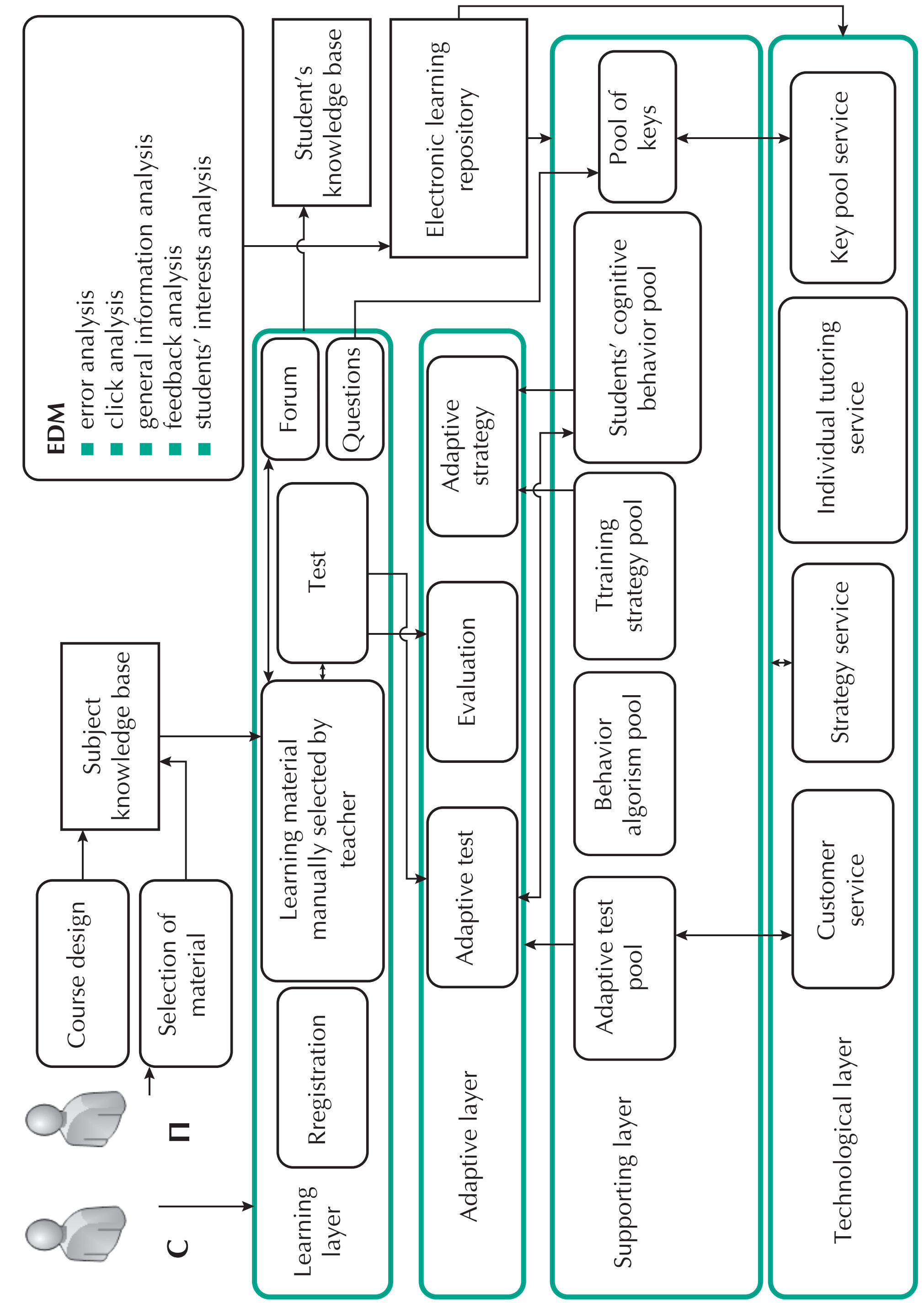
$h_l \in H$, $l = 1, 2, ..., n_h$ – a set of internal actions;

$z_k \in Z$, $k = 1, 2, ..., n_z$ – a set of environment impacts;

$y_j \in Y$, $j = 1, 2, ..., n_y$ – a set of output flows.

The term "scientometry" was coined by V.V. Nalimov [3] in 1969, and scientometric indicators are used to solve (not always unambiguously) the problem of measuring some quantitative characteristics of scientific information. The goal of scientometric studies is to provide a true picture of scientific trend development and their estimation. The results obtained will allow predicting the demands for the staff with higher education and high research competencies. Every scientific trend can be characterized by a set of scientometric parameters, on the basis of which the idea development graph is built [4] making possible to track the progress of trend. Hence, the extremum of target function in network cooperation

Fig. 2. The algorism of module selection



will be calculated for the condition of trend progress limitations. The modular technique is based on individual educational trajectory if a large resource of modules is available. It provides the possibility to transform curricula quickly, in this way reducing information uncertainties in labour market management.

Let us enumerate the university benefits expected from implementation of the project: minimization of graduates' adaptation period for the labour market requirements; transformation of curriculum variable part taking into account the professional requirements (internships in the industry); implementation of most effective ELR.

It should be noted that cost-reduction of new ELR development (that do not give any new information to students) increases the effectiveness of university financial and operational activity saving its resources . It makes possible to choose the best option in network cooperation based on target function:

$$Q = \sum_{m=1}^{n_Q} q_m \rightarrow \min \qquad (1)$$

The optimal option is that with the least value of the target function:

$$Q^* = \min(q_1, q_2, \ldots, q_{n_Q}) \qquad (2)$$

Management of students' individual educational trajectory development based on scientometric research in the course of university network cooperation will contribute to competitiveness of:

- universities on the global market of education services (development of graduates', post-graduates', doctoral students' research competences);
- industrial enterprises in the market of import-substituting products (more effective staff training);
- areas by means of extending universities' activities in the market of educational resources.

Conclusion: Management of students' individual educational trajectories using credits of discipline modules developed in different universities based on the results of scientometric research is an important factor of innovative development for all interested parties to set clear priorities and build effective corporate teams.

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Training of Specialists Using Network Forms of Educational Programmes

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The article discusses the features of implementing the network forms of educational programme. A functional model of interaction using the network forms of learning, the basic characteristics of the training network forms, their components and tasks are presented. The sequence of training process on the basis of the network of educational programmes and the possibilities of their implementation at the profile departments are considered.

Key words: professional training, network forms of educational programs, network forms of learning.

At the present stage of social and economic development of the country new strategic tasks are set for the higher educational system. The decree of the President of Russia No. 599 and the Resolution of the Government of Russia No. 211 are directed to inclusion of not less than five Russian universities in the first hundred leading world universities list according to the world rating of universities by 2020 [1, 2]. According to the Federal law on education [3], the network form of educational programmes implementation provides an access of a student to the resources of several organizations including foreign ones which carry out educational activity, and also, if necessary, to the resources of other organizations.

There is no unambiguous determination of «the network form of education» today, however, the specialists of the Center of information and innovations of The Open University Business School consider that network education is based around educational communities and interaction of educational and other organizations that expands access out of limits of educational space and promotes an increase in training efficiency.

In case of the network forms of education, a number of the researchers [4] consider information and communication technologies determining; by means of these technologies not only pupils, but also their works on joint creation of educational resources interact in the educational community with sharing responsibility among them.

According to the education law, the following organizations can participate in the network form of educational programmes implementation:

- the educational organizations, i.e. the organizations carrying out educational activities as the primary task with the license and according to the purposes and tasks for achievement of which such organization was founded;
- the organizations carrying out educational activities and the organizations carrying out educational activities as the secondary task with the license including the foreign educational organizations;
- the other (resource) organizations, such as: the scientific and medical organizations, organizations of culture, sports, etc., i.e. possessing necessary resources for education, training, etc.

Network interaction is a steady, organizationally arranged interaction of educational organizations and other organizations to increase efficiency of cumulative potential by education system, optimize used resources, and assure quality of graduate professional training conforming to labour market requirements.

The scheme of network interaction is given in Fig. 1, the functional model of interaction for network forms of education is shown in Fig. 2, the main characteristics for network form of education, its components and tasks are listed here.

The network educational programme is an educational programme which is jointly realized by educational, scientific, production, and other organizations on the basis of the agreement with the single curriculum. The organization of educational process for the network educational programme is characterized by the following:

- the purposes, tasks, content of the network educational programme, order of its implementation are regulated by the agreement or treaty which is signed by all partner organizations;
- organizers, partner organizations responsible for specific modules (disciplines, cycles of disciplines) are specified in the curriculum of the network educational programme;
- the basic higher education institution enrolls to the network programme of education; it coordinates actions for realization of network educational programmes, controls implementation of the curriculum, organizes final assessment of the students;
- the diploma of basic higher education institution is issued following the results of education; modules, disciplines, practical training sessions which the student has passed in other higher education institutions or organizations are listed in the appendix to the diploma (with indication of quantity of the academic credits);
- the general duration of education in basic higher education institution shall constitute at least 40% of the standard term (labor input) of all educational programme development;
- the development term of the network educational programme cannot exceed the development terms of the main educational programme of the corresponding direction;
- two curricula for two higher education institutions where a number of subjects are mutually set off are formed in case of education in the programme of joint or double diplomas; and a number of disciplines can be implemented in common (research work, final qualification work, etc.).

In case of educational organization within network interaction, the corporate customer participates not only in forming the social order, but also in educational process; it develops the curriculum of education for the specialists according to their own requirements together with the educational institution. The variable part of the professional educational programme is at the same time formed taking into account the requirements of the corporate customer, the required competences and studied disciplines are determined. These tasks are not always easily implemented by the corporate customer; organization of the basic departments at the enterprise is most effective. This form of cooperation for the educational environment of the Russian Federation is not new. The process of department creation of the educational organizations at the corporate customer is supported by the order of the Ministry of Education and Science of the Russian Federation on 8/14/2013 No. 985. The basic departments allow building any models of cluster interaction uniting at the same time all the participants and considering their interests. Education of specialists on the basis of the agreement on network interaction between the educational organization and enterprise allows carrying out educational process without violating legislative arrangements within the Federal State Educational Standards 3+, for example, for such

Fig. 1. Network interaction scheme

Tendencies in policy, economy and education

- Development of defense industry complex and increase in need for highly qualified specialists
- Youth migration to the large cities, demographic situation of the region
- Change of public financing mechanisms and strengthening of competition for personnel and resources
- New standard and legal and financial conditions of development
- Intensive development of knowledge-intensive industries and need for the advance preparation for high-technology sectors of economy
- Development of practice-oriented professional education
- Change in «landscape» of professional education systems
- Mechanisms of education regulation and training for labor market
- New functions of professional education for adults
- Search for new forms of interaction of educational institutions of professional education and production

↓

Network interaction for education development

Network interaction components

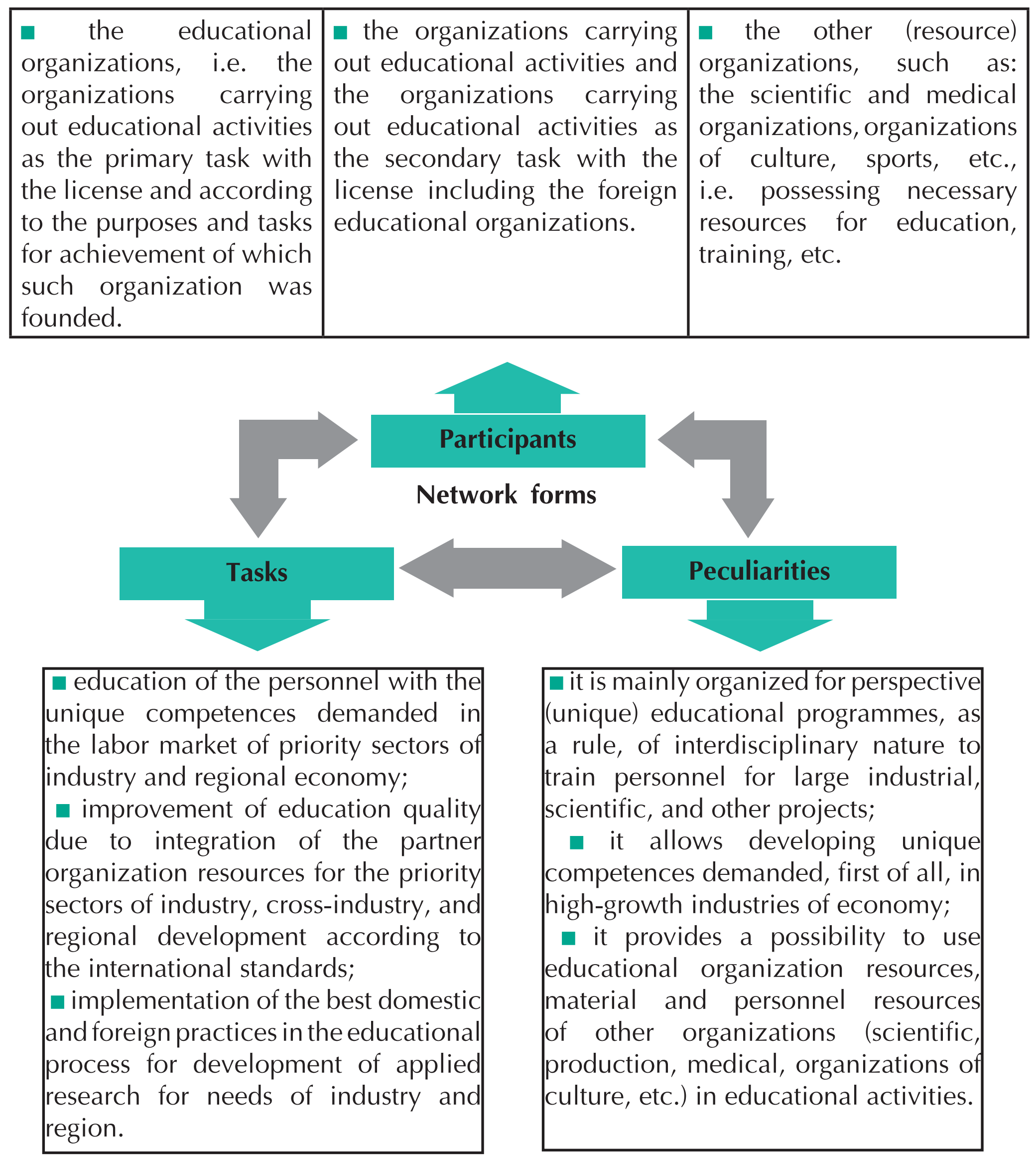
- The educational organizations implementing the main educational programme of higher and secondary vocational education
- The educational organizations implementing the supplementary educational programmes of higher and secondary vocational education; centers for continuing education
- The scientific and medical organizations, organizations of culture, sports, etc., i.e. possessing necessary resources for education, training, etc

↓

Network interaction advantages

- Dynamic change in educational activities due to transformation of learning service demand
- Development of educational programmes implemented by different educational organizations, and an increase in their accessibility
- Flexibility in teaching process due to individual training
- Increase in training efficiency of educational organization graduates
- Continuing education development
- Decrease in expenditures due to resource optimization and service development

Fig. 2. Functional model of interaction for network forms of education



majors as: 11.03.02 «Infocommunication technologies and communication systems» and 11.03.03 «Design and technology of electronic means».

The system of network interaction will allow uniting all resources of the educational and other organizations participating in implementation of the educational programmes, such as personnel, material, information, social, educational and methodical, etc.; it will promote improvement of graduates professional education quality conforming to the requirements of modern labor market.

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Fundamentalization of Transport Bachelors' Education with the Formation of Nature-Centered Consciousness

Ideas, thoughts result in real actions, therefore, they together with words form the future of human being and civilization

Lipetsk State Technical University
V.A. Korchagin, S.A. Lyapin, Y.N. Rizaeva

The necessity of transforming the entire system of knowledge about the universe, man, society, and the role of the fundamental base in the formation of an organic unity of its natural-science and humanitarian components is considered. The educational paradigm of forming nature-centered ecological consciousness of transport bachelors developed in LSTU is briefly analyzed, the results of its implementation are presented.

Key words: consciousness, thinking, development of a student, nature-centered approach.

For economy, where nowadays knowledge and information are dominating, education is a key element in all spheres not only at school and university, but also in professional activity. The idea is clear for everybody, but its application to practice is rather complicated. Our education system and human development potential are to be transformed. It is necessary to train creatively-thinking bachelors and masters capable of providing the required level of development for Russia at the given stage.

Improvement of education quality is one of the key factors to increase economic, social, and environmental safety and, in the long run, social living standards. In our opinion, living standards are to be defined by not only amount of consumed material welfare, but also the level of spiritual and moral wealth development allowing personality formation. The education quality influences significantly the ways and tempos of further scientific-philosophical progress (SPP), i.e. intellectual and moral advance. Under the condition of SPP there will be possibility of more rapid and efficient development of science and technology. The main human potential is concentrated in the intellect, human consciousness and morality.

Our higher school recognized the fundamentality of education, but it did not pay attention to the fact that it is not information that is an important competitive resource for the society, but a skill of generating new scientific knowledge. Nowadays, it should be accepted that we have neglected the issue of education – coordination with needs and development. Education based on manipulative pedagogical techniques is fraught with the danger of personality's deformation transforming him/her into a blind functionary having skills, but **not thinking**, hence, irrational, dismissive of current demands of the society, economy, and ecology in the planet Earth.

At present, the emphasis is placed on ensuring education being relied on personality, via personality, but a personality may not turn inward. Focus of education should be not only on a personality, but also **social-personal**, i.e. a man in the system of education is a goal, all the rest being means of its achievements. Hence, there should be the equilibrium between collective and individual issues, humanity and technocratism, creativity and technologies. As the true significance of the acquired knowledge can be understood by only a personality having socially-significant needs and following lofty ideals, it may be concluded that It is necessary to increase the education quality. One should revise radically the whole system of knowledge about the world, society, and man. These factors force to return to the idea of integrated world towards universal knowledge at the higher stage of human development.

There is a demand for increase in significance of education fundamental base as a part of organic integrity of its natural-scientific and humanitarian constituents: a personality has to realize his/her dependence on the environment.

One may distinguish the two groups of causes revealing its importance. One of them is related to the crucial issues of civilization, the current development period of which is defined by different crises: energy, information, economic, ecological ones, as well as sudden escalation of national and social conflicts, terrorism, refugees in many countries of the world.

The second group of causes is connected with the fact that the world community centers the priority of man in the educational system. It is necessary to provide the gnoseological condition to organize harmonic unity of the Man with the natural environment by means of studying fundamental laws of Nature. To make human existence in the society comfortable, one has to penetrate into cultural environment via learning history, philosophy, laws, economics, ecology, and other sciences. A man possessing general and conceptual natural-scientific knowledge will act in such a manner as to combine practical use with respect for nature.

Nowadays, the significance of transition towards rationally managed civil society is conditioned by not only causes of economy, but also ecology [1]. It incorporates the social importance of the theory of nature and society interaction. The principle of social interest priority over personal one may be considered as a basis for methodological principle of the nature and society interaction theory.

Society and governments choose and have to choose an effective model of global moral eco-development, which means environmentally oriented social-economic development based on scientific **knowledge and quality.** Human well-being, its growth, is possible due to qualitative changes of production economy in combination with gradual quantitative demographic and material-consumptive retreat. Only this route will prevent the deterioration of environmental quality and oppression of natural systems of the planet.

The main tasks for human mind still remain: his/her awareness of immediate actions to provide sufficient harmony in joint efforts with ecosystem in exchange processes of the Universe with the priority of natural environment and humanity, movement towards the model of meaningful regulation of eco-development based on quality and innovative approach. Such an approach will produce the most important social-economic effect for the entire humanity, i.e. improvement of environmental condition and increase in living standards of population within the life cycle [2, 3, 4].

Unfortunately, human mind is not fully ready to realize the coming catastrophe due to the absence of sufficient harmony between it and ecosystem. The intelligence developed a human being and will help to survive in future.

The developed in Lipetsk STU educational paradigm includes macroecological paradigm as production economy needs to be developed within the laws of environmental economy. To preserve the integrity over the maximum time period, humankind is recommended to establish: priority of increasing the entire quality of population living standards; improvement of environmental conditions; preserving the integrity of the Earth biosphere instead of current priority of consumption in terms of the Western pattern of society development.

One of the key requirements for the suggested development civilization paradigm is refusal of: violent human activity against nature; the world com-munity – against economic stereotype which estimate unlimited growth as a progress.

Solution of global problems and satisfaction of human needs necessitates "fundamentalization" of education content. One cannot acquire fundamental knowledge by rote or passively from university teachers. Knowledge is gene-rated by a man himself as a result of internal creative activity, a result of self-management and evolution of thinking process. Teaching activity is a mere acti-vation of students' intellect allowing them the ability of integral thinking that permits a man to feel like an integral part of the nature responsible for harmonic co-existence of man and nature, and to consider science a tool of achieving this harmony. The new educational paradigm is presented as a logically connected triad: "From integral world picture – towards new progressive knowledge and through it – towards scientific-philosophical and scientific-technical progresses".

Hence, in accordance with the suggested educational paradigm, it is the formation of integral-thinking person that is to be considered as a priority of contemporary higher education. In this case, the priority should be implemented only through fundamentalization of education in the context of integrated cultural environment based on organic unity of its natural-science and humanitarian constituents.

In one of his latest articles, academician O. Bogomolov paid attention to the fact that "economists and politicians tend to ignore the research in moral and spiritual aspects of production growth and improvement" whereas economy is only a part of social mechanism, all elements of which interact with each other and are equally significant [5]. The sustainability and stability of a government is defined by the level of human spiritual and moral development.

There is no other alternative for a man as to support his life in social harmony with himself and society, in co-existence with the environment. To preserve its integrity for a maximally long period, humankind has to rely on scientific bases of eco-harmonism.

In Nature the development of non-living matter, living world, and Society follow some common logic, which is called by academician N.N. Moiseev a universal evolutionism [6], since all of them – Man, Nature, and Society are the elements of one single system.

In our opinion, contemporary state of economy and environment requires ecologic-economic analysis of interaction of human activity and the environ-ment, introduction of concepts and generalizations into practice and economic theory as they express cause-and-effect relationships between social-economic and ecological systems. To accelerate the solution of the mentioned problems it is appropriate to form "ecological-economic nature-oriented consciousness" simultaneously [2, 3, 4].

Ecological-economic consciousness is a complex of ecological and social-economic knowledge, ideas, and views of communities directly reflecting the re-ality and expressing the attitude towards different events in human life and so-ciety, in particular, at the given historical period. The main criterion of knowledge transition into consciousness is public interests of strata and groups presented in views, ideas, theories focused on managing ecological-economic relationships in human activity and expressing the needs of social communities. The essence of ecological-economic consciousness is connected

with systematized knowledge based on scientific cognition and voluntary application of ecological and social-economic laws.

From the standpoint of development eco-psychology, for a man to survive in the anthropogenic environment created by him, he has not only to change nature anthropocentrically, but also change, develop himself psychologically in accordance with the universal principles and laws of nature including his own human nature. Hence, as an alternative to anthropocentric consciousness fo-cused on consumer attitude to nature, the idea of eco-centric type of ecological consciousness and thinking is put forward according to which a personality acts and is aware of oneself as "a procedural unit" of self-performance of nature in the form of human consciousness. But in this case, a personality will act and feel like an ecological subject of nature development including his abilities and environment.

The department has organized a perspective in Russia (in the view of lead-ing scientists of Russia and Europe) research-production school "Theoretical and practical application of bio-compatible technologies in transport".

One of the important fundamental scientific trends of the school deals with development of theory, methods, and pathfinding in coordination of social eco-logical and economic interests. The research results have allowed suggesting new ideas, ecosystem approach, and theory to solve the major problems: remediation of destroyed environmental systems; maintenance of ecological-economic balance in development; creation of the conditions for vital functions of biosphere and technosphere. The scientific school has gained its recognition for developing the theory of harmonic interaction of road transport with the environment and solution of fundamental problems, production problems on ecology, economics, and research bases of functioning open transport systems.

Within the framework of scientific school the teaching staff of the depart-ment works at development and implementation into practice the academic-pedagogical concept of continuous ecological-econo-mic education for bachelors in transport. The goal of this profile is to develop students' ecological-economic worldview with the nature-centered consciousness and thinking based on fundamental continuous ecologic-economical training of the youth. The concept of economic training consists in focus on knowledge of economic laws of nature and society, their legal framework, formation of a personality with market social-psychological intentions capable of fair enterprise, business activity, taking ecologically-balanced effective managerial decisions.

Let us present the report of independent expert from the conclusion of accreditation examination carried out in LSTU in 2015, prepared by Volkov V.S., Doctor of Technical Sciences, Professor, head of automobile and service department, Voronezh State University of Forestry: "The share of teaching staff involved in major professional programme and having both basic higher education and Candidate (Doctoral) Degrees, meeting the requirements of the profile taught by them, is 100%. To build the basis for training of an engineer capable of managing effective and biocompatible transport production, the staff of the department solved the high-priority problems:

- the research-production school of teachers, doctoral students, post-graduates, and students with nature-centered ecological consciousness and thinking was organized. The LSTU research school was recognized by the leading scientists and universities, which was supported by their reviews, reports at the international conferences, in 6 articles published in the journals from the RF State Commission for Academic Degrees and Titles list and abroad;

- within 20 years of working in LSTU the founder of the scientific school V.A. Korchgin has supervised 10 Doctors and 22 Candidates of Sciences, 4 of which are Candidates of Economic Sciences with the solution of ecological problems. He was awarded with the European order LABORE ET SCIENTIA "Labour and Science" for the contribution to the development of science and education acknowledged by the international community.

To achieve the primary goal – development of LSTU graduates' creative and scientific eco-humanitarian worldview-effective and up-to-date educational technologies have been developed and widely applied in teaching disciplines, the number of diploma projects of scientific-research profile that are awarded and placed high in the All-Russian Olympiads and competitions is growing.

Recognition of LATU achievements in training research staff, development and implementation of State Educational Standards in Higher Professional Education (SES in HPE) in transport profile has been confirmed by Professor Korchagin V.A. He was awarded with the honorary title of Professor by 10 leading universities of Russia and foreign countries; Victor Alexeevich gave workshops on creative approaches to academic process in the perspective majors in the universities of Russia and abroad (Austria, Italy, Tadzhikistan, Finland, Ukraine).

Over the past five years the staff of Transport Management Department has published 69 research articles in the journals of the RF State Commission for Academic Degrees and Titles list, three articles in the journals indexed in the international citation databases and in 20 international editions, 12 monographs, and 9 manuals with TMA stamp".

The majority of the department graduates will be successful and recognized in their career and life, as they are able to implement an important business principle: "to perform actions without deterioration of environment today, about which all other will only think of tomorrow". Today, one cannot do only that one wants or is ordered to do. Our graduates are able to raise and answer the question: "What do I have to do to improve the quality of my job and enhance the environment". This is a new issue in the history of humanity. This is a direction of sustainable development.

The significance of learning fundamental disciplines in development of ecological-economic consciousness and thinking is demonstrated by the words of Nobel-Prize winner, economist Paul Heyne: "That who argues about economy without theory gains, as a rule, only speculating about it using bad theory" [7]. Therefore, it should be concluded that the processes of progressive inclusion of the Russian education into international educational space are to be on the way of searching for such a model that comprises the best things from the previous one, would contain the tools for prompt respond to the market demands.

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Formation and Implementation of University Development Strategy as a Factor of Economic Stability and the Education Quality

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Long-term planning of higher educational institutions' activities based on the results of the SWOT analysis is an integral part of the management system and higher education development. Formation and implementation of the development strategy of a university in all spheres of its activities provide the predicted results, both in economics and in the field of education quality. In Togliatti State University "Strategy-2020" was developed and implemented based on five principal parts of its functioning.

Key words: Togliatti State University, development strategy, economic stability, quality of education, SWOT-analysis, program development, strategic objectives, priorities.

Under modern conditions of post-industrial society when wide-scale informatization of engineering and social systems is in progress, when globalization of the international community has led to extensive mobility of goods and services including educational ones, each definite educational institution, university in particular, has to form its development strategy and then implement all its provisions and strategic objectives thoroughly to compete and promote in the market. Article № 89 par. 2.2. of the Federal "Law on Education" [1] states explicitly the fact that management of education system is to include strategic planning of education system development.

Such a strategy is to cover all spheres of a university's activities from the key activity, learning process to its supplementary types, such as services and marketing. In this case, global indicators of development strategy are to be focused on the results which achievements are sure to promote a university in the overall ranking of Russian and international universities. Implementation of such a development strategy would enable not only competitiveness and promotion of a university in the external competitive environment, but also make possible to increase powerful intramural engineering and highly-qualified teaching staff potential. In its turn, it is these indicators of a university that are basic for assessment of educational programmes performed by both government agencies in Russia and foreign professional-public institutions [2].

Having a status of regional university and being aware of the problem in Togliatti city as a global problem of "single-industry city", Togliatti State University has turned its attention to the formation of its development strategy since 2005. At first, this activity included the development of The Programme of Structural University Department Arrangement for the period 2…3 years with its annual improvement. Since 2010 the management and control system has been implemented to manage The Programme of Development with participation of regular Group of Strategic Planning (GSP) consisting of representatives of top management.

In 2010 the TSU development strategy was also approved for the period until 2015 that had been discussed and agreed with wide range of interested parties: university staff, Academic Board, Board of Overseers, afterwards, TSU Academic Board formed it and accepted for execution.

As early as the beginning of 2013 the analysis of outcomes of "Strategy 2015" showed that they had been fulfilled by more than 85%, and, therefore, there was a demand for the strategy improvement. Besides, there was a form a new strategy of TSU development for the period until 2020.

Forming "Strategy-2020", SWOT-analysis was used to fully account and structure the information on university's intrinsic potentials and disadvantages, as well as threats and challenges of the environment. The process of "Strategy-2020" development included the following stages:

1. Campus-wide workshop on "Development of the University: problems and trends, potentials and limitations". The directors of the institutes, heads of the departments, supervisors and experts of infrastructure services participated in the workshop – more than 90 participants. As a result of the workshop, more than 80 specifications of weaknesses and strengths, potentials and threats were formulated.

2. Comprehensive analysis of TSU development strategy for the period until 2015. As a result, the report on "Strategy-2015" implementation was designed and published in the corporate mass media.

3. Developing the concept of Strategy-2020". The draft of the key conceptual statements of the university development for the period until 2020 was presented for the teaching staff at the current August meeting of teaching staff and for the TSU Board of Overseers under the chairmanship of Samara Oblast Governor N.I. Merkushkina.

4. Analysis of the external trends in development of science and education. As a result, visual aids of international and national trends in education were prepared, information on changes in research-innovative sphere was analysed.

5. Strategic session of "TSU development: potentials and limitations". In the framework of strategic session the SWOT-analysis of the university was worked out and updated. The event involved more than 100 members of university including TSU visiting professors as bearers of experience and traditions, as well as representatives of university active youth.

6. Formation of university development initiatives. As a result of uniting and grouping the statements of the TSU development areas, 22 strategic development initiatives were formulated which were decomposed into 141 spheres. All initiatives were grouped in five areas of activity of TSU development.

- Education (7 initiatives, 43 spheres).
- Science, innovations, engineering, and consulting (3 initiatives, 18 spheres).
- Management and staff (3 initiatives, 25 spheres).
- Services and infrastructure (3 initiatives, 19 spheres).
- Marketing, positioning, and promotion (6 initiatives, 36 spheres).

7. Update of strategic objectives and formations of development priorities. For each of the above mentioned blocks of university development 19 development priorities were formulated. They became a basis for updating strategic objectives of the university development. Finally, for every area of university activities a definite strategic objective was designed. To implement the strategies effectively 8 drivers of TSU development were established:

- global competitive educational programmes of Higher Professional Education (HPE) and Additional Professional Training (APT);
- wide-scale use of distance learning techniques;
- effective schemes of attracting applicants and graduates' employment;

- laboratories, technological, and engineering centers of the international level;
- effective marketing in education, R&D, and consulting;
- qualified staff with relevant competencies;
- effective system of management and diversified budget;
- attractive university environment and infrastructure.

8. Development of "Strategy-2020" performance indicators of implementation. The performance indicators of "Strategy-2020", are, on the one hand, focused on "The Road Map" of education and science development in the Russian Federation, on the other hand, set the expected outcomes of TSU strategic initiative implementation. In total, 20 planned indicators were determined for the period until 2020. To evaluate the development dynamics, the values of indicators of 2013 were taken as a basis. In addition, the reference points of indicator values were set for 2016 and 2018.

The described method of development strategy formation in Togliatti State University shows that a significant number of university staff was involved in its development, it was comprehensively discussed by internal and external experts. It enables us to speak about acceptance of "Strategy – 2020" by all university staff and wide community, urgency of the set objectives, and feasibility of planned indicators.

One of the key block in the TSU strategic development, namely Education, may be taken as an example in setting strategic objectives and prioritization of TSU development for the period until 2020 (Tab. 1).

All five blocks of development areas taken together will allow synergy of the university from the standpoint of TSU Mission: *"By joint efforts of teaching staff, students, graduates, and partners of TSU to ensure the development of competitive innovative socially-oriented economy, strengthening civil society and cultural prosperity of Samara Oblast and all Russia, in general"* [3].

As a result of "Strategy – 2020" implementation, Togliatti State University is to be presented by 2020 as:

- **TSU – competitive** in the globally-integrated international environment, dynamically developing state university, being in the forefront of the world educational trends, capable of responding the changes of environment adequately and promptly.
- **TSU – research university,** effectively integrating educational and research activities, a powerful research-educational center of Volga region, having a number of international priorities in different spheres of mechanical, electrical, and power engineering.
- **TSU – innovative university,** producing innovative ideas, projects, and businesses simultaneously with training of specialists who implement them.
- **TSU – city-forming and strategic university** producing a regional development force and providing staff assistance for modernization of Togliatti economy, contributing to its innovative development via its graduates, as well as design, adaptation, and implementation of innovative techniques.
- **TSU – information-open university,** a cultural center forming human-oriented urban environment of Togliatti and its positive image; a center for education of intellectual elite, responsible for the future of Togliatti and the whole country.
- **TSU – a university integrated** with the leading institutions and enterprises, effectively managing joint educational, research, innovative activities.
- **TSU – prestigious university** from the applicants', students' and employers' point of view widely applying modern educational techniques, focused on requirements of employers and professional communities, providing high competitiveness of its graduates in the Russian and global labour markets, responsible for its graduates employment and career.
- **TSU – comfortable university** with "open-for-city" modern campus of developed infrastructure providing all necessary conditions for study, work, life, and pastime and meeting the international standards.
- **TSU – socially responsible university,** capable of withstanding external threats and challenges, providing prestigious jobs and high living standards of its staff.

Table 1.

Block	STRATEGIC OBJECTIVES	DEVELOPMENT PRIORITIES
EDUCATION	To provide effective and competitive education in TSU based on modern approaches to organization of learning process including: ■ integration of research and education; ■ wide-scale implementation of distance learning techniques; ■ development and promotion of demanded courses and APT programmes; ■ use of advanced tools of applicants' attraction and graduates' employment; ■ development of continuous practice-oriented learning from secondary vocational education to postgraduate course and APT including network and cooperative learning.	1. Attraction of applicants: expansion of geography, increase in quality of modern attraction tools. 2. Strategic partnership and network cooperation with schools, colleges, employers. 3. Focus of the learning process on requirements of employers and professional standards as well as integration in research process and innovative activity. 4. Effective system of graduates' employment. 5. Economic effectiveness of education without loss of quality. 6. Wide-scale implementation of distance learning techniques. 7. Sharp increase of profit share from APT in the TSU budget, development of competitive system of APT.

Conclusions

1. The developed strategy of TSU strategy for the period until 2020 in accordance with the Federal Law N 273-FL «On Education in the Russian Federation" meets all contemporary requirements of university strategy development.

2. Developing "Strategy-2020" sufficient amount of research and practical material on strategic planning in universities was thoroughly studied, the experience in design and implementation of TSU development programmes and "Strategy-2015" was taken into account.

3. Implementation of TSU development strategy for the period until 2020 will provide TSU competitiveness in research-educational sphere of HPE.

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VAZ and Higher Education Institution: Historical Parallels. Experience in Implementing Development Strategy 2020

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In Togliatti, the automobile plant and the state university were established approximately at the same time and developed simultaneously. Currently, AVTOVAZ development strategy includes the program of personnel training and retraining. The strategy of Togliatti State University implies development of new engineering education programs in cooperation with the professionals of the automobile plant. Such programs will allow developing professional qualities in demand within automotive business sector. With business and education overlapping, it is possible to boost the national economic growth.

Key words: Togliatti State University, JSC AVTOVAZ, development strategy, economic stability, education quality, personnel training, education programs, automotive industry.

The history of AvtoVAZ began on July 20, 1966, when the Soviet government decided to construct an automobile factory in Togliatti. As late as April 19, 1970, the first six cars VAZ 2101 "Zhiguli" were launched. On October 28, 1970, the first vehicles were transported to Moscow by train. The 100000th car of this model was produced on July 16, 1971. On December 22, 1973, the factory was officially approved by the State Commission. The design capacity was 660 thousand cars annually [1].

On March 10, 2010, the AvtoVAZ Board of directors adopted a business-plan until 2020, according to which the vehicle production should reach 1.2 million items per year by the end of 2020. In February 2012, the design capacity of the factory was 900 thousand vehicles annually.

Automotive industry is one of the branches of engineering manufacture that determine the economic and social level of several regions of the country. However, the situation of the industry has been ambiguous for the last ten years. The growth of the Russian car market is not conditioned by the increase in the share of domestic producers. Thus, the share of Russian engineering reduces and the engineering staff leaves the industry.

The leading international car producers, who entered the Russian automotive industry, did not intend to launch contemporary cost-efficient production of car components for foreign cars in Russia. It is explained by the fact that the Russian legal system does not bind them a big amount of production capacity. Moreover, a lot of car components for Russian vehicles are produced in other countries. This fact made the Russian government elaborate a comprehensive strategy for the automotive industry development to 2020, which was adopted in 2010.

The strategy for the automotive industry development includes such basic measures as:

- development of the national base of R&D and automotive clusters;
- a complex of state measures to support domestic automotive industry including a medium-term activity plan [2].

The implementation of these activities aims at the following objectives:

1. to develop infrastructure for R&D to design new vehicles, auto components and technologies that are competitive on the global market;

2. to improve a staffing system of the industry based on a comprehensive prediction of enterprises' needs in competencies that meet current and prospective level of technology and management.

Currently, the problem of staff training for the domestic automotive industry is acute. Graduates with a Bachelor's degree both from universities and colleges do not have the competencies required by the employers, the training process being out of touch with the production, and the education facilities being out of date. Apart from this, low income level and job prestige in the industry do not encourage students to acquire new knowledge and competencies and to stay in the industry.

Thus, the Strategy for the automotive industry development in Russia states: « To train top-ranked professionals who are able to cope with the design and production tasks of a modern industry, to develop a multi-level higher education system that includes both profound fundamental (theoretical) training, and sufficient professional skills obtained during design, production, technological and pre-degree internships. It is necessary to develop requirements for new professional standards according to jobs and positions in the industry, educational and curricular documentation for State Educational Standards of new generation, and targeted training programs coordinated with the enterprises of the industry [2].

The strategy of "AVTOVAZ" complies with the development strategy of the Russian automotive industry in structure and content. Thus, it contains the same clusters and areas as the Federal strategy of automotive development has. Some activities in the frame of the strategy aim at interaction with Russian universities, including the biggest regional higher institution – Togliatti State University, which, apart from the automobile plant, is a "town-forming factor".

The history of the University dates back to 1951, when the branch of Kuybyshev Industrial Institute was founded. The first hydraulic and electric engineers graduated the University in 1956. With 2800 students and three faculties, it was reorganized in Togliatti Polytechnic Institute (TPI) in 1966. The foundation of the TPI was also conditioned by the demand for personnel for the plant under construction. In 2001, TPI became Togliatti State University (TSU).

Having made a progress from the branch of Kuybyshev Industrial Institute to the modern University, over 65 years, TSU have trained about 70 thousand graduates of different specialties. TSU alumni are country's leaders, mayors of cities, State Duma deputies, and top managers of big enterprises including JSC "AVTOVAZ". The TSU graduates have created a highly qualified environment both in Togliatti and Samara region [3].

Togliatti State University, as a big regional higher education institution, regards the problems of Togliatti as a global challenge of all Russian "one-company towns" as well as understands modern challenges of the automotive industry. Thus, the University developed the strategy of the University development. In 2010, "TSU Development Strategy till 2020" was first adopted. It was discussed and coordinated by a wide range of stakeholders: faculty members, the Academic Council, the Board of Trustees, and top and production managers of "AVTOVAZ".

Taking into consideration the main provisions of both the Federal Strategy of automotive industry development and the Strategy of "AVTOVAZ", TSU recognizes the following priorities in its development: "Education", "Science, Innovation, Engineering and Consulting", "Management and Human Resource", "Service and Infrastructure", "Marketing, Positioning and Promotion".

One of the strategic areas in education is to adjust TSU education programs to professional standards and employers' requirements with regard to growing competition in the education market that results from Russia's WTO accession and distance technologies. It is implemented through the following activities:

- to ensure strategic partnership with the key employers of the city and region, and professional communities to develop qualification requirements, competence model of the graduate and professional standards;
- to use the monopoly of TSU in main areas of engineering training in the city and the domination in the automotive industry of the region [4].

Since 2010, TSU have carried out the following activities to implement the TSU development Strategy and interaction with the automotive enterprises in terms of training of engineering staff and doing research and development:

1. TSU is claimed to be a "reference university" in the Program of innovative development (PID) of "AVTOVAZ", which is the company with state participation. TSU is chosen as a research and education center with approved research and technological areas and amount of cooperative work (in design and technology), as well as developed programs to improve education and training professionals for hi-tech industry.

The main R&D activities carried out by "AVTOVAZ" in collaboration with Russian higher education institutions and research centers over the period 2011-2016 are as follows [5]:

- development of advanced and upgrading of serial engines,
- advanced systems and parts of electrical equipment and electronics for vehicles,
- electric and hybrid vehicles,
- virtual design,
- methods of construction development,
- compliance with advanced vehicle standards,
- vehicle ergonomics,
- advanced technological processes,
- new materials.

To determine priority areas of research and development in the medium term (5 years) and for 1 year, a united scientific and engineering council in cooperation with Samara University was founded. It consists not only of the leading faculty members of the universities, but also specialists of "AVTOVAZ", who are involved in implementing the projects of the enterprise development.

2. Targeted training is provided by TSU for particular production conditions and needs of employers, which is based on a trilateral agreement between the University, "AVTOVAZ", and a student. "AVTOVAZ" funds additional training courses for the students, including foreign language courses, for better adaptation of the TSU graduates in the production structures of AVTOVAZ-Renault-Nissan Alliance.

3. There is a practical experience in providing training courses, modules, and internships at the plants of "AVTOVAZ" and the enterprises producing auto components.

4. The grants in the frame of decisions № 219 and 220 of the Ministry of Education allowed TSU to purchase the equipment for research and training activities. The equipment was chosen with regard to the nomenclature of education programs approved by "AVTOVAZ" and the enterprises producing auto components.

5. According to the contract with the automotive plant, TSU provides retraining and professional development courses for the engineers responsible for design and technology at the plant, but having "non-core" qualification.

6. TSU offers 10 master's, 14 bachelor's, and 6 specialist's degree programs for automotive industry. Three education programs "Mechanical-engineering Technology", "Equipment and Technology of Welding Industry", and "Power Supply to Industrial Facilities" were accredited according to «EUR-ACE» criteria. These programs are listed in European Network

for Accreditation of Engineering Education (ENAEE) register. According to the accreditation conditions, the graduates of these programs can be recognized as "Professional Registered Engineer", on meeting the ENAEE requirements. Most of these graduates work for JSC "AVTOVAZ". In February 2016, the Accreditation Center of Association for Engineering Education of Russia (AEER) assessed five master's degree programs in terms of their compliance with the standards. The AEER Accreditation Board decided to award «EUR-ACE» label to the programs.

7. The representatives of "AVTOVAZ" take part in state assessment committees that are involved in assessment of engineering degree's thesis.

8. In 2013, TSU won a competitive tender in the frame of President's Program of Professional Development of Engineers, 2013-2014, to provide further education programs for engineers in the spheres of "Energy Efficient and Environmental Friendly Transport with Alternative Energy Sources" and "Advanced European Requirements Related to Vehicle's Passive Safety". The first stage of the President's program has been completed. Both courses are finished. 30 employees of "AVTOVAZ" have successfully defended their thesis and been awarded with a certification of professional development. The final stage of the training in the frame of the President's was internship with UTAC-CERAM (France) and MES s.a. (Switzerland). The graduates had the possibility of learning modern and advanced approaches to electro mobile development and functional parts implementation. The Internships allowed them to know about current and prospective legal and technical requirements to passive safety, as well as to obtain practical experience in application these requirements and protocols in concrete situations. The program was implemented in cooperation with TSU and "AVTOVAZ".

9. Project-based learning is one of the well developed forms of educational process in TSU. The example is the international education, engineering and sport project "Formula Student", which was launched by the American Society of Automotive Engineers (SAE). The project has been implemented in TSU since 2008. Students of different specialties design and build a racing car, and introduce it on international racing competitions. The training involves such practical courses as "Mechanical-Engineering Technology", "Cutting Work", "Welding Processes", and "Assembly Process". The results are reflected in course papers and graduate thesis of the TSU students. "AVTOVAZ" takes an active part in implementing "Formula Student" project. The participants' skills are highly valued at the enterprise, and the graduates take well-paid jobs with prospects.

At the same time, it is necessary to note that the intensity of collaboration between the alliance and the University has significantly reduced since "AVTOVAZ" joined the alliance "AVTOVAZ-Renault-Nissan» and Mr. Anderson was appointed the head of the enterprises. In addition, the level of localization of Russian vehicle production has also reduced, because some Russian producers of auto components were substituted by foreign companies. Structural changes of engineering department, which led to engineering staff reduction, and collapse of some Russian auto components producers had a negative impact on the enterprise-University interaction in terms of research and development and staff training. In particular, the program of targeted training for the enterprise was first reduced from 100 students to 30, and then to zero. The united scientific and engineering council including representatives of "AVTOVAZ", TSU and Samara University, which was established in 2012 and chaired by Mr. Dibuan, was abandoned when the chairman was dismissed. The alliance may have economic reasons. However, pursuing only profit, the alliance should remember that the Russian Federation spends a big amount of funds to support

the automotive industry. Thus, it does not seem promising for regional and national economic development to transform the auto plant into "screwdriver industry" without any engineering structures, research and development activities, professional development of the staff, as well as without involving Universities in mutual implementation of the development strategies.

Conclusions

1. Implementation of joint activities that comply with the development strategies of TSU and "AVTOVAZ" ensures effective development of not only the program participants, but also the whole automotive industry of the country.

2. Current experience of the alliance-TSU interaction in the frame of strategic area development reveals the necessity to multiply the points of contact between education and research activities of University and production and innovative activities of automotive enterprises.

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Best Practices of Simulating New Approaches and Tools for Assessing Regional Demand for New-Generation Engineering Workforce

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In the context of a new paradigm of planning the demand for engineering workforce, the prediction should be formed by each constituent entity of the Russian Federation from the points of view of largest employers and the system of professional education. This stipulates the transition from strict calculation algorithms to a variety of approaches and methods and their free choice. The article discloses the assessment models for evaluation of engineering labor market demand.

Key words: forecasting, regional engineering labor market, models for assessing enterprises' demand.

The issues of predicting economy's needs and demand for professional workforce, including specialists with engineering education, have been widely discussed over the past few years. Researchers identify two levels of forecasting regional needs in professional workforce: a strategic level (creating long and mid-term forecasts) and operational predictions, determined by an annual amendment of prediction results in line with the employment rate monitoring and taking into consideration the employment of professional education system's graduates [1, p. 54].

Dividing the object of research into qualitative and quantitative workforce needs and indicating the corresponding methods of data collection and processing allows for determining three types of workforce forecasting. The evaluation of quantitative needs is a traditional sphere of economic forecasting. The quantitative criteria, as a rule, are used by the governmental agencies involved in the system of forecasting professional workforce, and large employer companies that execute the process of corporate workforce planning. The quantitative needs are determined by using regulatory, staff, balance methods, method of economical mathematical simulation, statistical methods, methods of extrapolation and expert evaluation, as well as their combination or other methods suitable for acquiring corresponding indicators. Having said this, the predomination of quantitative (economic) methods for workforce demand evaluation does not eliminate the existing misbalance between the structure of engineers' training and the unsatisfied employers' demand for qualified engineers. The quantitative strategies for workforce demand evaluation today do not solve the problem of engineers' competences deficit. This predetermines the need to find conceptually new approaches allowing regulating the system of supply-and-demand equilibrium on the labor market.

The process of forecasting qualitative indicators of the engineering labor market lies mostly in the area of managerial forecasting and is, in its essence, a simulation of alterations in the engineers' employment structure based on the competence-based approach. Foresight technologies applied in managerial forecasting combine various methods of managerial diagnostics (SWOT-analysis, brainstorming, scenarios, development of technological roadmaps, method of imitative simulation, etc.) with sociological tools of various polling types. However, the foresight approach is used, as a rule, when conducting large-scale strategic research relating to the formation of a list of on-demand competences for the field of technical innovations [2].

The advantage of sociological forecasting is the opportunity to use a combination of quantitative/formalized and qualitative/non-formalized methods for data collection and processing when working with both large and small, exclusive data sets in the context of an item-by-item research and in compliance with the specifics of researched enterprises. The transition from "demand for the workforce (professional perspective)" that is determined by employers' surveys to the "demand for the educational level and profile (educational perspective)" is one of the most difficult stages in the development of long-term and mid-term workforce forecasts. Such contradiction can be overcome by using forecasting of competences and qualifications needed for a particular workplace in order to determine prospective demand for engineering workforce of large employers. In order to conduct mid-term forecasting of competences and qualifications, the method of sociological analysis of qualifications may be used. Such analysis includes enquiry of engineers, managers of engineering projects at enterprises, analysis of workflow organization. There should be a thorough list of qualification needs stated as a result of this method's application. They should be strictly connected with particular work places. The identified deficient competences, the discrepancy in competences' supply and demand on the labor market should correlate with the National System of Competences and Qualifications in order to determine desirable educational majors that would form the required learning outcomes.

In June 2015 the Ministry of Labor and Social Protection and the Ministry of Education and Science of the Russian Federation approved a new methodology for calculating mid-term and long-term perspective of the professional workforce demand [3]. The basis of this methodology is the use of methodological and regulatory-juridical support of the national system for workforce forecasting. The forecast of the demand for professional workforce should be formed by each constituent entity of the Federation in line with the needs of the largest regional employers. The key role in development of the new forecasting system is given to the system of professional education.

The cornerstone for the formation of new-generation engineering workforce of the Sverdlov oblast/region (RF constituent entity) is the Ural Federal University. In order to implement the new paradigm of regional forecasting system the research group of the Higher Engineering School of the University has made an attempt to form new models for evaluation of the demand for engineering workforce.

Simulation of new approaches and tools for planning the demand for new-generation engineering workforce is based on three core conceptual preconditions. First of all, it is about measuring and assessing the demand for engineering specialists in line with the algorithms systematically interconnecting not the quantitative, but, before all, **the qualitative characteristics** of the engineering labor market state on a regional level. It is worth noting that the qualitative methods of evaluation are still on the evolvement stage, and there still are no flawless techniques for assessing the need in skills and qualifications. Alongside with these, most researches (economists, sociologists, psychologists) agree that in order to define the needs in particular engineering workforce, sets of professions, qualifications, competences, it is needed to exploit the qualitative methods of forecasting changes in the employment structure of one or another profession and level of education.

Secondly, for an independent evaluation of region's workforce demand it is necessary to take into account the innovation policy of industries and territories, to determine both the prospective leader by their level of innovative activity and level of production, and the low-tech and low producing industries and manufactures. Finally, the qualitative assessment of the demand for regional workforce should be run in the context of the interactive planning paradigm based on the principles of full and continual participation and resource provision of all the social interaction agents – government, industry and education.

The methodological basis for simulating new approaches and tools for demand assessment is the competence-based approach. This approach is aimed at finding solutions to the problem of engineers' qualifications deficit, determining the existing and the expected levels of engineering competences and qualifications development. The potential of competence-based approach introduction to the system of professional standard, unfortunately, is not reached. Professional standards methodology mostly uses the functional, not the behavioral approach. The developers of professional standards based them on their functional structure, knowledge, skills and attitudes, and not on the behavioral models, professional and production aims, etc. Thus, there still is a major contradiction between the system of training engineers and the new requirements from the professionals' labor market.

The requirements towards forecasts reliability lead to the necessity of applying integrated research strategy using non-linear (parallel-sequential) technologies for demand assessment. Key attributes of this technology are the sequential exchange of research information and the integrative calculations in line with the item-by-item identification of geographical, professional, industrial and functional characteristics of the demand for workforce. In other words, the key research objective is not just to assess one and the same object by using different assessment methods, but, to a greater extent, to refine and assess the advantages of various tools for measuring demand for qualifications on different objects, suitable for specific and each time different aims. Exploitation of a mixed research strategy "Hourglass Strategy" and the triangulation principle gave an opportunity to combine elements of formalized and non-formalized research approaches for a holistic and deep analysis and to find solutions to a wide spectrum of research objectives. Hourglass clock analogy indicates specific features of the research strategy, its temporal and methodological peculiarities, variable ability to use different models and methods on different temporal stages of research, decomposition of models and methods divergently.

As a result of this research strategy exploitation five prediction models occurred for forecasting qualitative parameters of regional engineering labor markets: the stakeholder model for assessment of learning outcomes, the model for assessment of innovative behavior of regional enterprises, the interactive model, the model for assessment of learning outcomes based on the CDIO Syllabus and the local model for assessment of particular competences of design engineers' professional activity.

The stakeholder model for assessment of learning outcomes is aimed at finding discrepancy in the assessment of importance and existing competences' development level of future engineers (graduates of engineering majors in Sverdlov region). The specifics of the model are the big body of data and the application of formalized methods for data collection and processing. Survey method – questionnaires. Expert team included faculty members of engineering majors from Ekaterinburg HEIs (N=146), practicing engineers of large regional enterprises (N=240), PhD students in STEM (N=88). A modular type of questionnaires (inclusion of similar blocks on assessing learning outcomes and competences) allowed for conduction of stakeholders' opinion comparative analysis.

Overall, the results of expert polling have not indicated any equivalence in assessments on the scale "importance-existence" for any competence. There is a visible gap between the desirable by the industry and the existing level of engineering graduates competences. Most severe discrepancy has been disclosed by all groups of experts in such competences, as "experience of interaction with real sector of economy" (a gap of 1.5 times), "comprehensive understanding of the chosen industry, understanding economic context of its functioning" (a gap of 1,4 times).

The need to find causes of stakeholders' assessments diversity led to the creation of the second research model – **the model for assessment of innovative behavior of regional enterprises.** The aim of the model is to identify special features and problems of managing innovative research and developments at Ural enterprises. A sample selection included 16 enterprises of key regional production industries. Survey method – formalized expert survey. The expert team included heads of scientific research centers and scientific technical departments of enterprises.

In the opinion of some regional experts, the current functional structure of scientific, educational and industrial sectors of the Sverdlov region in the context of its innovative development indicates that the region is on the beginning stage of the regional innovation system formation. The collected data allowed not only to segment real sector enterprises of the regional economy, but also to identify the dominant industrial type of the region. The results of the survey show that there are only two enterprises belonging to the leader industry – a competitive industry of the new technological wave. The overwhelming majority of enterprises (nine out of sixteen) were classified as belonging to stable industries of the old technological wave. The key conclusion of this model's application is the identified need for monitoring analysis of enterprises' innovation activities. This would lead to the development of long-term plans (requests to HEIs for training prospective specialists, joint R&D themes and projects) and mid-term plans (creation of professional development programs, possible engineering services, etc.); it would permit the correction of long-term and mid-term educational programs and scientific research activity.

The interactive model played a role of a "pivotal shaft" within the hourglass strategy. The interactivity in the name of the model has double meaning. On the one side, "interactive" indicates direct on-sight interaction with employers, working with them in the real-time mode. In this context the interactive model can be seen as a model of deep dive research ("immersion research" model) that focuses on the issues of identifying demand for workforce and finding key competences. On the other hand, similarly to the interactive models in mechanical engineering – models of reliability between the motion paths and the choice of reference system, our model discovered the reliability between competence paths and the specifics of companies' innovative behavior.

The immersion of the research has been assured by the transition from traditional quantitative, formalized assessment methods to the qualitative research methods. For data collection, a non-formalized (deep) interview with enterprises' representatives has been conducted. The data was processed by a thematic analysis of interview scripts with the use of program software. Two large enterprises, identified by the second model as having different innovative statuses and industry types, became the objects of research here. The enterprises represented two traditional leading production industries of the Sverdlov region – metallurgy and mechanical engineering industry. The metallurgical enterprise has been positioned to the "stable industry, but saving its competitiveness only due to the low production costs"; its innovative status is average. The mechanical engineering enterprise has been positioned to the "problem industries": the enterprise maintains good positions on domestic market, but had lost its positions on the global market due to its technological inferiority; its innovative status is low. Before conducting the field study a hypothesis has been proposed that the industrial and innovative statuses influence the assessment of engineering specialists' competences paths.

The survey has been conducted in line with the methodology of thematic text analysis. After studying interview scripts and conducting secondary review of text data a generalization of source codes has been made. The system of codes has been presented as follows: innovation development, assessment of modern engineering education, attitude towards cycle education, competence model, planned proportion of Bachelors and Masters in engineers' training, channels for recruiting specialists, and demand for graduates of regional HEIs.

A comparative analysis of enterprises' behavioral strategies indicated one common and highly representative feature – all respondents underlined the low level of competences of regional HEIs' graduates and demonstrated negative attitude towards cycle education of engineers.

Finding cause-and-effect relations between elements of data sets within the item-by-item research showed that such extracts as methods and character of demand forecast, sets of competences by the types of engineering activity, character and mechanisms of innovation development lie in the area of determinational interconnection. In particular, differentiating competences according to the types of engineering activity, organizational mechanisms for their formation correlate with the development/functional strategy implemented at an enterprise. The metallurgical enterprise with an average innovative status, belonging to the stable industry, features simulation of a new type of engineering activity (innovation engineer) with a corresponding set of competences of system and spherical engineering; its preferred network forms of cooperation with HEIs are Specialized (Company-based) Departments and Dual Master Programs. The mechanical engineering enterprise with low innovative status and a survival business strategy is focused on the formation of competences in line with the qualification and functional engineering design workplaces within the industry; a high level of fundamental education is prioritized in the structure of general professional competences; its prioritized organizational form serving for the purpose of acquiring extra practical competences is the corporate system of professional development programs. A set of personal competences differs as well depending on the innovative status of an enterprise: average status – stress resistance and self-motivation; low status – personal responsibility of an engineer.

The survey indicated restrictions in identifying quantitative needs of enterprises in engineering workforce. The enterprises use different levels of forecasting – corporate and industrial. Key corporate method of forecasting the demand for engineers is the functional analysis of workplaces. The method of expert survey is used when speaking of the industrial forecast. Prioritized and independent of the enterprise's development character is the mid-term forecasting for upcoming 3-5 years.

The results of the interactive model research have been verified at the next stage of research. **The model for assessment of learning outcomes based on the CDIO Syllabus** turned out to be a role model for the determination of required competences for the new-generation engineering workforce. The basis of the Worldwide CDIO Initiative is formed by the stages of any engineering product's lifecycle: Conceive – Design – Implement – Operate. CDIO Syllabus is a system of knowledge, skills and personal attitudes necessary for modern engineers. The CDIO Syllabus lies in the essence of reorganization of modern programs of engineering education all over the world at technical HEIs.

The CDIO Syllabus map has been tried out on the design engineering profession – one of the most desirable majors, especially in the field of regional mechanical engineering. The subject of assessment – competences of design engineers of a large mechanical engineering enterprise of Sverdlov region. The method for data collection is the formalized interview with managers of a large engineering project within the company. In the context of the embraced integration the formalized interview appeared as a sequel to the interactive model. Such integration allowed relating the non-formalized and formalized data in order to confirm the results of the questionnaire in all its varieties. The depth of a gap between the existing level of the set of competences and the employers' expectations on particular competences within the CDIO Syllabus has been determined and assessed in line with the professional qualification structure for design activities of three positions – design engineer, leading design engineer and manager of an engineering project.

The assessment of dynamics of design engineers' professional development on work position levels indicated that the volume of requirements and the importance of the expected competence increase from the starting level of qualification to a higher position more drastically (40% on average) than the actual level of engineers' expertise (20% on average). This supports the conclusion that the pace of overcoming the gap between the real and the expected by employers level of competences is not sufficient. The causes for such contradiction can be both personal limitations and inaccurately formed work conditions. In order to solve this problem a full-time working system of professional development should be organized; support and stipulation of design engineers' self-education should be provided. In the current case, this involves the organization of professional development programs on not just the existing production technologies, but on the design and development of new technologies.

This recommendation has been taken into account by the researchers when developing the last model – **the local model for assessment of particular competences of design engineers' professional activity.** Researchers calculate that professional development of highly qualified design engineers, and especially managers of engineering projects, takes up to 10 years of work within a large production enterprise. The current research shows that if this process is result-oriented and organized on the basis of modern technologies for professional development management, then it can be shortened by several-fold – down to 1,5-2 years. This may lead to dissolving or at least softening "qualification deficits" on the design engineering labor market. Generalization of the research results on professional competences of design engineers for mechanical engineering enterprises serves as a basis for the development of innovative programs of adult education with an aim to minimize the "qualification deficit" on the design engineers' labor market of the Ural region [4].

Thus, the developed models for the assessment of qualitative demand for the new-generation engineering force permitted specialists of the Higher Engineering School (based on their deep analysis of the large regional employers' interests and the specifics of their innovative behavior) to segment the routs for interaction between HEIs and enterprises of the real sector of the economy; to form the basis for an integrative system of scientific research and distinguished solutions on the assessment of workforce demand, to coordinate the expected learning outcomes on design and implementation stages of the engineering education programs.

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Humanization of Engineering Education: Current Challenges in Russia

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The paper deals with humanization of today's engineering education and analyzes interconnection between science and education in philosophical perspective. The author investigates different methodological approaches to engineering education, which were applied in Russia before and after the Revolution, in terms of humanization and dehumanization of the society.

Key words: humanization and dehumanization of the society, engineering education, technical education, scientism, education.

Engineering education in Russia is currently developing under complicated conditions due to significant social changes and fast technological progress. There is also an important question whether it is necessary for technical education to consider individual interests and needs. To answer this question, one should investigate engineering education as a social institution.

Engineering education as a social institution was established when the first complicated technical objects were created and the technics became the major factor boosting social development [1. p.3]. It was at the ages of Renaissance and Enlightenment when the paradigm of education was developed. This paradigm included a block of humanities, which were supposed to develop personal integrity and contribute to social positioning, as well as another block of natural and technical science disciplines necessary to understand the surrounding world.

Environmental problems, the threat of nuclear disaster, and resource depletion are the challenges which people face due to the intense development of technology. Technology is the link between theoretical knowledge and production activities and can be described as the sphere of human knowledge aiming at nature change, the bulk of human abilities and skills. J. Ellul remarked that technology is the machines that make the human being an object of manipulation revealing everything that used to be concealed. Therefore, an engineer is supposed to play a major part in designing new social reality.

In the 18th century in Russia there was a contraversion between the natural sciences and humanities representatives in the spheres of science and education. Within the framework of classical rational science there were two approaches to analyze the correlation between morals and science, ethics and knowledge. "One pole implies scientific perspective while the other one is connected with establishing, strengthening and disseminating morals, human ideals and values" [2, p. 16]. This issue is currently urgent. The correlation between humanization of education and science should be based on interconnection of technology, science, and education, which will allow determining the proportions of humanities and technical sciences contribution to worldview formation.

The intense development of technics and natural sciences made some people think that science and technics fail to play a positive role in the development of the society and engineering education cannot secure social progress. This point of view derives from the age of Enlightenment: J.-J. Rousseau developed and disseminated the concept of education, according to which technical and humanities approaches to social development are set against. As J.-J. Rousseau stated, only humanities can help to bring up an ethical person in terms of humanist ideals.

The Russian gymnasium education broadened the European model of the "enlightened person" and a wide range of humanities were taught, such as ancient, early modern and modern history, theory and history of writing, history of verbal folklore and literature, several foreign languages, philosophy.

The foundation of the Russian engineering education rested on the German model of technical education enriched with national philosophical concept of education and spiritual V.S. Solovyev, L.N. Tolstoy, N.A. Berdyaev, N.F. Fyodorov [3. p. 48]. These scholars suggested the idea of interconnection between spirituality, education, and enlightenment: the human consciousness is formed by three aspects – sense, intellectual, and spiritual experience. Therefore, total perception of world is possible only through the synthesis of philosophy, science, and theology. The empirical experience was supposed to be acquired through studying natural sciences and rational thinking, humanities contributed to enculturation, and spirituality was developed by theology. If to analyze the concept of engineering education humanization, it is important to note that religion, education, science, and philosophy, three essential constituents in the system of Russian culture, conditioned and promoted its development.

In the second part of the 19th century an evolution of science, culture, and education began in Russia and Europe. The intense development of fundamental and applied natural science and technology resulted in new challenges faced by pedagogy and education system in general. The Russian system of education was not ready for technicalization of society and did not allow including a technocratic component into the long-established educational model of the "enlightened person".

One of the factors used to play an important role in the development of national engineering education was the struggle between two groups – liberal reform (or people's education) and conservative one oriented towards gymnasium education regarded as securing and stabilizing.

The representatives of the liberal reform party were starving for people's education. They did not have any particular plan but believed that illiteracy elimination and dissemination of culture and science would boost the technical development of the country.

Humanization of education and bringing-up were topical issues after the Revolution, however, the idea was politically determined and failed to secure universal human values and civilizational ideas. The national education in general was politically determined: in 1925 A.V. Lunacharsky identified three basic components of education as follows – communist ideological content, proletarian ideology, politics. As Lunacharsky stated, education has always been, currently is and will always be a political issue [4. p.74].

Any attempts to save humanization potential of national engineering education were regarded as relapses of bourgeoisness and ideological defeatism. Higher technical education was idealized and unified, development of scientific worldview came with development of conformist consciousness, which accepted all social and judicial changes in the country. This resulted in the system of pedagogic manipulation, especially in humanities, which was reflected in the pedagogy theory and practice of the Soviet period.

However, the situation was different at some higher education institutes. In the 20-30s humanities-oriented staff of technical institutes disapproved the national education policy and due to this fact the country witnessed the generation of the 60s, who first of all were moral. Teachers of humanities were forced out from Russian schools and universities and there was no adequate substitution. New generation of teachers met the requirements of the unified socialistic education and science system of the end of the 30s.

Humanities were taught in compliance with unified programmes, which were responsive to any government interests and could be easily amended. In the 70-80s there was an urgent need in qualified personnel for the national industry, which resulted in changes in technical education. The amount of humanities disciplines was significantly reduced, especially at technical schools and training colleges. A new education pattern was developed in the USSR, which was based on the unified system of labour nurturing and unified school structure. At that time the secondary school, which technical schools and training colleges were based on, provided students with poor knowledge of humanities. Moreover, there was the only pattern in teaching humanities, i.e. Marxism-Leninism ideology. Many changes in teaching humanities were attributed to the heavy burden of marginality laid on the education system: the history was only taught in the perspective of formation approach and class struggle, which led to socialist revolution, was considered as the major factor of historical development.

Currently, national history within the framework of technical education is still taught in compliance with the Soviet pattern. Nihilist attitude to the national culture prevails over teaching tolerance and respect to the ancestors, which A. S. Pushkin considered to be the most important characteristic of the civilized society distinguishing "education from wildness".

Therefore, by the beginning of the 90s humanization of technical education was kept to a minimum and humanities within the framework of higher technical education were oriented towards prevailing ideology and policy.

The processes mentioned above were rather complicated and had to be deeply analyzed since the issue was crucial in terms of its practical significance and further development. This stipulated a complete rethink of content and structure of the education system to train not only cultured and well-educated humanities professionals, but also engineers performing their professional activities within the paradigm "science – technology – production – society". It is noteworthy that humanities-oriented approach to the education was mostly developed by the staff of higher education institutes.

Humanist values suggested by the humanities and stipulating intellectual creativity and search for the truth failed to comply with current science and education patterns due to the prevailing opinion that humanities are "specific labour of producing thoughts and ideas".

However, dehumanization of professional education was criticized by the most prominent European philosophers, such as A. Bergson, K. Jaspers, M. Heidegger. K. Jaspers supposed that dehumanization of education limits individual worldview. Natural science disciplines prevailing within the educational framework change the way people perceive the surrounding world and nature and make them oriented towards unsustainable consumption which impacts the environment. Education becomes rational knowledge embodied in the form of "learned knowledge" and "primitive truth". In K. Jaspers's opinion, modern education is in crisis due to the fact that humanities are substituted by natural science disciplines and technocratic approach based on experiment and calculation is predominant in education.

Having analyzed humanization of science and engineering education in Russia, one can make a conclusion that Russian history witnessed different education systems with various approaches to education. In this perspective, national education is a competition between different and even controversial ideas and concepts. Actually, there are two main

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paradigms – humanistic and technocratic, and humanization of education within both paradigms will allow gaining a new perspective and changed worldview.

Modern education is a system with a number of functions: bringing-up, social, professional, cultural and educational, administrative, however, the only function currently accomplished is professional. Learning humanities, the students of technical universities and institutes form their personality, acquire morals, develop a flexible way of thinking, etc. Unfortunately, the disciplines based on humanist values are beyond the scope of today's education programmes. We live in the world inherited from our ancestors and the question is what our children will inherit if we train narrowly-specialized technicians incapable of predicting the effects of their actions.

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Automotive Engineer Training: Challenges and Solutions

KAMAZ PTC
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The paper proves the necessity for using a specific tool in engineer training, namely, mobile training laboratory equipped with all necessary facilities and provided with educational and methodological support. This mobile class will allow solidifying theoretical knowledge and developing the team work skills effective at each stage of product life cycle.

Key words: engineering education, competencies, mobile training laboratory, innovations, engineering personnel, requirements.

Introduction

Today, the slogan "Personnel is a key to everything" is still popular. There is an urgent need in engineers with systemic thinking and interdisciplinary competencies, and this is the issue to discuss at the Government of the RF, development institutions, different conferences and forums, and also on the pages of many journals – "Inzhenernoe obrazovanie" ("Engineering Education"), "Forsait" ("Foresight"), "Problemy upravleniya v sotsial'nykh sistemakh" ("Problems of Governance"), etc.

It is noteworthy that many efficient measures have already been implemented to improve the quality of practice-oriented education. For example, there are federal target programmes and the President's Programme for personnel training; different competitions and grants to support young scientists and engineers; business, science, and education support provided by the Government in compliance with the Resolution № 218 dated April 9, 2010, etc. To improve engineer's competencies, national educational and professional standards have also been implemented. However, the measures mentioned above are not enough to solve all business and social challenges.

Based on business experience, corporate engineer training, and interaction between KAMAZ and national education system, the key corporate engineer's competencies have been specified:

- knowledge of sciences and fundamental technical disciplines;
- ability to apply systemic engineering approach and make forecasts;
- ability to use interdisciplinary knowledge;
- creativity and ability to generate innovations;
- skill to find efficient solutions for different hand-on tasks based on the knowledge acquired at university via TRIZ technology;
- knowledge in the sphere of cutting-edge CAD – CAE– CAM – PDM – PLM systems;
- knowledge in the spheres of business process and quality management;
- project presentation skills;
- wish and skills necessary to work in a project team and to ensure efficient management at all project stages;
- knowledge about the principles of sustainable production;
- English language skills.

The above-mentioned competencies prove the idea that the engineer should not only possess fundamental and interdisciplinary knowledge, abilities, and skills, but also have a wish to intensively use them in practice.

This idea is shared by many education experts. For example, the classification described in paper [1, p. 36] includes five categories, each of them comprising four competencies. The categories are as follows: professional knowledge, team work, management skills, personal performance and communicative skills. It is noteworthy that professional knowledge, team work, and management skills are among the priorities.

Articles [2, p. 15] emphasized the necessity to boost the development of engineer's competencies since it is necessary for the national knowledge-based economy. The engineering education should be improved through education programme modification with due regard to business demand for elite engineering education. The authors of paper [3, p. 18-19] point out the need for additional corporate engineering education after graduation from university, which is efficiently implemented at our enterprise, as well as goal-oriented training. It is also important to keep in mind "breakthrough" competencies, which will be in need in future.

In paper [5, p. 13] the authors put emphasize on the personnel competencies, which are the same as those specified by KAMAZ. The information on modern notions and trends in the sphere of "elite" education are described in paper [6, pp. 15-17]. Practice-oriented engineering education and its perspective are considered in article [4, p. 49] and other works.

In the present paper the authors explain how to involve engineering students in scientific work, how to improve their professionalism, and what to do to develop team work skills.

Current challenges: business perspective

Automotive industry plays an important part in securing economic stability and boosting national development, ensuring social progress, political and economic independence, and improving defense capacity. In terms of statistics, one person working in automotive industry is supplied with materials and utilities by 5–6 people, therefore, automotive industry development is a national strategic objective and the level of its development is the criterion to estimate the economic strength of the country.

Modern automobiles have to meet a number of restrictive specifications on their efficiency, reliability, comfort, level of active and passive safety, and environmental impact. To develop innovative products, the automotive sector needs innovative personnel and technologies, including educational ones.

Today, the major challenges of automotive industry development and staff training are as follows:

- lack of national utility base;
- a number of competencies which remain undeveloped: knowledge of systemic engineering, mechatronics, electronic systems, algorithms for management and programming;
- inefficient facilities and resources of universities and their laboratories;
- inadequate system of professional training and current demand for the staff possessing interdisciplinary competencies meeting international standards.

In the Republic of Tatarstan, there are many small and medium-sized enterprises which supply materials and utilities for KAMAZ. In general, the enterprises employees graduate from Naberezhnye Chelny Institute (NCI), Kazan Federal University (KFU). Some professionals of enterprises-suppliers cooperate with research department staff of KAMAZ. However, this cooperation fails to be on a regular basis and research in design and engineering is unsystematic.

Another challenge is the staff of enterprises-suppliers, who are not experienced enough in conducting scientific research to provide world-class outcomes. There is no IT unification in CAD – CAE– CAM – PLM systems. Many enterprises lack professionals possessing interdisciplinary competences in need.

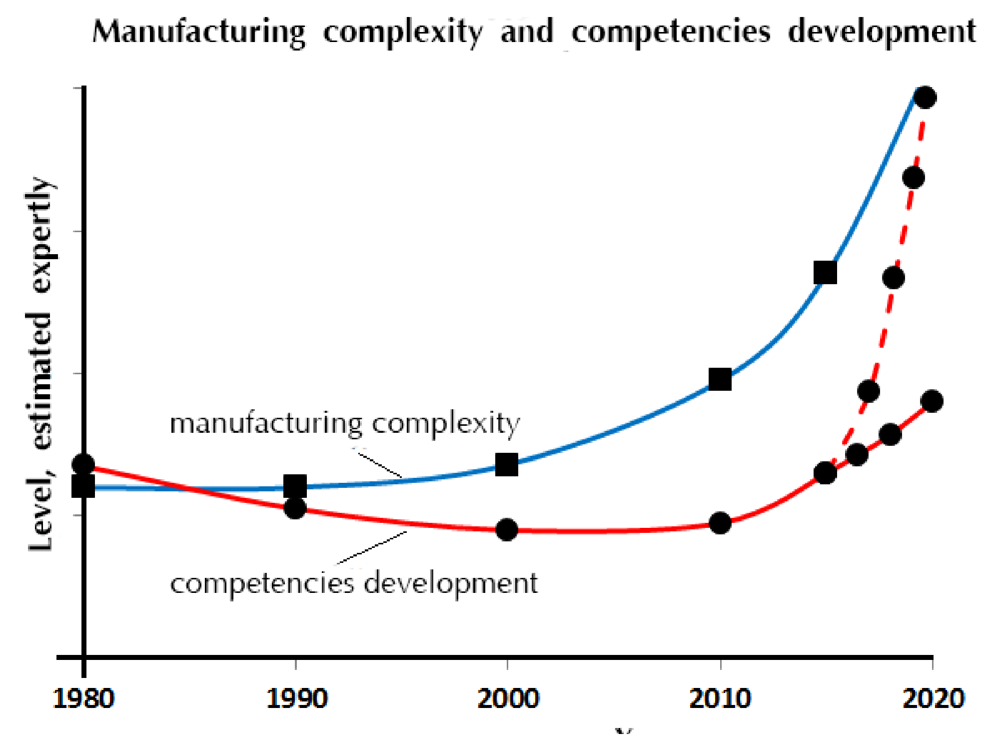
Moreover, to train highly-qualified engineers for automotive industry, higher education institutions need modern laboratory and research equipment. For instance, there should be engine test rigs to assess their quality in compliance with EURO-5 requirements; however, it is only at KAMAZ where the automatized transmission and vehicle test rigs are used.

As a result, the educational process in general and conducted tests and experiments in particular are hindered due to the lack of facilities at higher education institutions. However, work with cutting-edge vehicles and their components allows involving today's students in scientific research.

E-learning courses designed in 3D and presenting video on different components and assembly units fail to make students comprehend a vehicle as a system. Furthermore, the products and utilities become more and more enhanced, which makes them impossible to be produced at the current level of competencies development (see Fig. 1). However, it should be noted that at the end of the 80s of the 20th century, the level of competencies development corresponded to that of manufacturing complexity.

It should be noted that the levels are estimated expertly, in relative units, to emphasize the differences between them and it is obvious that there is an urgent need to reduce the gap between the two levels. The scenario of increasing the level of competencies development marked by solid line is inadequate since it is too time-consuming but there is another option to be successfully used even under the circumstances when the enterprises lack qualified personnel and financial resources.

Fig. 1. Manufacturing complexity and competencies development



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Solutions for the challenges

One of the ways to improve professional competencies is to organize mobile training and research laboratories (TRL) at NCI KFU. Even today there is a solid base for laboratory establishment:

- engineering school at KAMAZ Scientific and Technical Center (STC);
- educational resources and methodological support to train a new generation of engineers and to found a scientific school;
- the infrastructure of Engineering Centre of NCI KFU.

Educational activities consolidated under the auspices of a staff education centre established by KAMAZ and NCI KFU in cooperation, equipped with all necessary facilities and TRL, provided with necessary methodological support will allow ensuring the high quality of education.

As for TRL, it is supposed to fulfill the following functions:

1. Educational facility – TRL is a special vehicle for students and engineers to conduct on-road practical tests to estimate parameters and properties of vehicles and their components.

2. During extracurricular time, TRL is a mobile complex for the university and KAMAZ personnel to conduct research on design and checkout algorithms for assist and development systems (engine, transmission, breaks, suspension), robot vision, etc.

3. During winter time, TRL is an instrument to promote engineering education, a tool of occupational guidance for prospective students, especially for those living in remote areas of the Republic of Tatarstan and other regions of the RF.

The concept of TRL and educational activities.

Let us enumerate the education and research fields where TRL can be efficiently used:

- Testing robot vision, engine control, driving machine, and mobile units.
- Scientific research and checking out algorithms for electronic component control and vehicle control systems.
- Testing undercarriage, vehicle cabin, hydraulic, pneumatic, and mechatronic components of energy-saving and autonomous vehicles.

The above-described TRL is represented in Fig. 2.

Vehicle chassis can be equipped with radar, lidar, video camera, odometer, speedometer, accelerometer, decelerometer, fuel flowmeter, resistive strain sensor, noise and vibration sensor, etc. There can also be climate control system with the options of air heating or cooling inside the van, screen, projector, system of collecting, analysing, processing and transmitting data from digital and analog sensors (up to 100 channels), various lockers and drawers, fridge, special gages, devices and equipment.

When testing, TRL moves in the immediate proximity of tested objects (one or two vehicles, Fig. 3) equipped with the systems of signal detection and transmission. The data are transmitted from tested vehicles to the TRL computer center via local area network or Internet.

Engineers or students in the TRL process and analyze data obtained on-line when the vehicles are moving. Therefore, there is an opportunity to adjust the tested vehicle's systems from the mobile lab directly.

TRL will include the following components:

1. Studying room "on wheels" placed on KAMAZ chassis. The number of studying seats is no less than 16.

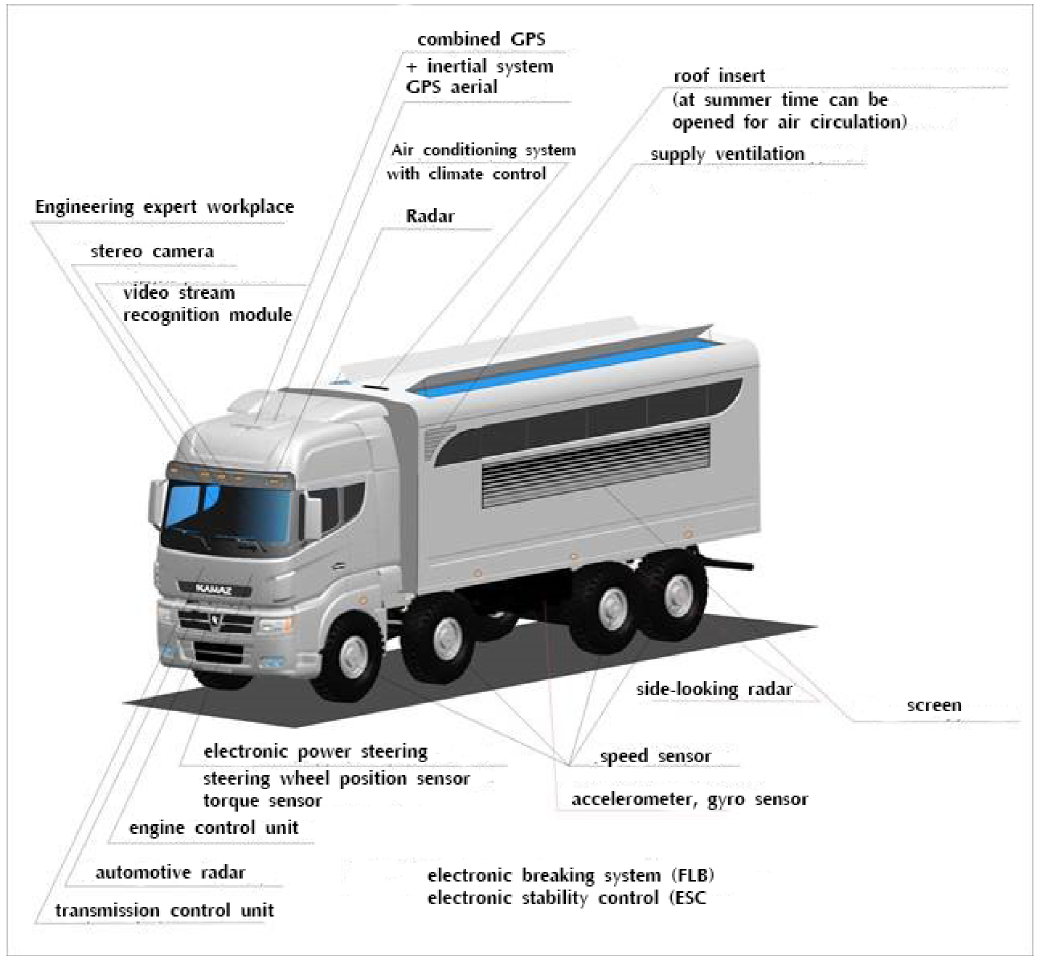
2. Measuring and recording equipment.

3. A set of educational resources and methodological support materials for conducting laboratory activities.

Target audience and educational process.

- Students of NCI KFU and other higher education institutions of the RF of the relevant professional domain.

Fig. 2. TRL: general view



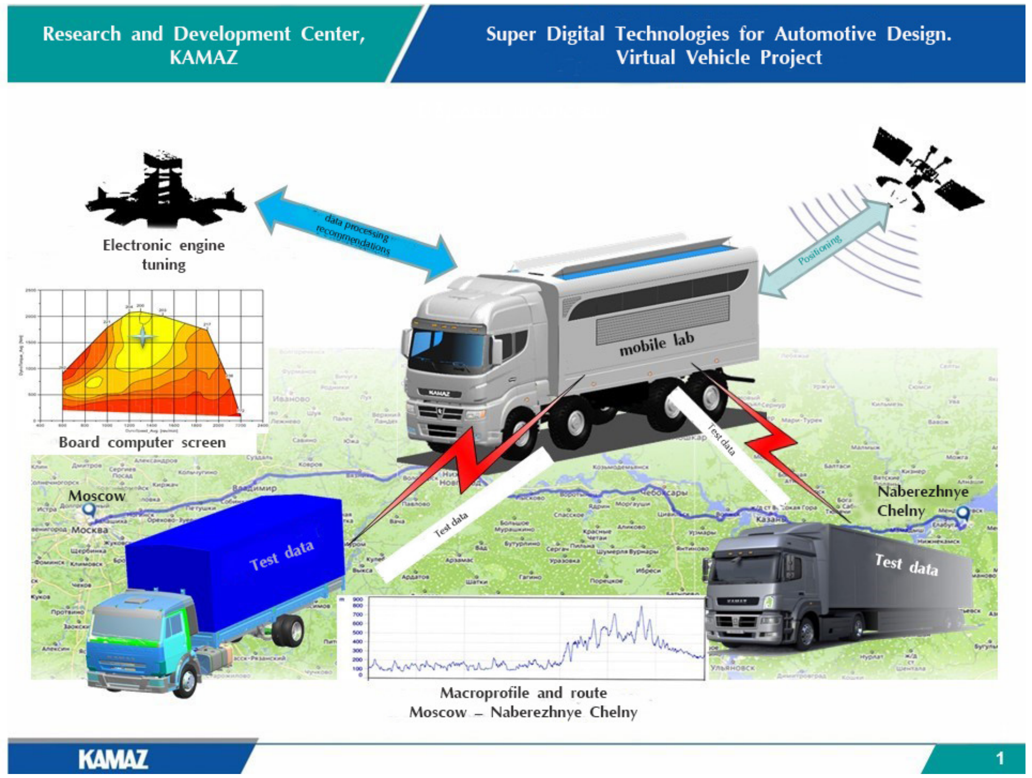
- Engineers of the enterprises, which are key members of Kamsky innovative cluster "Innokam", taking continuing professional development courses.
- Engineers of enterprises, which are suppliers for KAMAZ, taking continuing professional development courses.
- Teachers of the RF higher education institutions of automotive profile in the framework of continuous professional development.
- School graduates – prospective students and engineers.

TRL will be designed and implemented by the engineers of KAMAZ, who will develop project documentation for the lab design, set the equipment, purchase and fit the van, develop methodological support materials, ensure proper maintenance, etc.

At the test site, the instructor gives a class to explain the methodology of the prospective work. Then the students (engineers) under the instructor's supervision conduct tests on vehicle mass, tire pressure, vehicle assemblies, systems and aggregators, check traffic striping for driving test maneuvers, etc. While testing, students observe the process outside the lab.

After testing students or engineers with the instructor process the data obtained in

Fig. 3. Testing and data transmission



the study room. They work individually, each having an individual data file, and prepare test protocols or report on study deliverables.

Expected outcomes and conclusion

- Practice-oriented approach will ensure professional qualification required.
- A new scientific school for automotive industry will be founded (about 30–40 professionals with the degree of candidate of technical sciences, 4 – 6 with doctor's degree.
- The number of student and engineers educated within five years will be more than 250.

To sum up, TRL can make a great contribution to training "engineering elite" for national automotive industry, which is a key driver of economic growth. To be implemented, the project needs to be supported by the government. The lab costs 70 million rubles. KAMAZ investment is vehicle chassis, providing methodological support, ensuring proper use and maintenance of the equipment and lab.

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Internationalization of Higher Education

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The paper considers internationalization of higher education associated with the increased number of foreign students in Russian higher education institutions. Education internationalization is proved to be important through the case study of Tomsk Polytechnic University, which is one of the global leaders in the sphere of resource-efficient technologies. The authors have analyzed the specialties mostly chosen by foreign TPU students studying in Russian language.

Key words: education, training, foreign students, specialties.

Today, higher education is a major factor to facilitate scientific and technological progress, increase labour capacity, strengthen innovation potential. There are regularities in the development of education system, and one of them is internationalization. The notion of internationalization within the education domain comprises two components: inner and outer internationalization. Internationalization of higher education improves its quality and makes it more available, boosts innovation, strengthen international cooperation. Migration policy of the RF up to 2025 should be in line with the Concept of the President [1], which describes all types of migration.

Education abroad is important to improve professional competence, provide universities and countries with information on the latest scientific achievements, contribute to international cooperation, and foster mutual understanding.

The number of foreign students in Russian universities increases every year, which is illustrated in the graph (Fig. 1). The data are taken from the statistical abstracts by the Ministry of Education and Science of the RF [2, 3, 4, 5].

If we turn to the dynamics of growth in the number of foreign students at Russian higher education institutions (Fig. 1), it is clear that the number of Bachelor's degree students is almost five times as much as that in 2007/2008 and the number of Master's degree students is more than three times as much as it used to be. This is attributed to the Bologna Declaration and successful development of the Bologna process in European Community including the RF (implementation of two-level system of higher education). The number of those taking Specialist's degree courses remains approximately the same.

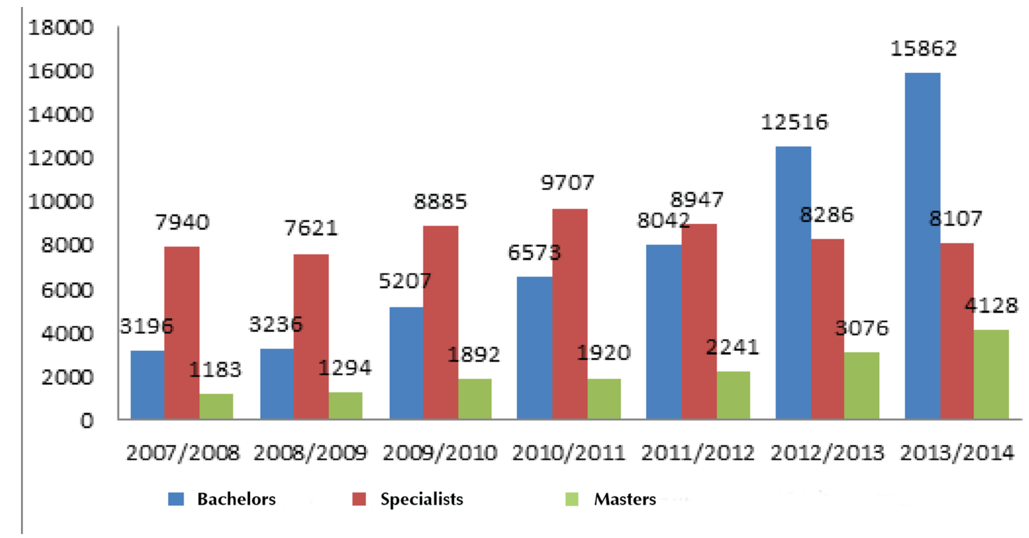
Today, internationalization of higher education, with its quality and availability, significantly contributes to international cooperation. Any activity is performed due to motivation, which is based on three major components: interest, profit, and psychological comfort. The interest and profit of knowledge integration are undisputable. As for psychological comfort, it is obviously interrupted in alien linguistic environment. However, knowledge of Russian culture and education obtained in Russia are highly estimated all over the world.

Foreign students show sympathy to Russian universities: RUDN University (People's Friendship University of Russia) ranks first, St. Petersburg State University ranks second, Lomonosov Moscow State University – third and Peter the Great St. Petersburg Polytechnic university – forth. National Research Tomsk Polytechnic

O.N. Chaikovskaya

E.A. Titenko

Fig. 1. Number of foreign students obtaining degrees at Russian higher education institutions



University, the oldest technical higher education institution in Siberia, occupies the fifth position [5].

It is worth noting that the location of university influences its competitive ability: the universities located in the European part of the RF gain more popularity. Tomsk Polytechnic University (TPU), one of the best technical universities in Russia, is located in the Asian part. Life in Tomsk and education at TPU are not so expensive as those in Moscow or St. Petersburg, therefore, education at TPU is a good choice for foreign students.

Let us turn to TPU statistical data: Fig. 2 shows the number of foreign students graduated over the period 2007–2015.

The most popular academic degree among foreign students is Bachelor's degree. For instance, in 2007 about 49% of foreign student obtained Bachelor's degree, 38% – Specialist's degree, and about 13% – Master's degree. In 2008, 62% got Bachelor's degree, 32% – Specialist's degree, and only 6% – Master's degree. In 2009 48% and 43% obtained Bachelor's and Specialist's degrees, respectively. In 2010, almost one half of all graduates (49%) were awarded Bachelor's degree, 30% – Specialist's degree (engineer), and 21% – Master's degree.

degrees over the period from 2007 till 2015

Since 2011, Master's degree programmes have gained popularity. In 2011, about 66 % of foreign students got Bachelor's degree and 28.5% – Master's degree; in 2012, about 72% and 24.7% (one forth), respectively; in 2013, 68.5% and 28%, respectively; in 2014, 65.4% and 31%. Last year, 2015, 73% of foreign students obtained Bachelor's degree and 22% – Master's degree.

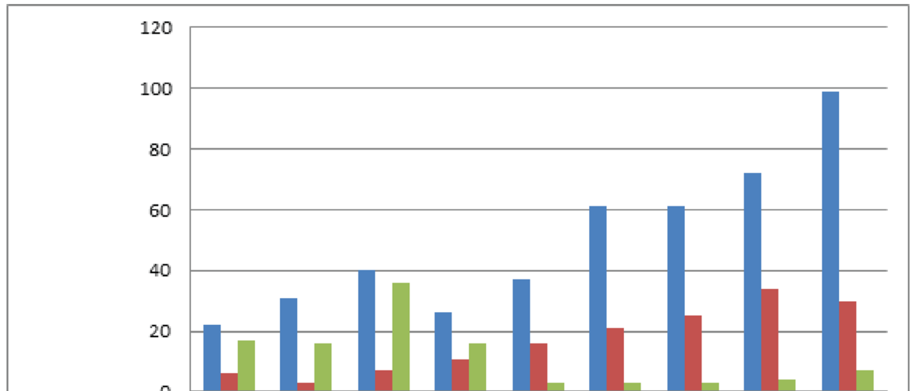
Statistical data analysis indicated that annually more than 50% of TPU graduates obtained Bachelor's degree. Since 2011, about 30% on average got Master's degree. The rest share (about 10% – 20%) graduated from Specialist's degree programmes.

Fig. 3 shows countries which Bachelor's degree students come from.

It is worth noting that the majority of foreign students awarded Bachelor's degree are from China and Vietnam. The other students doing Bachelor's degree courses come from Asia, Africa, South America, and European countries.

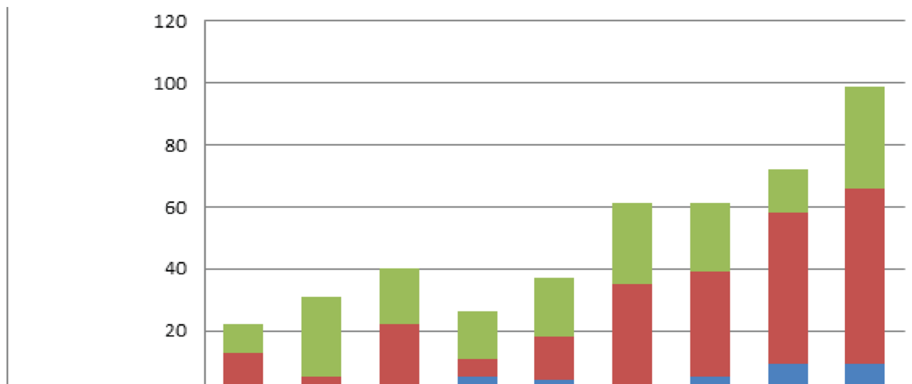
TPU popularity among the students from China and Vietnam is due to the fact that, firstly, TPU participates in the programme

Fig. 2. Number of graduates awarded Bachelor's, Specialist's, and Master's degrees over the period from 2007 till 2015



	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bachelor's degree programme	22	31	40	26	37	61	61	72	99
Specialist's degree programme	6	3	7	11	16	21	25	34	30
Master's degree programme	17	16	36	16	3	3	3	4	7

Fig. 3. Number of graduates from Vietnam, China, and other countries awarded Bachelor's degree



	2007	2008	2009	2010	2011	2012	2013	2014	2015
Vietnam	9	26	18	15	19	26	22	14	33
China	12	3	21	6	14	33	34	49	57
Other countries	1	2	1	5	4	2	5	9	9

"Duty to Help" to provide education for Vietnamese students [6], and secondly, there is an agreement between TPU and some universities of China (Jilin University, Shenyang University) on cooperation in educating Chinese students [6]. Moreover, since 2012 TPU in cooperation with the Harbin Institute of Technology provides double-degree programmes, conducts research, develops and implements mutual projects.

In 2007, there were 22 foreign students awarded Bachelor's degree including 12 students (54.5%) from China and 9 students (about 41%) from Vietnam. In 2008, about 84% of foreign students awarded Bachelor's degree were from Vietnam (26 out of 31 graduates). In 2009, more than half of students (21 student – 52.5%) awarded Bachelor's degree were from China and 45% (18 students) from Vietnam. In 2010, 2011, 2012, and 2013, the numbers of students from China and Vietnam were 6 (23%) students vs 15 (58%) students, 14 (37.8%) vs 19 (51.3%), 33 (54%) vs 26 (42.6%), and 34 (about 56%) vs 22 (36%) students, respectively. In 2014, there were 72 students awarded Bachelor's degree including 49 (68%) from China, 14 (about 19%) from Vietnam, and 7 (9.7%) from Mongolia. In 2015, the number of foreign students awarded Bachelor's degree was 99 including 57.5% of Chinese and 33.3% of Vietnamese students.

As for the foreign students graduated from TPU Master's degree programmes, the shares of different countries are approximately the same as those for Bachelor's degree programmes.

It is important to note that over the period 2007–2009, there were few foreign graduates awarded Master's degree. In 2007 and 2008, students from Vietnam, apart from Bachelor's degree, were awarded Specialist's degree: in 2007 – 11 out of 20 (55%) Vietnamese graduates and in 2008 – 14 (35%) out of 40. In 2009, 66% of students from Vietnam (35 out of 53) obtained Specialist's degree. In 2010, 9 students from Vietnam were awarded Master's degree (82% as the total number of such graduates was 11) and 16 students obtained Specialist's degree (40% of the total number of Vietnamese students graduated from TPU in 2011). In 2011, the majority of graduates awarded Master's degree were from Vietnam – 11 out of 16 (68.75%), as well as in 2012, when there were 10 Vietnamese students among 23 Master's degree programme graduates (about 43%). In 2013, 14 Vietnamese and only 4 Chinese students (56% and 16%, respectively) obtained Master's degree. In 2014, these numbers were 17 and 12 (35%), respectively. In 2015, among 30 graduates awarded Master's degree 16 (56.6%) were from China and 10 (one third) – from Vietnam.

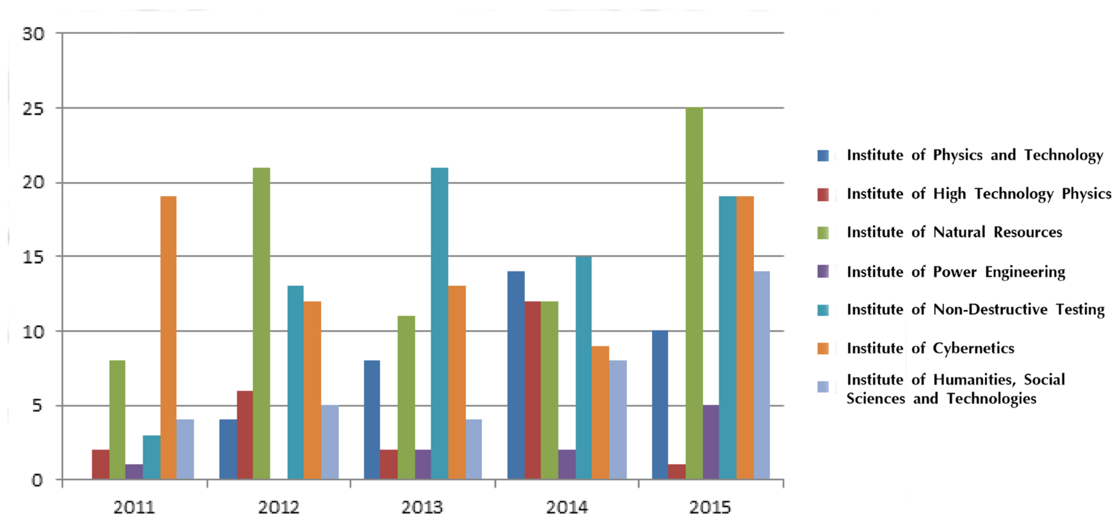
These data indicate that the majority of students awarded Specialist's degree (over the period 2007–2010) and Master's degree (2011–2014) were Vietnamese. The students from China preferred doing Bachelor's degree programmes.

In compliance with TPU Development Programme 2009–2018, the university faculties were reorganized into 7 institutes: Institute of Physics and Technology, Institute of High Technology Physics, Institute of Natural Resources, Institute of Power Engineering, Institute of Non-Destructive Testing, Institute of Cybernetics, Institute of Humanities, Social Sciences and Technologies. Foreign students did basic education programmes provided at the Institutes.

Let us consider the specialties chosen by foreign students over the past five years (Fig. 4, 5). Most students chose the Institute of Natural Resources, the Institute of Non-Destructive Testing, and the Institute of Cybernetics for their studies, with the number of foreign students at each of the institutes being approximately the same. Over the period 2011–2015, there were 330 foreign students awarded Bachelor's degree, with 77 students graduated from the Institute of Natural Resources, 71 – from the Institute of Non-Destructive Testing, and 72 – from the Institute of Cybernetics. As for the other Institutes within this period, the Institute of Humanities, Social Sciences and Technologies ranked forth (41 students), the Institute of Physics and Technology – fifth, and the Institute of High Technology Physics – sixth. The least popular institute among foreign students is the Institute of Power Engineering.

As for Master's degree courses, the situation is similar to that of Bachelor's degree and the most popular Master's degree programmes are those of the Institute of Natural Resources, the Institute of Non-Destructive Testing, and the Institute of Cybernetics. Over the past five years, about 70% of foreign students (87 out of 126) chose the three above mentioned institutes for their studies. About 20% (25 students) did Master's degree courses

Fig. 4. Number of students doing Bachelor's degree courses

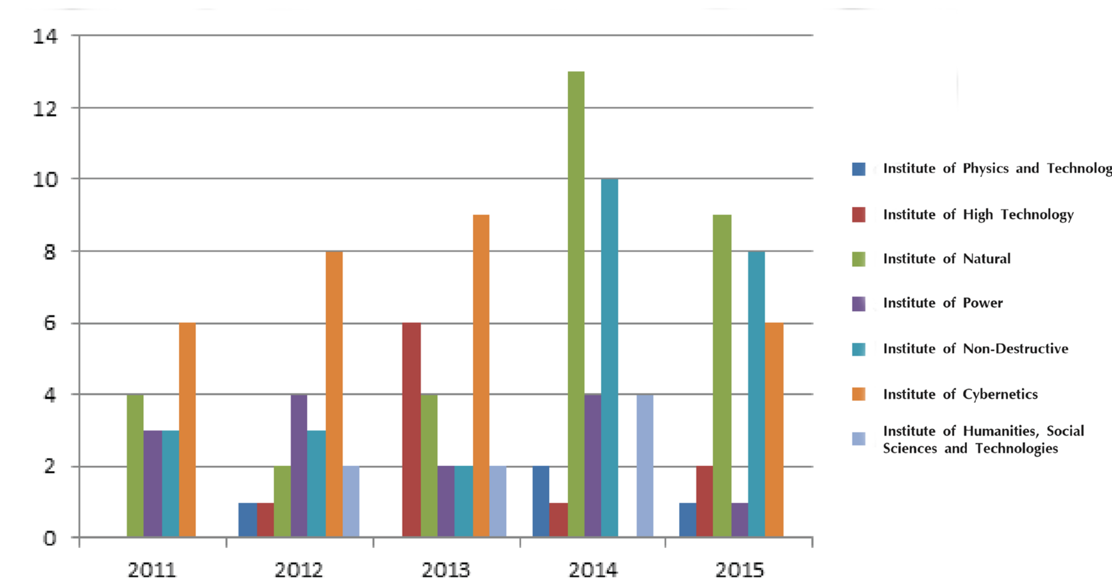


at the Institute of Power Engineering and the Institute of Humanities, Social Sciences and Technologies. The least popular Master's degree programmes were those of the Institute of Physics and Technology and the Institute of High Technology Physics (only 14 students).

The research results indicate that the choice of professional domain depends on two factors: professions in demand in student's native country and student's personal preferences.

In conclusion, it is important to note that internationalization of education not only contributes to bringing up talents all over the world, but also boosts global integration of science and education. Under internationalization of education we mean widely-spread programmes of studying abroad, development of international education programmes, participation of students and academic staff in global educational process. Therefore, internationalization of education will improve the quality of education only if it involves modern technologies and conforms to high standards which ensure quality, variety, and availability of global higher education.

Fig. 5. Number of students doing Master's degree courses



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UDC 378

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Institute of Engineering, Technology and Technical Sciences for New Industry

Ural Federal University named after the first President of Russia B.N. Yeltsyn
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The present paper considers the Institute of Engineering, Technology and Technical Sciences as an efficient model of university structure to provide engineering education of a new format [1] and develop the education programmes for the next generation engineering and technical personnel [2], [3], [4], [5]. The effects of the model implementation at universities have been described.

Key words: new format of engineering education, master of engineering degree programme, bachelor of universal engineering degree programme, integrated programmes, organization structures, engineering and technical personnel.

Introduction

Most industrial sectors in Russia suffer from lower labour capacity (compared to that in developed countries), dependence on import in various forms and to varying degrees, industrial backwardness, and as a result, competitive disadvantage of national production. The situation is getting worse due to the rapid pace of technological advancement and the forth industrial revolution, which humankind is facing today. Industry 4.0 introduces a new level of robotic automation in manufacturing and widely implemented adaptive digital technologies. The reality of today is self-adjust industrial automation systems, collaborative robots, bionics, digital production process, and other technical innovations. To remain economically independent, the country has to get into this process through enhancing today's national production, but to make a technological breakthrough and implement cutting-edge industrial technologies is most important.

New industry requires new personnel. Today's engineers should be ready to cope with complex technological processes and equipment, adapt to changing requirements for product competitive advantages, be able to find non-standard and even revolutionary solutions, accomplish an intellectual feat. In fact, it should be a new generation of engineers who can combine research, project management, engineering, and economic competencies, which should be acquired while studying at universities and then improved through life.

The particularities of modern technical education system at the stage of transition from large output of engineers to three cycles of higher education qualifications are conceptually-indefinite first cycle of bachelor's degree and bias in research at the second cycle (master's degree).

As a result, reduced study time hinders engineering education at the first cycle, while master education programme fails to be oriented to manufacturing and technological activities. Therefore, there is a deficiency of engineering staff, who correspond to the 7th level of National Qualifications Framework, are able to become leaders of national reindustrialization and creators of new competitive technologies.

However, it would be naive to expect that the technical education system established over several decades can undergo large-scale changes [4], [5], [6].

An efficient way to overcome the challenges is green field development, when those who step up efforts to design new education models do not have to spend them against the resistance of conventional schemes and approaches.

To bring up the next generation of engineers capable of beating back the challenges of the 21st century, it is necessary to introduce new administrative mechanisms in institutes providing engineering education of a new format [9], [10].

One of the ways to solve the problem is to develop a polytechnic network, which will allow involving resources of the industry partners, as well as attracting best experts and university teachers from all over the world.

Institute of Engineering, Technology and Technical Sciences

The aim of the Institute is further development and synergy of scientific and educational achievements in engineering, technologies, and technical sciences.

The objectives of the Institute are as follows:

1. Scientific and technical production based on the achievements in the important and promising fields and attraction of partners from leading Russian and international scientific and technical centers. Creation of a new interdisciplinary trend in scientific and technical research.
2. Development and implementation of Elite Engineering Bachelor's Degree Programmes (3-4 years), Master's Degree Programmes in Science and Engineering, as well as postgraduate programmes to train highly-qualified personnel.
3. Development of the Institute as a model of education, science and innovation management, with synergetic effects from uniting the best.

One of the Institute's distinguishing features is networking: it is of primary importance to develop integrated continuing (in terms of outcomes and levels) education programmes.

Model Structure of the Institute

In terms of its structure, the Institute includes scientific laboratories, as well as scientific and technical personnel, selected through competition and having relevant scientific and technical achievements in priority manufacturing sectors. Together they make up a cluster, which is conventionally named the Academy of Technology and Technical Sciences. The main objective is scientific and technical production (research and development works, publications, involvement of the best Russian and foreign professionals in co-design).

The Academy provides Master's Degree Programme in Science and Engineering and postgraduate programme in compliance with the scheme 2+4.

The Institute also includes School of Higher Engineering Education, which provides Engineering (Technical) Master's Degree Programme aimed to develop qualifications (competencies) necessary to perform engineering activities, i.e. creating engineering products, systems, and technologies. The programmes can be oriented to satisfy the demand of partner manufacturing enterprises and labour market in general, as well as to graduate "innovative engineers", who can contribute to innovative processes at companies and research centers, to implement their own pilot projects.

Some modules of Engineering Master's Degree Programme may be used as a basis for developing additional professional education programmes. In its turn, realization of these short-term programmmes will result in continuous updating and improvement of the basic master's degree programme.

School of Higher Engineering Education is to provide methodological support for development and implementation of education programmes in Engineering, Technology and Technical Sciences in compliance with the best international practices and at all education levels (Bachelor's degree – Master's degree – postgraduate courses) under the auspices of the new Institute.

The structural basis is the Institute of

Fundamental Education, which provides the unified educational courses in compliance with the state specialty and professional classification for technical specialties within 1-2 years of studies (120 credits). The students acquire knowledge in mathematics, natural sciences, and general engineering.

Educational process management is performed by education program supervisors, who provide the whole cycle of engineers training. Together, these supervisors compose the Directorate for Engineering Education. The programme supervisor is responsible for student selection, network interaction maintenance, student academic mobility and their involvement in competition and project activities.

An important component of the Institute infrastructure is student self-organization, i.e. student clubs, constructive bureaus, etc.

The educational project particularities are project-based learning [11], [12], [13] and individual educational technologies, which imply different levels of study (different learning outcomes) and various ways of study, including online courses. Free online courses make it possible to study some disciplines even before entering the university, ensure continuous study for the student of vocational training colleges and technical schools, and provide network programmes for the students in other universities.

Within the module "Engineering Fundamentals" (taught instead of the traditional one "Fundamentals of Specialty"), students get exposure to engineering and work in team engineering activities within the CDIO educational framework implemented for producing the next generation of engineers. Based on the student ranking performed at this stage, educational paths are determined, including the type and academic major of the educational programme.

Another component of the Institute structure is School for Bachelors in Engineering. Students can be enrolled in the School after two years of study at the Institute of Fundamental Education and are selected through a competition. The School graduates are Bachelors of Engineering meeting the particular employer skill demands. As for best-trained and most motivated graduates, they can be enrolled in different Master's degree programmes.

Bachelor of universal engineering degree programme provides many opportunities: besides technical competencies, the graduates can get profound knowledge in economics, management, and law, as well as develop additional competencies, such as foreign language or information technology skills. Any student has an opportunity to select an educational path, which will be the most adequate to develop additional competencies and thus improve the graduate's competiveness on the labour market. If a graduate decides to continue education, he or she will also have a wider range of Master's degree programmes to choose from.

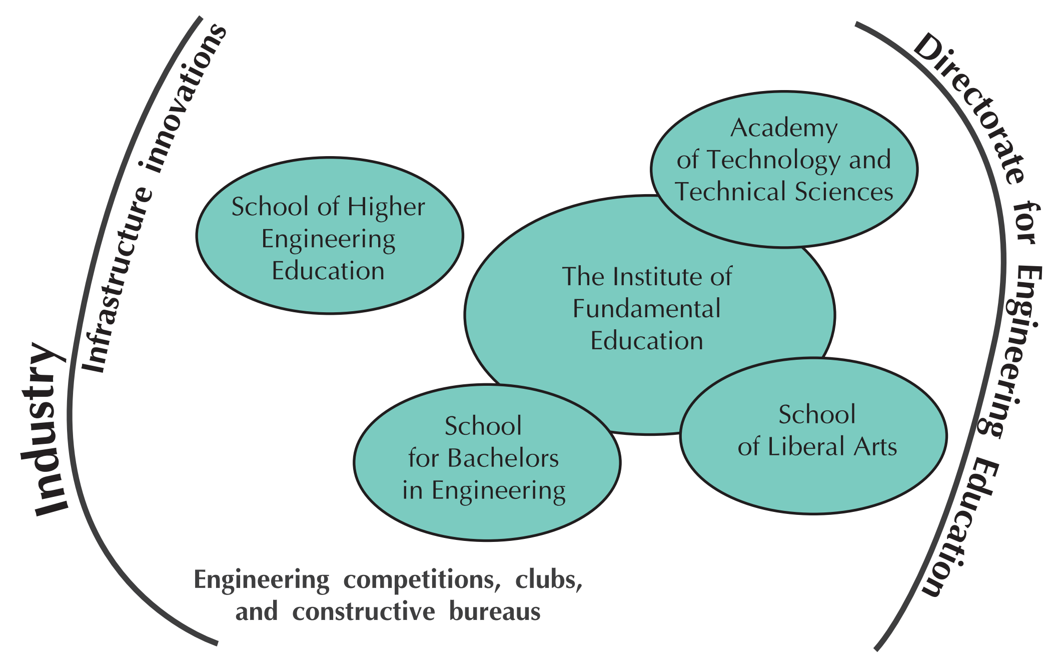
This is so called Liberal Arts model, which will be implemented at the School of Liberal Arts (Fig. 1).

The whole cycle of higher engineering education based on interdisciplinarity and educational programme integrity is provided by the following organizations:

- Academy of Technology and Technical Sciences.
- School of Higher Engineering Education.
- School for Bachelors in Engineering.
- School of Liberal Arts.
- The Institute of Fundamental Education.
- Directorate for Engineering Education.

The objectives of the Institute are supposed to be reached involving the resources of innovative infrastructures to train engineers-researchers, who will design and develop a "smart world", including "smart networks", "internet of things", additive technologies, robotics, artificial intelligence, transport of future, etc.

Fig. 1. Institute of Engineering, Technology and Technical Sciences



The model of the Institute described above can work as a separate entity or be integrated into the structure of large polytechnic universities. The major condition for the Institute to be established and developed is the development of the region industry.

The model components can be used in different variations in various university environments, however, the whole model ensures the maximum efficiency.

The effects of the model implementation are as follows:

- Engineering Master's Degree Programme substitutes Specialist's Degree Programme and allows improving graduates' competitive advantages.
- Master's Degree Programme and post-graduate programme are interconnected since two years of study are not enough to train an engineer- researcher, who is capable of using the latest achievements of both fundamental and applied sciences to create new products in demand.
- Engineering clubs, constructive bureaus, and competitions allow selecting the most motivated, smartest and determined applicants with high level of self-organization, as well as help to choose the appropriate educational path (scientific and research, entrepreneurship, etc.).
- Specified learning outcomes (engineer's competencies), project-based learning (including engineering competitions), industrial internship provided by the relevant entities (departments, continuing professional development centers) ensure that industrial enterprises participate in the educational process and minimize enterprises' costs for personnel education [14], [15].
- Implemented by the Directorate for Engineering Education, education programmes are independent from the department or institute administration. Network and interdisciplinary

programmes are widely implemented. Education programme supervisors are interested in collaboration with industrial partners to implement practice-oriented learning, hand-on activities and practical tasks solving.

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UDC 377.5

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S.V. Dryga

Vocational Education in Russia: Topicality, Challenges and Trends

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The paper considers challenges and trends in the development of secondary vocational education, which is regarded as an educational resource meeting the demand for skilled trades in the territory of the Russian Federation. The authors have investigated the reasons for the national secondary vocational education being uncompetitive on the global educational service market.

Key words: vocational education, networking; competencies, competitiveness of secondary vocational education, internship marketplaces, certification centers.

When analyzing the contemporary vocational education in the Russian Federation, one may speak of steady demand for this type of education in the society. According to the statistics for 2013–2014, the number of students involved in mid-level professional training increased in Tomsk Oblast from 15705 to16582, with rise in the number of fee-paying students – from 3954 to 4126 [1]. Similar situation is observed in other Russian regions.

The trend of stabilizing and even the increase in demand for vocational education is accompanied by the lack of blue-collar workers on the labour market. Therefore, the RF Ministry of Labour developed and is intensively promoting "The list of 50 most in-demand new and perspective jobs requiring secondary vocational education" [2].

However, one may say that being in demand in the domestic market of educational services, the Russian vocational education is low competitive on the international market. In other words, the graduates' professional level is low, which is proved by the results of 43 international competitions on professional skills Worldskills Competition-2015, where the Russian team took the 14th place in team rating, though its position improved as compared to the previous result at the competition of Worldskills – 2013 in Leipzig, where the Russian team took the 27th place [3].

This raises the predictable question – what current problems are there in the secondary vocational education and what prevents students from developing competencies relevant to the international demands?

According to the expert estimate (representatives of secondary vocational education institutions), in the course of project research "Potential of the Russian vocational education to increase the competitiveness of Russia on the world education market" performed by the research team of Tomsk Polytechnic University supported by the Russian Humanitarian Research Fund, the major problems are caused by low effectiveness of vocational guidance. The entire system of vocational guidance is to develop students' ability to choose a profession that best suits personal qualities and labour market demands. But the survey analysis of 800 respondents in one of Tomsk colleges has shown that 68% of students made their professional choice unconsciously, and only 32% chose the profession they would like to do. Hence, based on the statistical data of vocational education institutions and reports of academic departments, 50% of students writing the resignation letters indicate the reason "Wrong professional choice".

The second significant factor is that secondary professional diploma does not guarantee further employment in the profession. Based on the analysis of collage graduates' employment in Tomsk Oblast, only 60% of graduates practice their profession. The employment problems of secondary vocational graduates are explained by many factors – both prestige of the profession and salary level. But there is one important parameter, i.e. the third factor specified by all experts – it is a level of competencies, which, in most cases, is unsatisfactory for the potential employers. Therefore, upgrade of discipline educational-methodic complex with focus on development of professional competencies has become rather urgent. The current educational standards allow doing it, as they permit 30% of variable part that can be changed in content.

But in spite of methodical potential, the current physical facilities of secondary vocational education institutions do not provide proper upgrade of professional competencies. There is out-of-date equipment in most of institutions that does not permit effective laboratory or practical classes. To some extent, the situation is improved by virtual platforms, but students do not acquire practical skills.

Moreover, professional competencies are virtually impossible to be developed not only on the basis of colleges, but also in the course of educational and work experience internships that students have at the companies. The logistical facilities of the companies are of different quality, but in most cases they are low (at the moment companies can afford to update machine-tools by 5-10% at best), which does not provide students with universal professional skills. In experts' opinion, it is the cause of failure in development of student professional competencies, since it is not possible to visit the company in large groups.

When arranging internships, teachers have to split student groups and assign them to small companies. In this case, every manager takes into consideration the company's technical capacity and focuses on those competencies that are necessary for him/her. It causes the problems in qualification exam in terms of students' different work experience internships, as it is impossible to unify the criteria for competency assessment.

In fact, the given problem can be solved by, firstly, unification of requirements for graduates' professional competencies of vocational education schools focused on international standards and those of FSES; secondly, arrangement of internship sites and centers equipped with modern facilities to develop specific professional competencies. What is more, students are to be assigned to such sites in full groups, not at random, for every student to work with the equipment as it will contribute, among others, to more effective mastering of theory. Such internship sites and certification centers might also be an intermediate in network cooperation between vocational education institutions and companies.

Polyfunctional Center of Applied Qualifications (PCAQ) for Oil and Gas Industry based on Tomsk Industrial-Humanitarian College may serve as an example of successful network cooperation [4]. Training in PCAQ is performed using the curricula developed and approved by JSC "Transneft". Today everyone who has taken training course in the Center knows that they have official certificate equal to multidisciplinary standards.

Summing up, one can conclude that topical trends in improving secondary vocational education are more effective career guidance for prospective students, guaranteed employment, international level of developed professional competencies or, at least, universal competencies meeting employers' requirements. The latter issue can be solved by means of arranging internship sites for students of secondary vocational institutions and establishing certification centers. High-level professional competence-based training with the focus on international standards will make the Russian professional education more competitive on the international market of educational services.

The article was written within the project supported by the Russian Humanitarian Research Fund № 16-03-00446 "Potential of the Russian professional education to increase the competitiveness of Russia in the world education market". The project deals with analysis of potentials, social-economic consequences, and perspectives of enrollment of foreign students in Russian engineering universities.

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UDC 378

Modern Engineering Education in Conditions of "Information Explosion"

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Qualitative technological base is being upgraded and innovative technologies are being implemented in many countries of the world. The analysis of basic trends in education sphere proves that the strategy of e-learning is conditioned by the necessity of improving engineering education, educational process and inevitable globalization of education due to technological and communicational changes.

Key words: engineering education, pedagogics, training methods, "information explosion", generation Z, e-learning.

1. INTRODUCTION

One of the major challenges of modern life is to increase the quality of engineering education, mathematics, in particular, which tends to worsen in conditions of "information explosion". One of the solutions is to make easier the understanding of fundamentals of advanced mathematics, develop training methods, and use technologies of e-learning (TEL). The latter allows speeding up learning process by 10-15%, saving training time by 35-45%, increasing efficiency of academic activity of faculty staff by 30%, adjusting forms of educational materials to psychological features of Z generation, which would improve the quality of training.

2. NECESSITY TO IMPROVE ENGINEERING EDUCATION

In our digital epoch, mathematics has become a methodological base for almost all branches of science. Even biology and sociology are actively using mathematical methods. Thus, mathematics is necessary not only for physicists and engineers, as it used to be 40 years ago, but for all scientists and specialists. The "tip of the mathematical iceberg" is traditionally divided into three parts. The first part presents the essence of mathematics inherited from the ages from Antiquity to Medieval times. This part is studied at secondary school. The second part is advanced mathematics created during the last 400 years. It is studied at bachelor's, specialist's and master's degree engineering courses. The third part is divided into special disciplines the fundamentals of which are trained at departments of mathematics. These disciplines constitute a root system of a contemporary fast growing mathematical tree. There are no distinct boarders between the parts of the iceberg. In addition, the "University mathematics" course involves the basic ideas and facts of the elementary mathematics in more complicated forms. The "submerged part of the mathematical iceberg" involves separate facts, methods, and even theories that are already unnecessary, for whatever reason, or cannot be yet applied waiting for being developed in future. "Pure" and "applied" mathematics are even more relative classification [1]. In addition to inner demands and logics of mathematics development, there are external factors to increase mathematical knowledge and develop mathematical research; they are needs of natural science and technologies, and technical capacity to perform practical tasks. It is essential to increase the quality of education. The Russian education system is rapidly changing, with introduction of new education standards. Instead of 5-year training courses, which are cancelled now, bachelor's and master's degree courses have been introduced, federal Universities have been established.

2.1. Loss of quality of mathematics education

Meanwhile, there is a tendency of education quality loss. The reason is "information explosion", which attacks the humankind this century. According to science theorists, knowledge doubled for 1750 years since the beginning of our era, the second doubling occurred in 1900, and the third one took place in 1950, that is for 50 years, with 8-10-fold increase for the recent 50 years. This tendency is increasing; the amount of knowledge in the world doubled by the end of the 20th century, and the information increased more than 30 times. In this regard, it is necessary to note that the "information explosion" makes it necessary for higher education system to apply the approach of "education without boarders" based on unlimited access to information, since limited access to information is practically impossible. Access to knowledge has become an inalienable right of every human being, which is ensured by the existing mass media infrastructure [2]. A strong information flow passes through people networks, organizations, and everyday life. There are numerous sources, from Internet to books, that constantly provide people with different kinds of information. Is an average student capable of perceiving it? Do modern students suffer from information overload? Can classroom training be efficient and informative in such a situation? Perhaps, there is no such problem at all. Only a couple percents of human brain potential are used. The information flows train human "grey cells". People have become smarter for the recent 100 years. Secondary school education programme has been significantly changed for the last 20 years. Some school subjects lag behind rapid development of science and technology. Such a school subject as "Computer Science" has become almost useless, since pupils know more about it than teachers of preretirement age. However, the question is if the main information source (news, advertisement and social nets) is able to develop a brain, or can only fill it forcing useful information out.

2.2 Basic forms of educational process

The variety of learning forms can be grouped in 3 basic types: classical or traditional that implies classroom academic activities (classes, lectures, supervision), distant learning that ensures learning without teacher-student direct contact, and a blended type that involves both type of teacher-student interaction- classroom activities and e-learning.

The importance of fundamental mathematics can hardly be overestimated. Mathematics is not only special method of nature study, but also, as Lobachevski stated, "a language used by exact sciences". Mathematics is an important tool to study other disciplines. Thus, mathematics is in demand not only for engineering education, but also for economics, humanity science etc.

The main weak point of the traditional educational form is human factor. New information technologies (NIT) allow solving many problems relating to learning process. A student can revise the material required for study (including educational content at secondary school). If students miss classes, they can obtain the missing information in electronic form, video, etc. A student can apply mathematical skills in such professional activities as mathematical analysis and modeling, theoretical and experimental research [3].

There is a recent trend to reduce academic hours for mathematics with increase in hours for student's independent work. The importance of mathematics in development of professional competencies also tends to increase. Classroom hours are decreased without reducing educational mathematical content, since a highly-qualified teacher can easily explain the material and organize students' independent work more effectively.

In the frame of distant learning, the stumbling point is ineffective control of students' knowledge. Besides, there are quite a number of engineering subjects implying laboratory work. No matter how perfect laboratory simulators may be developed, they cannot fully substitute real laboratory work of students. However, distant learning has its advantages. While the traditional learning requires alertness to perceive information at once, the distant learning allows revising and repeating learning material several times until it is understood by a student.

Apart from traditional methods, a modern teacher's set of techniques contains the following activities: teaching on line, multimedia and IT application use of computer models and virtual platforms. Besides, a teacher should be well educated to realize the interrelations between different subjects of a curriculum. Education also implies profound knowledge of the subject, which ensures free professional communication with students.

3. PROBLEM SOLUTION

3.1. Pedagogics is one of the way to increase education quality

Deming cycle is a well-known model used to control and continually improve any processes in different spheres of life. It is also known as PDCA, which stands for Plan – Do– Check – Action or Adjust.

Teaching is one of the ways to learn. The aim of education is learning but not teaching. Pedagogics is one of the ways to achieve this aim [4]. Pedagogics is a science studying patterns of social experience transfer from older generation to younger one. The object of pedagogics is goal-oriented activities of society and teachers that condition personality development. For example, one of these activities is education, which is a purposeful process of teaching and training performed in favour of a person, society and state. The subject of pedagogics is a goal-oriented educational process. Pedagogical science studies principles, patterns, trends, and prospects of education process development. It develops theory and techniques of pedagogical management. It also improves the education content, and offers new forms, methods and tools of the educational activity. Basing on the definitions mentioned above, it can be concluded that pedagogics is a science relating to teaching, training and education of children and adults. The aim of pedagogics is to identify patterns of personality development and choose the most adequate methods that would facilitate such development [5].

3.2. Effective application of informational resources and consideration of psychological and physical characteristics of the contemporary young generation

Experts state that the growth of knowledge is being exponential [6], which could be overcome by effective use of informational resources (IR). However, it is necessary to ensure the conditions for realizing personality's potential and taking into account social traditions and values. Contemporary Russia needs intellectual capital, creative people capable of processing and providing information needed for a society, organization or person [7].

Traditional education ensures linear character of knowledge accumulation approximately until the age of 35 with further possible decrease in knowledge due to forgetting. The contemporary rate of information perception is expected to result in 60%-information-gap between graduates' knowledge and knowledge to be perceived by the 30's of the current century. The predicted information gap can be even more because of the so-called generation Z entering Universities soon. They grew in Internet and can hardly be able to perceive information presented in a traditional academic form, which can lead to loss of interest in learning [8]. Generation Z (known also as Generation M, Net Generation, and Internet Generation) is the generational cohort following the Millennials, approximately those who were born from the mid-1990s to mid-2000s. Generation Z are predominantly the children of Generation X, but they also have parents who are Millennials. The technologies that used to be regarded as "cutting edge" and "future" have become everyday reality for them. It makes the basic difference between the two generations.

3.3. Training methods improvement

The decrease in education quality often results not only from information overload and slow learning but also from poor teaching methods. Science progress implies new research and achievements as well as promotion and facilitation of the results obtained by previous generations of scientists. The aim is to make the understanding of fundamental mathematics easier. Progress in pedagogics and training methods might lead to studying advanced mathematics as early as the alphabet. [9].

3.4. Effective use of e-learning technology

Another way of education improvement is active application of modern training tools and technology. First of all, it is e-learning technology (ELT) that enhances learning by 10-15%, saves time by 35-45%, increases efficiency of academic activity of faculty staff by 30%, and complies with psychological and physical peculiarities of the Generation Z [10].

The increase in e-courses and online courses made it necessary for educational institutions to rearrange educational process and professional requirements for faculty staff with regard to e-learning. It is reasonable to apply a complex approach to education enhancement by optimal combination of traditional training forms with innovative educational methods.

However, e-learning makes the education system face new challenges. How to focus and keep students' attention through the Net? How to involve students and provide a feedback?

3.5. Effective use of "educational technologies"

UNESCO defines educational technologies as a systematic approach to educational process with regard to human and technical resources, and their interaction aimed at education and learning outcomes enhancement.

An educational technology is a detailed model of all stages of educational activity that implies comfortable conditions both for students and teachers. The educational technology implements the idea of total manageability of educational process.

The efficiency of educational process depends significantly on an adequate choice and professional implementation of particular educational technologies, which are traditionally called modes of instruction and training methods. Educational technologies should be regarded as systematic and consistent implementation of educational process planned beforehand, a set of techniques and tools that ensure effective process management.

Innovation means something new. Thus, innovation in the education system implies changes in aims, content, methods and technologies, forms and management of the education system. It should involve all aspects of educational activity: management and assessment systems, curricula and education programmes, instruction and training materials, and teaching-learning activities.

Currently, there are the following innovative trends in Russian higher education system:

- Multi-level education system is being developed in many Russian Universities. The advantages of such a system are wider choice of training periods and specialties for students. It facilitates the ability of gradates for further education and professional development.
- The universities are using more and more informational technologies, and are intensively using Internet by providing distant learning and introducing e-courses, e-modules, e-textbooks, and other educational content through educational networks and platforms.
- All higher education institutions in Russia are being integrated with the leading Russian and international Universities, which results in university complexes.
- Russian Universities are becoming self-financing.
- The higher professional education standards are being changed to meet the international standards. It has led to the experimental stage to approbate new curricula, education standards, educational technologies, and management structures.

3.6. Effective educational framework

The educational framework involves both traditional forms of instruction and "systematic use of new computer technologies". The first academic years of University study are to create a solid foundation for further development of professional and special skills and competencies. Educational equipment has been lately significantly upgraded. The application of new informational and multimedia facilities contributes to better visibility of instructed material, diversity of educational activities, which improves the learning outcomes. It allows students to develop systemic thinking, problem solving, and information processing skills.

A modern graduate of a technical university should be a highly-qualified professional. These social requirements make it necessary to pay special attention to engineering training. A competitive graduate can quickly get adapted to new working conditions and equipment, perform set tasks and solve non-standard problems. To ensure such an education level it is required to apply efficient educational approaches.

3.6.1. Application of electronic lecture notes

Currently, many teachers are using electronic lecture notes (lecture presentations) for more effective presentation of instruction material. Electronic lecture notes are a roadmap to present educational content in a clear and comprehensible way. New informational technologies allow controlling the presentation quality while delivering a lecture, and using different ways of material presentation (application of videos, figures, drafts, and all kinds of electronic support). It increases the quality of the presented material. According to numerous research studies, up to 80% of the information received from the outside world is processed by the visual pathway. Thus, visibility and attractive presentation of instruction material, as well as combination of the visual presentation with lecture reading, allow focusing students' attention and having emotional impact on the audience, facilitating learning progress.

Electronic lecture notes (lecture presentations) combine the advantages of multimedia and traditional lecture delivering. Actually, it is a modern tool to control the educational process in a class regardless the number of students. A lecturer usually uses several styles of material delivery: descriptive, narrative and explanatory for students to remember the material better. The use of electronic lecture notes multiplies the efficiency of this method.

While developing electronic lecture motes, it is necessary to take into account the following requirements: a slide should contain maximum information but be visual; fonts and numbers should be readable; the number of slides should be from 25 to 60; the presentation should support but not copy the lecturer's report, otherwise, students' attention is distracted. The structure of the presentation can be as follows: lecture theme, objectives, topics to be covered, topic delivery, and references.

The application of multimedia equipment makes it necessary for a lecturer to keep with new informational technologies. The design of a lecture-presentation should be as modern as the design of internet web-sites. Thus, it takes a lecturer more time to design electronic lecture notes than hand-written lecture notes but it is worth it [11].

3.6.2. Increasing student motivation for learning

Engineering education is considered

a key factor of social and economical development in Russia. Rapid development of informational and communicational technologies led to changes in content of engineering work, which, in its turn, caused changes in requirements for graduates training as well as development of new approaches to assessment of professional competencies.

Let us consider motifs of learning activity in higher school.

The first motivation level. Doing sums, making equations, writing essays do not attract students. They tend to escape such kind of activities. Simple formal content and easy tasks are more preferable for students. Fulfilling these tasks ensures passing exams and relative success without much effort. Professionally related personal qualities are not manifested, their professional significance is difficult to identify. The motif can be defined as "I have to". It is often related to the external aspect of learning and focused on formal success and achievement of assessed results.

The second motivation level. Students pay more attention to the subjects that seem to be more important and interesting. They are active and self-sustained in the classes they are interested in. They can set learning objectives, acquire and develop new knowledge and skills deliberately. Learning and professional activities bring them pleasure, they are often involved in additional courses, non-academic and social activities. This level is characterized not only by personally important motifs but also by understanding social significance of such activity.

The third motivation level. Cognitive activity and need for personal development are the typical characteristics of the level. There is a rapid progress in personal and professional development, which makes a strong motif for learning. Students can see their professional prospects related to field of study. This level is characterized by persistence in achieving objectives and active cognitive activity. Projects, essays, course papers are often original. Such students study subjects deeply and independently.

According to research studies, most students are at the first motivation level. It is also proved by the fact that one of the predominant motifs to study at university is to "get a diploma". It implies formal attitude to study and search for the easiest or even illegal ways to pass exams. The motivation level does not change during a university course, which is a problem. Second-year students start to study subjects related to their future jobs, which should increase students' interest in study [12]. Success in professional activity should lead to success in study thus increasing motivation to learning.

3.6.3. Development of MOODLE courses

Tomsk Polytechnic University has been lately introducing the third (a combined) educational form and developing electronic textbooks, modules and courses at different educational platforms. One of such platforms is MOODLE (Modular Object Oriented Dynamic Learning Environment). A lot of educational materials and e-courses have been set up on this platform for students to use them in their learning process [13]. The advantages of the Moodle courses are the possibility to present different kinds of educational resources such as lectures, tasks for practical and laboratory works, presentations, reference links to additional information sources. It also provides a wide range of test forms, a news forum and "question-answer" tutorial instruction, etc.

Each subject course contains an electronic content, theoretical, practical and testing blocks, and references. The following methodology materials have been developed: course programme, instruction for students, academic calendar (or a schedule showing a training and testing form, terms for task performing for each topic), teacher's book containing instruction and recommendation relating to the whole course and to some units in particular). Such courses should not be overloaded with information. It should contain maximum information in minimum educational material, which is a very difficult task for a course developer).

Those students who use the elements of distant learning have better learning outcomes, are more active and successful with individual tasks. It is explained by that fact that they can adjust the learning process to their needs by using new technologies.

Training tests set up in these courses usually contain several standard tasks, with one algorithm, but varied parameters. These tests help students improve their competencies independently. They allow students to identify gaps in their knowledge and induce them to improve their learning outcomes.

Educational tests in theoretical mathematics should be aimed at training to apply theoretical notions in different situations, to determine relations between these notions and facts but not to learn by heart mathematical notions and theorems. An instructor can give examples of the most important notions by developing a test. A student, in this case, takes an active part, since he/she has to deal with the task on his/her own but not to repeat teacher' words and actions.

Home-task tests differ from common home tasks. They are more variable (each student is given an individual set of tasks that can be immediately self- checked). There can be no time limit, if a student writes down a test task, then does it in a copybook, and then loads the answer. It makes students more disciplined. Such tasks can sometimes fully substitute traditional home tasks. In addition, students have the opportunity to improve test results, by doing it several times, until they achieve the desired scours.

Thus, testing is an effective addition to the traditional educational techniques. Testing allows students to assess their mathematical knowledge, train some particular material, and understand theoretical notions and difficult aspects of practical tasks. Students can spend even more time doing mathematics, but, as students say, it is more interesting to do tests. Moreover, the Internet makes it possible for students to choose comfortable time for this kind of learning. In some cases, it is possible to save time by loading only final result without detailed notes [14].

4. CONCLUSION

The computer engineering system described above is an efficient tool to organize educational process. There are two forms of mathematics courses for full-time students: a traditional form and a combined one. The latter is a traditional form (lectures, practical classes, and seminars), supported by an electronic course.

While analyzing basic trends in education, it is obvious that the demand for better engineering education and more effective educational process, as well as inevitable education globalization, determine the modern strategies of e-learning in the world.

In terms of pedagogics, the use of IT technologies facilitates students' personal development and makes them feel comfortable in the information society. It also facilitates development of communicative skills, decision making, experimental and research skills, information culture, and data processing competencies [15].

E-learning is being more and more actively used and integrated in the traditional education system all over the world. It is becoming one of the basic components of every leading University, which makes it even more popular among potential users of education services. We should face this reality and keep up with the times by effectively introducing e-learning, taking new advantages, and assessing possible risks.

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Summary

SUPPORT FOR ELITE ENGINEERING EDUCATION: STUDENT CREATIVE WORKSHOPS

O.V. Solnyshkova
Novosibirsk State University of Architecture and Civil Engineering (Sibstrin)
E.V. Dudysheva
Shukshin Altai State Humanities Pedagogical University

The paper considers elite engineering education provided at the higher education institution of architecture and civil engineering. The elements of the educational process have been described. The regional employers are supposed to play an important role in setting learning outcomes, therefore, the questionnaires filled out by the representatives of civil engineering enterprises have been analyzed. The paper also describes the results of the poll held among the institution graduates. The authors of the paper have analyzed the poll data with due regard to the fact whether the respondent participated in the student creative workshop for designing and developing e-learning resources on geodetics engineering at Novosibirsk State University of Architecture and Civil Engineering (Sibstrin). The authors suggest that student professional creative workshops play a significant part in providing elite engineering education at the higher education institution of architecture and civil engineering.

THOUGHT PROCESS OF ENGINEERING "ELITE FORCE": RUSSIAN DEVELOPMENT TECHNOLOGIES

A.V. Kozlov
Siberian Federal University

The paper studies potential of Russian cognitive technologies of creative engineering thinking. The technologies are based on applied dialectics or the Theory of Inventive Problem-Solving (TRIZ) and can be applied in the elite engineering education. The author suggests using tested didactic technologies.

PROJECT OF INNOVATIVE ENGINEERING EDUCATION

V.A. Prokhorov
North-Eastern Federal University in Yakutsk

The paper provides the analysis of engineering education and proves the necessity to develop an innovative engineering education programme. Basic principles of the innovative education programme as well as qualifications of engineering Bachelor's degree programmes are suggested. Education modules of the suggested programme are described.

HUMANITIES AND SOCIAL TECHNOLOGIES TO DEVELOP ENGINEER'S PERSONAL POTENTIAL IN SELF-DEVELOPING UNIVERSITY ENVIRONMENT

E.A. Evstifeeva, A.A. Tyagunov, S.V. Rassadin, S.I. Filippchenkova
Tver state technical university

Techno-humanitarian balance conditions the prospects of human survival as well as competitiveness of Russian industry on the global market. This balance depends strongly on such engineers' qualities as way of thinking, ethical priorities and reflexive positioning.
The article describes a practice-oriented approach to study personal potential of modern engineers, development of their personal qualities by means of socio-humanitarian technologies and reflexive approach used in educational process.

ISSUES OF FOSTERING STUDENTS' ARTISTIC TASTE IN THE PROCESS OF ENGINEERING

K.B. Danilenko
Bauman Moscow State Technical University

The article justifies the need to develop such personal skills of future engineers, as the artistic taste, the sense of beauty, and the inner personal culture. The basic requirements towards mechanical components, connection joints and structures are addressed allowing the creation of not only technically ingenious, but also eye-catching products that would be notable for their harmonic configuration and beauty. Special emphases are put on the phenomenon of golden ratio, inherent to the most attractive and beautiful items created by nature or by human.

PREPARATION AND CONDUCT OF WORLDSKILLS COMPETITION AS AN INNOVATIVE METHOD OF TECHNICAL STUDENT TRAINING IN VOCATIONAL EDUCATION SYSTEM

V.G. Doronkin, V.V. Eltsov, E.M. Chertakova
Tolyatti State University

The paper examines the issues concerning preparation and holding of professional skill competitions between experts in automotive repair. It also provides the assessment of auto mechanic training in terms of its conformity with the global requirements to technical specialists of the automotive service industry.

ELECTRONIC PRESENTATION AS A FACTOR TO IMPROVE LEARNING OUTCOMES IN MATHEMATICS: THE CASE OF ELITE ENGINEERING EDUCATION

O.V. Yanuschik, E.G. Pahomova
National Research Tomsk Polytechnic University
N.Y. Galanova
National Research Tomsk State University

The paper describes the dependence of the quality of mathematics education on the methods applied at lectures delivered for elite engineering students. Two approaches to giving lectures, conventional and presentation-based, are compared. The academic progress performed by students within the frameworks of these two approaches is assessed. The assessment is based on the comparative analysis of the results achieved by students doing theoretical tasks in different sections of the course.

UNIFICATION OF ENGINEERING EDUCATION PROGRAMMES

V.S. Gryzlov
Cherepovets state University

The article deals with the unification of engineering academic programmes. It provides a professional functional map and generalized analysis of the competencies included in FSES in engineering. The author suggests a unified engineering education model developed in terms of the structure of basic competencies and including competency-based modules.

COMPETENCY-BASED APPROACH TO EDUCATION PROGRAMME DEVELOPMENT: THE CASE OF TECHNOLOGY AND ENGINEERING TEACHER QUALIFICATION (TECHNOLOGY OF LIGHT INDUSTRY)

O.V. Ezhova
Kirovohrad Volodymyr Vynnychenko State Pedagogical University

The article is devoted to development of competency-based education programmeme to train technology and engineering teachers with regard to prospects of light industry development. The developed model includes general and professional competences. The general competences comprise instrumental, interpersonal, systemic, informational, communicative, and legal ones. Professional competences include professional, pedagogical and special competences: engineering and production technology.

ANALYSIS OF THE CURRICULUM SUBJECTS CORRELATION

A.A. Mitsel
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N.V. Cherniaeva
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The methodological foundation for the analysis of courses dependencies within the university curriculum has been studied. To build an effective curriculum, a model of disciplines correlation analysis based on Spearman's rank correlation using students' assessment as input information was proposed.

INNOVATIVENESS IN FUTURE ENGINEERS: VALUE AND MOTIVATIONAL CHARACTERISTICS

O.B. Mikhailova
Peoples' Friendship University of Russia

The article presents the results of research concerning the peculiarities of value-motivational structure of engineering students with different levels of innovativeness manifestation.
The obtained data allow introducing new practical technologies aiming at future engineers' motivational activity and innovativeness development.

NANOTECHNOLOGY EDUCATION PROGRAMMES: EXPERIENCE IN ACCREDITATION

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S.B. Mogilnitsky, Yu.P. Pokholkov, A.I. Chuchalin, E.Yu. Yatkina
National Research Tomsk Polytechnic University, Association for Engineering Education of Russia

The paper presents the results of pilot accreditation of nanotechnology education programmes. The analysis performed allowed revealing a number of challenges in engineering education of Russia and suggesting solutions ensuring its future development and competitive growth of Russian economy in general and professionals, in particular.

ACCREDITATION OF APPLIED BACHELOR'S EDUCATIONAL PROGRAMMES IN LITHUANIA

S.O. Shaposhnikov
Saint Petersburg Electrotechnical University "LETI"
E.Yu. Yatkina
National Research Tomsk Polytechnic University

This article is to some extent a sequel to the notes on organization of accreditation process of Study Programmes in the field of technology in Lithuania [1]. In 2015 one of the article's authors took part in conducting independent external evaluation of 5 Study Programmes of Applied Bachelor level in 4 universities of Lithuania. Together with the earlier publications this material allows to assess the level of development of the system for Study Programmes' (SPs) accreditation and the specifics of its execution in the country.

SCIENTOMETRIC RESEARCH RESULTS FOR EDUCATIONAL TRAJECTORY DEVELOPMENT IN ELECTRONIC EDUCATIONAL ENVIRONMENT

S.V. Kalmykova, E.M. Razinkina
Peter the Great St. Petersburg Polytechnic University
P.N. Pustylnik
Herzen State Pedagogical University of Russia

The higher education system keeps changing; therefore, development of new training methods is currently urgent. Control algorithm designed for the most effective individual educational trajectory is a rather important task. Results of scientometric research allow transformations of the variable part of the curriculum on the basis of modular approach taking into account demands of the most intensively-developing industries. Model formalization of information streams in development of educational trajectories is suggested to choose an optimal option of network interaction.

TRAINING OF SPECIALISTS USING NETWORK FORMS OF EDUCATIONAL PROGRAMMES

T.Y. Dorohova, A.N. Gribkov
Tambov State Technical University

The article discusses the features of implementing the network forms of educational programme, a functional model of interaction using the network forms of learning, the basic characteristics of the training network forms, their components and tasks are presented. The sequence of training process on the basis of the network of educational programmes and the possibilities of their implementation at the profile departments are considered.

FUNDAMENTALIZATION OF TRANSPORT BACHELORS' EDUCATION WITH THE FORMATION OF NATURE-CENTERED CONSCIOUSNESS

V.A. Korchagin, S.A. Lyapin, Y.N. Rizaeva
Lipetsk State Technical University

The necessity of transforming the entire system of knowledge about the universe, man, society, and the role of the fundamental base in the formation of an organic unity of its natural-science and humanitarian components is considered. The educational paradigm of forming nature-centered ecological consciousness of transport bachelors developed in LSTU is briefly analyzed, the results of its implementation are presented.

FORMATION AND IMPLEMENTATION OF UNIVERSITY DEVELOPMENT STRATEGY AS A FACTOR OF ECONOMIC STABILITY AND THE EDUCATION QUALITY

M.M. Krishtal, V.V. Eltsov, A.V. Komyagin
Togliatti State University

Long-term planning of higher educational institutions' activities on the basis of the results of the SWOT analysis is an integral part of the management system and higher education development. Formation and implementation of the development strategy of a university in all spheres of its activities provide the predicted results, both in economics and in the field of education quality. In Togliatti State University "Strategy-2020" was developed and implemented based on five principal parts of its functioning.

VAZ AND HIGHER EDUCATION INSTITUTION: HISTORICAL PARALLELS. EXPERIENCE IN IMPLEMENTING DEVELOPMENT STRATEGY 2020

V.V. Yeltsov, V.G. Doronkin
Togliatti State University

In Togliatti, the automobile plant and the state university were established approximately at the same time and developed simultaneously. Currently, AVTOVAZ development strategy includes the programme of personnel training and retraining. The strategy of Togliatti State University implies development of new engineering education programmes in cooperation with the professionals of the automobile plant. Such programmes will allow developing professional qualities in demand within automotive business sector. With business and education overlapping, it is possible to boost the national economic growth.

BEST PRACTICES OF SIMULATING NEW APPROACHES AND TOOLS FOR ASSESSING REGIONAL DEMAND FOR NEW-GENERATION ENGINEERING WORKFORCE

L.N. Bannikova, L.N. Boronina,
I.I. Sholina
Ural Federal University

In the context of a new paradigm of planning the demand for engineering workforce, the prediction should be formed by each constituent entity of the Russian Federation from the points of view of largest employers and the system of professional education. This stipulates the transition from strict calculation algorithms to a variety of approaches and methods and their free choice. The article discloses the assessment models for evaluation of engineering labor market demand.

HUMANIZATION OF ENGINEERING EDUCATION: CURRENT CHALLENGES IN RUSSIA

T.A. Rubantsova
Siberian Transport University

The paper deals with humanization of today's engineering education and analyzes interconnection between science and education in philosophical perspective. The author investigates different methodological approaches to engineering education, which were applied in Russia before and after the Revolution, in terms of humanization and dehumanization of the society.

AUTOMOTIVE ENGINEER TRAINING: CHALLENGES AND SOLUTIONS

A.M. Ushenin, D.Kh. Valeev,
V.S. Karabtsev
KAMAZ PTC

The paper proves the necessity for using a specific tool in engineer training, namely, mobile training laboratory equipped with all necessary facilities and provided with educational and methodological support. This mobile class will allow solidifying theoretical knowledge and developing the team work skills effective at each stage of product life cycle.

INTERNATIONALIZATION OF HIGHER EDUCATION

O.N. Efremova, O.Yu. Korneva,
I.V. Plotnikova,O.N. Tchaikovskaya,
E.A. Titenko
National Research Tomsk
Polytechnic University

The paper considers internationalization of higher education associated with the increased number of foreign students in Russian higher education institutions. Education internationalization is proved to be important through the case study of Tomsk Polytechnic University, which is one of the global leaders in the sphere of resource-efficient technologies. The authors have analyzed the specialties mostly chosen by foreign TPU students studying in Russian language.

INSTITUTE OF ENGINEERING, TECHNOLOGY AND TECHNICAL SCIENCES FOR NEW INDUSTRY

O.I. Rebrin, I.I. Sholina
Ural Federal University named after the first President of Russia B.N.Yeltsin

The present paper considers the Institute of Engineering, Technology and Technical Sciences as an efficient model of university structure to provide engineering education of a new format [1] and develop the education programmes for the next generation engineering and technical personnel [2], [3], [4], [5]. The effects of the model implementation at universities have been described.

VOCATIONAL EDUCATION IN RUSSIA: TOPICALITY, CHALLENGES, AND TRENDS

E.V. Giniyatova, S.V. Dryga
National Research Tomsk
Polytechnic University

The paper considers challenges and trends in the development of secondary vocational education, which is regarded as an educational resource meeting the demand for skilled trades in the territory of the Russian Federation. The authors have investigated the reasons for the national secondary vocational education being uncompetitive on the global educational services market.

MODERN ENGINEERING EDUCATION IN THE CONTEXT OF THE "INFORMATION BURST"

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National Research Tomsk
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Qualitative technological base is being upgraded and innovative technologies are being implemented in many countries of the world. The analysis of basic trends in education sphere proves that the strategy of e-learning is conditioned by the necessity of improving engineering education, educational process and inevitable globalization of education due to technological and communicational changes.

Professional-Public Accreditation of Educational Programmes (Results)

Over the past 20 years, Russian Association of Engineering Education (AEER) has been developing the system ofprofessional and social accountability accreditation of engineering and technology programmes in Russia.

AEER is a member of the most authoritative international organizations involved in engineering programme accreditation: International Engineering Alliance, Washington Accord, European Network for Accreditation of Engineering Education (ENAEE). AEER is the only national organization entitled to assign the international certification label (EUR -ACE label) for accredited programmes.

The system of professional and social accountability accreditation of engineering programmes developed and implemented by AEER is now international and accepted in the majority of developed countries.

By June 01, 2016, AEER has accredited 424 education programmes (first and second cycles) provided by 67 leading universities of Russia, Kazakhstan, Kirgizstan, Tajikistan, and Uzbekistan. The European certification label EUR-ACE has been awarded to 343 programmes. Also, three secondary vocational education programmes provided by Russian vocational training colleges have been accredited. The lists of education programmes accredited by AEER are regularly submitted to Federal Education and Science Supervision Service and reported to the signatories of Washington Accord and ENAEE.

International accreditation of the education programmes improves the image of Russian education on the global market, and makes national universities more attractive both for Russian and foreign students. It intensifies academic mobility and development of international cooperative education programmes. Graduating from an accredited institution allows young professionals to be recognized by APEC and FEANI engineer registers.

The following Register shows the education programmes accredited by AEER.

List of Accredited Programmes, Russian Federation (as of 01.06.2016)

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	Altai State Technical University named after I.I. Polzunov				
1.	100400	INT	Electrical Supply	AEER	1997-2002
2.	120100	INT	Mechanical Engineering Technology	AEER	1997-2002
3.	120500	INT	Welding Equipment and Technology	AEER	1997-2002
4.	150900	FCD	Technology, Equipment and Automation of Mechanical Engineering Productions	AEER	2003-2008
5.	151900 (15.03.05)	FCD	Design Engineering Solutions for Mechanical Engineering Industries	AEER EUR-ACE®	2015-2020
	Belgorod State National Research University				
1.	210400	FCD	Telecommunications	AEER EUR-ACE®	2012-2017
2.	210406	INT	Communication Networks and Switching Systems	AEER EUR-ACE® WA	2012-2017
3.	210602	INT	Nanomaterials	AEER EUR-ACE® WA	2012-2017
4.	120700	FCD	Land Management and Cadastre	AEER EUR-ACE®	2014-2019
5.	120700	SCD	Cadastre and Land Monitoring	AEER EUR-ACE®	2014-2019
6.	130101	INT	Exploration and Prospecting of Underground Waters and Engineering Geological Survey	AEER EUR-ACE® WA	2014-2019
7.	210700	FCD	Communication Networks and Commutation Systems	AEER EUR-ACE®	2014-2019
8.	150100	SCD	Materials Science and Technology	AEER EUR-ACE®	2015-2020
	Belgorod State Technological University named after V.G. Shukhov				
1.	08.04.01 (270800.68)	SCD	Nanosystems in Building Materials Science	AEER EUR-ACE®	2015-2020
	Dagestan State University				
1.	210104	INT	Microelectronics and Solid State Electronics	AEER EUR-ACE® WA	2013-2018
2.	280201	INT	Environmental Protection and Rational Use of National Resources	AEER EUR-ACE® WA	2013-2018
	National Research University Higher School of Economics				
1.	11.04.04	SCD	Electronic Engineering	AEER EUR-ACE®	2015-2020
2.	11.04.04	SCD	Measurement Technologies of Nanoindustry	AEER EUR-ACE®	2015-2020
3.	09.03.01	FCD	Information Science and Computation Technology	AEER EUR-ACE®	2016-2021
4.	09.04.01	SCD	Computer Systems and Networks	AEER EUR-ACE®	2016-2021
5.	01.03.04	FCD	Applied Mathematics	AEER EUR-ACE®	2016-2021
6.	01.04.04	SCD	Management Systems and Information Processing in Engineering	AEER EUR-ACE®	2016-2021
	Ivanovo State Power University				
1.	140404	INT	Nuclear Power Plants and Installations	AEER EUR-ACE® WA	2009-2014
2.	210106	INT	Industrial Electronics	AEER EUR-ACE® WA	2009-2014

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
	Irkutsk National Research Technical University				
1.	130100	INT	Aircraft and Helicopter Construction	AEER	2004-2009
2.	250400	INT	Chemical Engineering of Natural Power Supplies and Carbon-base Materials	AEER	2004-2009
3.	140400	SCD	Optimization of Developing Power-supply Systems	AEER EUR-ACE®	2014-2019
4.	140400	SCD	Energy Efficiency, Energy Audit and Energy Department Management	AEER EUR-ACE®	2014-2019
5.	190700	SCD	Logistic Management and Traffic Control	AEER EUR-ACE®	2014-2019
6.	280700	SCD	Ecological Safety	AEER EUR-ACE®	2014-2019
7.	280700	SCD	Waste Management	AEER EUR-ACE®	2014-2019
8.	15.04.01	SCD	Technology, Equipment and Quality System for Welding	AEER EUR-ACE®	2015-2020
9.	20.04.01	SCD	Fire Protection	AEER EUR-ACE®	2015-2020
10.	15.04.02	SCD	Food Engineering	AEER EUR-ACE®	2015-2020
11.	20.04.01	SCD	Population Saving, Occupational, Environmental and Disaster Risk Management	AEER EUR-ACE®	2015-2020
	Kazan National Research Technical University named after A.N. Tupolev				
1.	150600	FCD	Science and Technology of New Materials	AEER EUR-ACE®	2011-2016
2.	160100	FCD	Aircraft Construction and Rocket Production	AEER EUR-ACE®	2011-2016
3.	230100	FCD	Computer Science	AEER EUR-ACE®	2011-2016
	Kazan National Research Technological University				
1.	240100	FCD	Chemical Technology and Biotechnology	AEER	2004-2009
2.	240100	SCD	Chemical Engineering for Innovative Entrepreneurship	AEER EUR-ACE®	2013-2018
3.	28.04.02	SCD	Nanostructured Natural and Synthetic Materials	AEER EUR-ACE®	2015-2020
	Kemerovo Institute of Food Science and Technology				
1.	240700	FCD	Food Biotechnology	AEER EUR-ACE®	2013-2018
	Krasnoyarsk State Technical University				
1.	200700	INT	Radio Engineering	AEER	1997-2002
2.	220100	INT	Computers, Systems and Networks	AEER	1997-2002
3.	210302	INT	Radio Engineering	AEER	2003-2008
	Komsomolsk-on-Amur State Technical University				
1.	140600	FCD	Electrical Engineering, Electromechanics and Electrical Technology	AEER	2005-2010
2.	140601	INT	Electromechanics	AEER	2005-2010
3.	140604	INT	Electrical Drives and Automated Industrial Sets and Engineering Systems	AEER	2005-2010
	Kuban State Technological University				
1.	260100	FCD	Technology of Fermentation Manufacture and Winemaking	AEER EUR-ACE®	2014-2019
2.	260100	FCD	Technology of Bread Products	AEER EUR-ACE®	2014-2019
3.	260100	FCD	Technology of Fats, Essential Oils, Perfume and Cosmetic Products	AEER EUR-ACE®	2014-2019
	«MATI» – Russian State Technological University				
1.	190300	INT	Aircraft instruments, Measuring and Computing complexes	AEER	1996-2001
2.	110400	INT	Foundry of Ferrous and Non-ferrous Metals	AEER	1996-2001

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
3.	110500	INT	Metal Science and Thermal Treatment of Metals	AEER	1996-2001
4.	110700	INT	Welding Metallurgy	AEER	1996-2001
	Moscow State Mining University				
1.	090400	INT	Mine and Underground Construction	AEER	1996-2001
2.	090500	INT	Open-pit Mining	AEER	1996-2001
3.	130408	INT	Mine and Underground Construction	AEER EUR-ACE® WA	2010-2015
	Moscow State Technological University "Stankin"				
1.	120100	INT	Mechanical Engineering Technology	AEER	1993-1998
2.	120200	INT	Metal-cutting Machines and Tools	AEER	1993-1998
3.	120400	INT	Machines and Metal Forming Technology	AEER	1993-1998
4.	210200	INT	Automation of Technological Processes and Manufacturing	AEER	1993-1998
5.	210300	INT	Robots and Robotic Systems	AEER	1993-1998
6.	220300	INT	Automated Production Systems	AEER	1993-1998
	Moscow State University of Applied Biotechnology				
1.	070200	INT	Low Temperature Physics and Technology	AEER	1996-2001
2.	170600	INT	Food Production Machines and Devices	AEER	1996-2001
3.	210200	INT	Automation of Technological Processes and Manufacturing	AEER	1996-2001
4.	250600	INT	Plastic and Elastoplastic Processing Technology	AEER	1996-2001
5.	270900	INT	Meat and Meat Products Technology	AEER	1996-2001
6.	271100	INT	Milk and Dairy Products Technology	AEER	1996-2001
	Moscow State Technical University of Radio Engineering, Electronics and Automation				
1.	210302	INT	Radio Engineering	AEER	2004 -2009
2.	220402	INT	Robots and Robotic Systems	AEER	2005-2010
3.	200203	INT	Optoelectronic Devices and Systems	AEER	2005-2010
4.	220401	INT	Mechatronics	AEER	2005-2010
5.	210104	INT	Microelectronics and Solid State Electronics	AEER	2005-2010
6.	230105	INT	Computer Technology and Automated Systems Software	AEER	2005-2010
7.	230201	INT	Information Systems and Technologies	AEER	2005-2010
8.	230101	INT	Computers, Systems and Networks	AEER EUR-ACE® WA	2008-2013
9.	210104	INT	Microelectronics and Solid State Electronics	AEER EUR-ACE® WA	2010-2015
10.	200200	FCD	Optical Engineering	AEER EUR-ACE®	2010-2015
11.	210300	FCD	Radio Engineering	AEER EUR-ACE®	2010-2015
12.	211000	SCD	Quality Assurance and Certification of Electronic Equipment	AEER EUR-ACE®	2013-2018
13.	210100	SCD	Measurement and Information Technologies and Systems	AEER EUR-ACE®	2013-2018
	National Research University of Electronic Technology (MIET)				
1.	210100	FCD	Electronics and Microelectronics	AEER	2003-2008
2.	230100	FCD	Computer Science	AEER	2003-2008
	National Research University (MPEI)				
1.	140600	FCD	Electrical Engineering, Electromechanics and Electrical Technology	AEER	2005-2010
2.	140602	INT	Electrical and Electronic Machines	AEER EUR-ACE®	2007-2012

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
3.	140604	INT	Electrical Drives and Automated Industrial Sets and Engineering Systems	AEER EUR-ACE® WA	2007-2012
4.	140609	INT	Electrical Equipment for Aircraft	AEER EUR-ACE® WA	2007-2012
5.	140611	INT	Insulators, Cables and Capacitors	AEER EUR-ACE® WA	2007-2012
6.	140403	INT	Technical Physics of Thermonuclear Reactors and Plasma Installations	AEER EUR-ACE® WA	2010-2015
	National Research Tomsk Polytechnic University				
1.	071600	INT	High Voltage Engineering and Physics	AEER	1996-2001
2.	080200	INT	Geology and Prospecting of Mineral Resources	AEER	1996-2001
3.	180100	INT	Electromechanics	AEER	1996-2001
4.	200400	INT	Industrial Electronics	AEER	1996-2001
5.	210400	INT	Applied Mathematics	AEER	1996-2001
6.	250900	INT	Chemical Engineering of Modern Energetic Materials	AEER	1999-2004
7.	250800	INT	Chemical Engineering of Refractory Non-Metal and Silicate Materials	AEER	2000-2005
8.	070500	INT	Nuclear Reactors and Power Plants	AEER	2000-2005
9.	220100	INT	Computer Science	AEER	2000-2005
10.	100500	INT	Thermal Power Plants	AEER	2000-2005
11.	101300	INT	Boiler and Reactor Engineering	AEER	2000-2005
12.	230100	FCD	Computer Science	AEER	2003-2008
13.	140600	FCD	Electrical Engineering, Electromechanics and Electrical Technology	AEER	2003-2008
14.	140601	INT	Electromechanics	AEER	2004-2009
15.	140604	INT	Electrical Drives and Automated Industrial Sets and Engineering Systems	AEER	2004-2009
16.	230101	INT	Computers, Systems and Networks	AEER	2004-2009
17.	020804	INT	Geoecology	AEER	2004-2009
18.	130100	FCD	Geology and Prospecting of Mineral Resources	AEER	2005-2010
19.	200106	INT	Measurement Devices and Technologies	AEER EUR-ACE® WA	2007-2012
20.	200203	INT	Opto-Electronic Equipment and Systems	AEER EUR-ACE® WA	2007-2012
21.	240304	INT	Chemical Engineering of Refractory Non-Metal and Silicate Materials	AEER EUR-ACE® WA	2007-2012
22.	240901	INT	Biotechnology	AEER EUR-ACE®	2008-2011
23.	140200	FCD	Electrical Power Engineering	AEER EUR-ACE®	2008-2013
24.	150917	SCD	High-technology Physics in Mechanical Engineering	AEER EUR-ACE®	2008-2013
25.	230100	FCD	Computer Science	AEER EUR-ACE®	2008-2013
26.	140600	FCD	Electrical Engineering, Electromechanics and Electrical Technology	AEER EUR-ACE®	2008-2013
27.	140200	SCD	High Voltage Engineering and Physics	AEER EUR-ACE®	2010-2015
28.	130100	SCD	Groundwater Resources Formation and Composition	AEER EUR-ACE®	2010-2015
29.	150900	FCD	Technology, Equipment and Automation of Mechanical Engineering Productions	AEER EUR-ACE®	2011-2016
30.	220301	INT	Automation of Technological Processes and Manufacturing (Gas and Oil field)	AEER EUR-ACE® WA	2011-2016

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
31.	210100	SCD	Physical Electronics	AEER EUR-ACE®	2011-2016
32.	140200	SCD	Mode Control of Electric Power Systems	AEER EUR-ACE®	2011-2016
33.	140400	SCD	Electrical Drives and Electrical Drive Control Systems	AEER EUR-ACE®	2011-2016
34.	200100	SCD	Stabilization and Navigation Systems	AEER EUR-ACE®	2011-2016
35.	130500	FCD	Petroleum Engineering	AEER EUR-ACE®	2011-2016
36.	130500	SCD	Geologic-geophysical Problems of Oil and Gas Field Development	AEER EUR-ACE®	2011-2016
37.	140801	INT	Electronics and Automated Physical Installations	AEER EUR-ACE® WA	2012-2017
38.	240501	INT	Chemical Technology of Modern Power Engineering Materials	AEER EUR-ACE® WA	2012-2017
39.	140404	INT	Nuclear Power Plants and Installations	AEER EUR-ACE® WA	2012-2017
40.	200100	SCD	Devices and Methods of Quality Control and Diagnostics	AEER EUR-ACE®	2012-2017
41.	200100	FCD	Measurement Devices and Technologies	AEER EUR-ACE®	2012-2017
42.	200100	FCD	Instrumentation Engineering	AEER EUR-ACE®	2012-2017
43.	200100	FCD	Devices and Methods of Quality Control and Diagnostics	AEER EUR-ACE®	2012-2017
44.	200100	SCD	Measurement Devices and Technologies of Nondestructive Testing	AEER EUR-ACE®	2012-2017
45.	240100	FCD	Chemical Engineering of Natural Power Supplies and Carbon-base Materials	AEER EUR-ACE®	2012-2017
46.	240100	FCD	Chemical Technology of Organic Substances	AEER EUR-ACE®	2012-2017
47.	240100	FCD	Chemical Technology of Inorganic Substances	AEER EUR-ACE®	2012-2017
48.	240100	FCD	Polymer Processing Technology	AEER EUR-ACE®	2012-2017
49.	240100	FCD	Technology of Refractory Non-Metal and Silicate Materials	AEER EUR-ACE®	2012-2017
50.	240100	SCD	Chemical Engineering of Refractory Non-Metal and Silicate Materials	AEER EUR-ACE®	2012-2017
51.	150100	SCD	Science and Technology of Nanomaterials and Coatings	AEER EUR-ACE®	2012-2017
52.	200400	FCD	Opto-Electronic Equipment and Systems	AEER EUR-ACE®	2012-2017
53.	022000	FCD	Geoecology	AEER EUR-ACE®	2012-2017
54.	201000	FCD	Biotechnical and Medical Devices and Systems	AEER EUR-ACE®	2012-2017
55.	140400	FCD	Electrical Drives and Automation	AEER EUR-ACE®	2014-2019
56.	140400	FCD	Protection Relay and Automation of Power Grids	AEER EUR-ACE®	2014-2019
57.	221400	FCD	Quality Management in Manufacturing and Technological Systems	AEER EUR-ACE®	2014-2019
58.	150100	FCD	Nanostructured Materials	AEER EUR-ACE®	2014-2019
59.	150100	FCD	Materials Science and Technologies in Mechanical Engineering	AEER EUR-ACE®	2014-2019
60.	150100	SCD	Nanostructured Materials Tool Production	AEER EUR-ACE®	2014-2019
61.	150100	SCD	Computer Simulation of Material Production, Processing and Treatment	AEER EUR-ACE®	2014-2019
62.	130101	INT	Petroleum Geology	AEER EUR-ACE® WA	2014-2019

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
63.	12.04.02	SCD	Lighting Technology and Light Sources	AEER EUR-ACE®	2014-2019
64.	12.04.02	SCD	Photonic Technologies and Materials	AEER EUR-ACE®	2014-2019
65.	15.04.01	SCD	High-technology Physics in Mechanical Engineering	AEER EUR-ACE®	2014-2019
66.	19.03.01	FCD	Biotechnology	AEER EUR-ACE®	2014-2019
67.	12.04.04	SCD	Medical and Biological Devices, Systems and Complexes	AEER EUR-ACE®	2014-2019
68.	15.03.01	FCD	Automation of Manufacturing Processes and Production in Mechanical Engineering	AEER EUR-ACE®	2014-2019
69.	21.05.03	INT	Geology and Exploration of Minerals	AEER EUR-ACE® WA	2014-2019
70.	21.05.03	INT	Geophysical Methods of Well Logging	AEER EUR-ACE® WA	2014-2019
71.	11.04.04	SCD	Electronics and Nanoelectronics	AEER EUR-ACE®	2015-2020
72.	27.04.01	SCD	Standardization and Metrology	AEER EUR-ACE®	2015-2020
	National Research Tomsk State University				
1.	12.04.03	SCD	Appliances and Devices in Nanophotonics	AEER EUR-ACE®	2015-2020
	National Research University «Lobachevsky State University of Nizhni Novgorod»				
1.	010300	FCD	Software Engineering	AEER EUR-ACE®	2014-2019
2.	010300	FCD	Fundamental Computer Science and Information Technologies (in English)	AEER EUR-ACE®	2014-2019
3.	010300	SCD	Software Engineering	AEER EUR-ACE®	2014-2019
	National University of Science and Technology «MISIS»				
1.	150101	INT	Metallurgy of Ferrous Metals	AEER	2004-2009
2.	150105	INT	Metal Science and Thermal Treatment of Metals	AEER	2004-2009
3.	150601	INT	Science and Technology of New Materials	AEER	2004-2009
4.	150400	FCD	Metallurgy of Ferrous Metals	AEER EUR-ACE®	2011-2016
5.	150400	FCD	Physical Metallurgy of Non-Ferrous, Rare-Earth and Precious Metals	AEER EUR-ACE®	2011-2016
6.	150400	FCD	Functional Materials and Coatings	AEER EUR-ACE®	2011-2016
7.	150400	FCD	Metal Forming	AEER EUR-ACE®	2011-2016
8.	011200	FCD	Physics of Condensed Matter	AEER EUR-ACE®	2012-2017
9.	150100	FCD	Materials Science and Engineering of Functional Materials for Nanoelectronics	AEER EUR-ACE®	2012-2017
10.	150400	FCD	Metallurgy of Non-ferrous, Rare and Precious Metals	AEER EUR-ACE®	2012-2017
11.	151000	FCD	Metallurgical Machines and Equipment	AEER EUR-ACE®	2012-2017
12.	210100	FCD	Semiconductor Devices for Micro- and Nanoelectronics	AEER EUR-ACE®	2012-2017
13.	210100	FCD	Materials and Technologies of Magnetoelectronics	AEER EUR-ACE®	2012-2017
14.	210100	FCD	Micro- and Nanotechnology Processes	AEER EUR-ACE®	2012-2017
15.	220700	FCD	Automated Systems in Manufacturing	AEER EUR-ACE®	2012-2017
16.	230100	FCD	Automated Systems	AEER EUR-ACE®	2012-2017
17.	150400	SCD	Metallurgy of Non-Ferrous and Precious Metals	AEER EUR-ACE®	2014-2019
18.	011200	SCD	Physics of Condensed Matter	AEER EUR-ACE®	2014-2019

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	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
19.	011200	SCD	Physics of Nanosystems	AEER EUR-ACE®	2014-2019
20.	210100	SCD	Materials and Technologies of Magnetoelectronics	AEER EUR-ACE®	2014-2019
21.	210100	SCD	Micro- and Nanotechnology Processes	AEER EUR-ACE®	2014-2019
	North-Caucasus Federal University				
1.	140400	FCD	Electrical Power Systems and Networks	AEER EUR-ACE®	2015-2020
2.	240100	FCD	Process Chemistry of Natural Energy Carriers and Carbon Materials	AEER EUR-ACE®	2015-2020
3.	090900	FCD	Organization and Technology of Information Security	AEER EUR-ACE®	2015-2020
4.	090303	INT	Information Security of Automated Systems	AEER EUR-ACE® WA	2015-2020
5.	131000	SCD	Oil Field Reservoir Management	AEER EUR-ACE®	2015-2020
6.	140400	SCD	Monitoring and Control of Electrical Networks Based on Intelligent Information-Measuring Systems and Technologies	AEER EUR-ACE®	2015-2020
7.	21.05.02	INT	Geology of Oil and Gas	AEER EUR-ACE® WA	2015-2020
8.	21.05.03	INT	Geophysical Methods for Well Exploration	AEER EUR-ACE® WA	2015-2020
9.	23.04.03	SCD	Technical Exploitation of Automobiles	AEER EUR-ACE®	2015-2020
10.	23.03.03	FCD	Automobiles and Vehicle Fleet	AEER EUR-ACE®	2015-2020
11.	09.04.03	SCD	Knowledge Management	AEER EUR-ACE®	2015-2020
12.	10.04.01	SCD	Comprehensive Protection for Computerization Facilities	AEER EUR-ACE®	2015-2020
13.	11.03.02	FCD	Communication network and Switching Systems	AEER EUR-ACE®	2015-2020
	Institute of Service, Tourism and Design (Branch of North-Caucasus Federal University in Pyatigorsk)				
1.	27.03.04	FCD	Management and Computer Science in Technical Systems	AEER EUR-ACE®	2015-2020
2.	23.03.03	FCD	Automobile Service	AEER EUR-ACE®	2015-2020
	Nosov Magnitogorsk State Technical University				
1.	150400	FCD	Forming of Metals and Alloys (Rolling)	AEER EUR-ACE®	2014-2019
2.	150400	SCD	Rolling Production Technology	AEER EUR-ACE®	2014-2019
3.	27.04.01	SCD	Testing and certification	AEER EUR-ACE®	2015-2020
4.	22.04.02	SCD	Hardware Production Technology	AEER EUR-ACE®	2015-2020
5.	11.04.04	SCD	Industrial Electronics and Automation of Electrical Systems	AEER EUR-ACE®	2015-2020
6.	03.04.02	SCD	Solid State Physics	AEER EUR-ACE®	2015-2020
	Novosibirsk State Technical University				
1.	150501	INT	Materials Science in Mechanical Engineering	AEER EUR-ACE® WA	2012-2017
2.	16.04.01	SCD	Laser Science and Technology	AEER EUR-ACE®	2015-2020
3.	22.04.01	SCD	Material Science, Technology and Processing of Materials with Specific Properties	AEER EUR-ACE®	2015-2020
4.	28.04.01	SCD	Micro- and Nanosystem Engineering Materials	AEER EUR-ACE®	2015-2020

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
	Ogarev Mordovia State University				
1.	151900	FCD	Mechanical Engineering Technology	AEER EUR-ACE®	2014-2019
2.	210100	FCD	Industrial Electronics	AEER EUR-ACE®	2014-2019
3.	11.04.04	SCD	Electronics and Nanoelectronics	AEER EUR-ACE®	2015-2020
	Penza State University				
1.	11.04.04	SCD	Electronics and Nanoelectronics	AEER EUR-ACE®	2015-2020
2.	27.04.01	SCD	Standardization and Metrology	AEER EUR-ACE®	2015-2020
	Peoples' Friendship University of Russia				
1.	270100	SCD	Structural Theory and Engineering	AEER EUR-ACE®	2013-2018
2.	270100	SCD	River and Underground Hydraulic Engineering Works	AEER EUR-ACE®	2013-2018
3.	270100	SCD	Theory and Practice of Organizational, Technical and Economic Decisions in Building and Construction	AEER EUR-ACE®	2013-2018
4.	141100	SCD	Internal Combustion Engines	AEER EUR-ACE®	2013-2018
5.	141100	SCD	Steam- and Gas Turbine Plants and Engines	AEER EUR-ACE®	2013-2018
6.	151900	SCD	Automated Engineering Technology	AEER EUR-ACE®	2015-2020
7.	220400	SCD	Intellectualization and Optimization of Control Processes	AEER EUR-ACE®	2015-2020
	Perm National Research Polytechnic University				
1.	150700	SCD	Beam Technologies in Welding	AEER EUR-ACE®	2014-2019
2.	270800	SCD	Underground and Urban Construction	AEER EUR-ACE®	2014-2019
3.	27.04.04 (220400.68)	SCD	Distributed Computing Information and Control Systems	AEER EUR-ACE®	2015-2020
	Petrozavodsk State University				
1.	210100	SCD	Electronics and Nanoelectronics	AEER EUR-ACE®	2015-2020
	Samara State Aerospace University (National Research University)				
1.	160301	INT	Aircraft Engines and Power Plants	AEER EUR-ACE® WA	2008-2013
2.	160802	INT	Spasecraft and Rocket Boosters	AEER EUR-ACE® WA	2008-2013
3.	24.05.01	INT	Design, Production and Maintenance of Rockets and Space Complexes	AEER EUR-ACE® WA	2015-2020
4.	24.05.07	INT	Airplane and Helicopter Designing	AEER EUR-ACE® WA	2015-2020
5.	12.04.04	SCD	Biotechnical Systems and Technologies	AEER EUR-ACE®	2015-2020
6.	01.04.02	SCD	Supercomputing, Information Technologies and Geoinformatics	AEER EUR-ACE®	2015-2020
	Saint Petersburg Electrotechnical University "LETI"				
1.	220200	FCD	Automation and Control	AEER	2003-2008
2.	210100	FCD	Electronics and Microelectronics	AEER	2003-2008
3.	230100	FCD	Computer Science	AEER	2003-2008
4.	200300	FCD	Biomedical Engineering	AEER	2003-2008
5.	210400	FCD	Radio Electronic Systems	AEER EUR-ACE®	2014-2019

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
6.	210400	FCD	Radiotechnical Devices for Signal Transmission, Reception and Processing	AEER EUR-ACE®	2014-2019
7.	210400	FCD	Audiovision Equipment	AEER EUR-ACE®	2014-2019
8.	210100	FCD	Electronic Devices	AEER EUR-ACE®	2014-2019
9.	200100	FCD	Information and Measurement Technique and Technology	AEER EUR-ACE®	2014-2019
10.	200100	FCD	Laser Measurement and Navigation Systems	AEER EUR-ACE®	2014-2019
11.	200100	FCD	Devices and Methods of Monitoring of Quality and Diagnostics	AEER EUR-ACE®	2014-2019
12.	231000	SCD	Development of Distributed Software Systems	AEER EUR-ACE®	2014-2019
13.	010400	SCD	Mathematical Provisions and Software of Computers	AEER EUR-ACE®	2014-2019
14.	220451	SCD	Automation and Control of Industrial Complexes and Mobile Objects	AEER EUR-ACE®	2014-2019
15.	220452	SCD	Automated Control Systems for Sea Vehicles	AEER EUR-ACE®	2014-2019
16.	220453	SCD	Shipborne Information and Control Systems	AEER EUR-ACE®	2014-2019
17.	140452	SCD	Automated Electromechanical Complexes and Systems	AEER EUR-ACE®	2014-2019
18.	230161	SCD	Microsystem Computer Technologies: Systems on Chip	AEER EUR-ACE®	2014-2019
19.	230162	SCD	Distributed Intelligent Systems and Technology	AEER EUR-ACE®	2014-2019
20.	230151	SCD	Computer Technologies in Engineering	AEER EUR-ACE®	2014-2019
21.	201051	SCD	Biotechnical Systems and Technologies of Rehabilitation and Prosthetics	AEER EUR-ACE®	2014-2019
22.	201053	SCD	Information Systems and Technologies in Patient Care Institutions	AEER EUR-ACE®	2014-2019
23.	210153	SCD	Electronic Devices and Equipment	AEER EUR-ACE®	2014-2019
24.	210176	SCD	Physical Electronics	AEER EUR-ACE®	2014-2019
25.	210152	SCD	Microwave and Telecommunication Electronics	AEER EUR-ACE®	2014-2019
26.	211006	FCD	Information Technologies for Radio Electronic Engineering	AEER EUR-ACE®	2014-2019
27.	211008	FCD	Information Technologies in Microwave Electronic Engineering	AEER EUR-ACE®	2014-2019
28.	11.04.04	SCD	Nanoelectronics and photonics	AEER EUR-ACE®	2015-2020
29.	11.04.01	SCD	Radiolocation of Objects and Environments	AEER EUR-ACE®	2015-2020
30.	11.04.01	SCD	Microwave, Optical, and Digital Telecommunications Hardware	AEER EUR-ACE®	2015-2020
31.	11.04.01	SCD	Infocommunication Technology in Space Patterns Analysis and Processing	AEER EUR-ACE®	2015-2020
32.	13.04.02	SCD	Electrotechnologies	AEER EUR-ACE®	2015-2020
33.	12.04.01	SCD	Devices and Methods of Quality Control and Diagnostics	AEER EUR-ACE®	2015-2020
34.	12.04.01	SCD	Lazer Measurement Technologies	AEER EUR-ACE®	2015-2020
35.	12.04.01	SCD	Adaptive Measuring Systems	AEER EUR-ACE®	2015-2020
36.	27.04.02	SCD	Integrated Quality Management Systems	AEER EUR-ACE®	2015-2020
37.	11.04.04	SCD	Heterostructure Solar Photovoltaics	AEER EUR-ACE®	2015-2020
38.	28.04.01	SCD	Nano- and Microsystem Engineering	AEER EUR-ACE®	2015-2020
39.	09.04.02	SCD	Distributed Computing Systems of Real-Time	AEER EUR-ACE®	2015-2020
40.	27.04.04	SCD	Control and Information Technologies in Technical Systems	AEER EUR-ACE®	2015-2020

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	Saint Petersburg National Research University of Information Technologies, Mechanics and Optics				
1.	27.04.03	SCD	Intelligent Control Systems of Technological Processes	AEER EUR-ACE®	2014-2019
2.	09.04.01	SCD	Embedded Computer Systems Design	AEER EUR-ACE®	2014-2019
3.	09.04.02	SCD	Automation and Control in Educational Systems	AEER EUR-ACE®	2014-2019
4.	09.04.03	SCD	Overall Automation of Enterprise	AEER EUR-ACE®	2014-2019
5.	24.04.01	SCD	Quality Control of Products of Space Rocket Complexes	AEER EUR-ACE®	2014-2019
6.	12.04.02	SCD	Applied Optics	AEER EUR-ACE®	2014-2019
7.	16.04.01	SCD	Integrated Analyzer Systems and Information Technologies of Fuel and Energy Complex Enterprises	AEER EUR-ACE®	2014-2019
8.	19.04.03	SCD	Biotechnology of Therapeutic, Special and Prophylactic Nutrition Products	AEER EUR-ACE®	2014-2019
9.	12.04.01	SCD	Methods of Diagnosis and Analysis in Bionanotechnology	AEER EUR-ACE®	2015-2020
10.	12.04.01	SCD	Devices for Research and Modification of Materials at the Micro- and Nanoscale Level	AEER EUR-ACE®	2015-2020
11.	12.04.03	SCD	Metamaterials	AEER EUR-ACE®	2015-2020
12.	12.04.03	SCD	Nanomaterials and Nanotechnologies for Photonics and Optoinformatics	AEER EUR-ACE®	2015-2020
13.	12.04.03	SCD	Optics of Nanostructures	AEER EUR-ACE®	2015-2020
	Saint-Petersburg State Polytechnic University				
1.	010800	SCD	Mechanics of Deformable Solid Body	AEER EUR-ACE®	2014-2019
2.	210700	SCD	Protected Telecommunication Systems	AEER EUR-ACE®	2014-2019
3.	210100	SCD	Micro- and Nanoelectronics	AEER EUR-ACE®	2014-2019
4.	223200	SCD	Physics of Low-dimensional Structures	AEER EUR-ACE®	2014-2019
5.	151900	SCD	Machine-building Technology	AEER EUR-ACE®	2014-2019
6.	140100	SCD	Technology of Production of Electric Power and Heat	AEER EUR-ACE®	2014-2019
7.	220100	SCD	System Analysis and Control	AEER EUR-ACE®	2014-2019
8.	270800	SCD	Engineering Systems of Buildings and Constructions	AEER EUR-ACE®	2014-2019
9.	270800	SCD	Construction Management of Investment Projects	AEER EUR-ACE®	2014-2019
	Siberian State Aerospace University				
1.	220100	FCD	System Analysis and Control	AEER EUR-ACE®	2011-2016
2.	230100	FCD	Computer Science and Computer Facilities	AEER EUR-ACE®	2011-2016
3.	11.04.04	SCD	Electronic Devices and Facilities	AEER EUR-ACE®	2015-2020
4.	11.04.02	SCD	Telecommunication Networks and Communication Devices	AEER EUR-ACE®	2015-2020
5.	11.04.02	SCD	Satellite Communication Systems	AEER EUR-ACE®	2015-2020
	Siberian Federal University				
1.	210200	SCD	Microwave Equipment and Antennas	AEER EUR-ACE®	2010-2015
2.	230100	SCD	High-Performance Computing Systems	AEER EUR-ACE®	2010-2015
3.	09.03.02	FCD	Information Systems and Technologies	AEER EUR-ACE®	2015-2020

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	Program Code	Qualification	Program Name	Certificate	Accreditation Period
4.	09.03.04	FCD	Software Engineering	AEER EUR-ACE®	2015-2020
5.	15.03.04	FCD	Automation of Technological Processes and Productions	AEER EUR-ACE®	2015-2020
	Siberian Federal University Sayano-Shushensky Branch				
1.	08.03.01	FCD	Hydrotechnical Construction	AEER EUR-ACE®	2016-2021
	Southwest State University				
1.	28.04.01	SCD	Nanotechnology	AEER EUR-ACE®	2015-2020
	Stary Oskol Technological Institute named after A.A. Ugarov (branch of National University of Science and Technology "MISIS")				
1.	150400	FCD	Metallurgy of Ferrous Metals	AEER EUR-ACE®	2012-2015
	Taganrog Institute of Technology of Southern Federal University				
1.	210100	FCD	Electronics and Microelectronics	AEER	2003-2008
2.	230100	FCD	Computer Science	AEER	2003-2008
3.	230100	FCD	Computer Science	AEER EUR-ACE®	2010-2015
4.	220200	FCD	Automation and Control	AEER EUR-ACE®	2010-2015
5.	210100	FCD	Electronics and Microelectronics	AEER EUR-ACE®	2012-2017
6.	200100	FCD	Equipment Engineering	AEER EUR-ACE®	2012-2017
	Tambov State Technical University				
1.	210201	INT	Design and Technology of Radioelectronic Devices	AEER	2006-2011
2.	140211	INT	Electrical Supply	AEER	2006-2011
	Togliatty State University				
1.	140211	INT	Electrical Supply	AEER EUR-ACE® WA	2009-2014
2.	150202	INT	Industrial Welding Technology and Equipment	AEER EUR-ACE® WA	2009-2014
3.	151002	INT	Mechanical Engineering Technology	AEER EUR-ACE® WA	2009-2014
4.	22.04.01	SCD	Welding and Soldering of Advanced Metal and Non-Metal Inorganic Materials	AEER EUR-ACE®	2016-2021
5.	22.04.01	SCD	Material Science and Technologies of Nanomaterials and Coatings	AEER EUR-ACE®	2016-2021
6.	20.04.01	SCD	Productional, Industrial and Environmental Safety Management Systems	AEER EUR-ACE®	2016-2021
7.	15.04.05	SCD	Computer-Aided Engineering Technology	AEER EUR-ACE®	2016-2021
8.	13.04.02	SCD	Operating Modes of Electric Power Supplies, Substations, Circuits and Systems	AEER EUR-ACE®	2016-2021
	Tomsk State University of Control Systems and Radio Electronics				
1.	210100	FCD	Industrial electronics	AEER EUR-ACE®	2013-2018
2.	222000	FCD	Innovation Management in Electronic Engineering	AEER EUR-ACE®	2013-2018
	Transbaikal State University				
1.	21.05.04 (130400.65)	INT	Open Mining	AEER EUR-ACE® WA	2015-2020
2.	08.05.01 (271101.65)	INT	Construction of High-Rise and Long-Span Buildings and Structures	AEER EUR-ACE® WA	2015-2020

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	Trekhgorny Technological Institute				
1.	230101	INT	Computers, Systems and Networks	AEER	2004-2007
	Tyumen State Oil and Gas University				
1.	130501	INT	Design, Construction and Operation of Gas and Oil Pipelines and Storage Facilities	AEER	2006-2011
2.	130503	INT	Development and Exploitation of Oil and Gas Fields	AEER	2006-2011
3.	130504	INT	Oil and Gas Drilling	AEER	2006-2011
4.	190601	INT	Automobiles and Transportation Facilities	AEER WA	2007-2012
5.	190603	INT	Transport and technological machinery and equipment service (oil and gas production)	AEER WA	2007-2012
6.	190701	INT	Transportation organization and transport management (automobile transport)	AEER WA	2007-2012
7.	130602	INT	Oil and Gas Fields Machinery and Equipment	AEER EUR-ACE® WA	2008-2013
8.	150202	INT	Industrial Welding Technology and Equipment	AEER EUR-ACE®	2008-2011
9.	190205	INT	Lifting, Transportation Means and Road Machines	AEER EUR-ACE® WA	2008-2013
10.	240401	INT	Chemical Technology of Organic Substances	AEER EUR-ACE® WA	2009-2014
11.	240403	INT	Chemical Engineering of Natural Power Supplies and Carbon-base Materials	AEER EUR-ACE® WA	2009-2014
12.	240801	INT	Machines and Apparatus of Chemical Production	AEER EUR-ACE® WA	2009-2014
13.	280201	INT	Environmental Control and Rational Use of Natural Resources	AEER EUR-ACE® WA	2010-2015
14.	280102	INT	Safety of Technological Processes and Productions	AEER EUR-ACE® WA	2010-2015
15.	120302	INT	Land Cadastre	AEER EUR-ACE® WA	2010-2015
	Tyumen State University of Architecture and Civil Engineering				
1.	270800	SCD	Water Supply and Sanitation	AEER EUR-ACE®	2013-2018
2.	270800	SCD	Industrial and Civil Construction	AEER EUR-ACE®	2013-2018
3.	280700	SCD	Safety of Technological Processes and Production	AEER EUR-ACE®	2013-2018
	Ural State Forest Engineering University				
1.	270205	INT	Automobile Roads and Aerodromes	AEER	2006-2011
	Ural Federal University named after the first President of Russia B.N. Yeltsin				
1.	240302	INT	Technology of Electrochemical Productions	AEER EUR-ACE®	2008-2013
2.	210100	SCD	Electronics and Nanoelectronics	AEER EUR-ACE®	2015-2020
3.	221700	SCD	Standardization and Metrology	AEER EUR-ACE®	2015-2020
4.	22.04.01	SCD	Material Science, Technology Acquisition and Processing of Metal Materials with Special Properties	AEER EUR-ACE®	2015-2020
5.	22.04.01	SCD	Materials Science, Production Technology and Processing of Non-Ferrous Alloys	AEER EUR-ACE®	2015-2020
6.	22.04.01	SCD	Material Science and Materials Technology in the Nuclear Energy Industry	AEER EUR-ACE®	2015-2020

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	Ufa State Aviation Technical University				
1.	280200	FCD	Environment Protection	AEER	2005-2010
2.	230100	FCD	Computer Science	AEER	2005-2010
3.	150501	INT	Material Science in Mechanical Engineering	AEER	2005-2010
4.	280200	SCD	Environment Protection	AEER EUR-ACE®	2008-2013
	Ufa State Petroleum Technological University				
1.	130504	INT	Oil and Gas Drilling	AEER EUR-ACE® WA	2007-2012
2.	130603	INT	Oil and Gas Processing Equipment	AEER EUR-ACE® WA	2007-2012
3.	150400	FCD	Processing Machinery and Equipment	AEER EUR-ACE®	2007-2012
4.	240100	FCD	Chemical Engineering and Biotechnology	AEER EUR-ACE®	2008-2013
5.	240403	INT	Chemical Engineering of Natural Power Supplies and Carbon-base Materials	AEER EUR-ACE® WA	2008-2013
6.	130602	INT	Oil and Gas Fields Machinery and Equipment	AEER EUR-ACE® WA	2008-2013
7.	130501	INT	Design, Construction and Operation of Gas and Oil Pipelines and Storage Facilities	AEER EUR-ACE® WA	2009-2014
8.	551830	SCD	Equipment Design Theory for Oil and Gas Processing, Petrochemical and Chemical Production	AEER EUR-ACE®	2010-2015
9.	551831	SCD	Technological Systems and Equipment Reliability	AEER EUR-ACE®	2010-2015
10.	550809	SCD	Chemical Engineering of Fuel and Gas	AEER EUR-ACE®	2010-2015
11.	270100	FCD	Building Construction	AEER EUR-ACE®	2011-2016
12.	550109	SCD	Building Construction	AEER EUR-ACE®	2011-2016
13.	131000	FCD	Petroleum Engineering	AEER EUR-ACE®	2013-2018
14.	151000	FCD	Production Machines and Equipment	AEER EUR-ACE®	2013-2018
15.	241000	FCD	Environmental Protection and Rational Use of National Resources	AEER EUR-ACE®	2015-2020
16.	240100	FCD	Process Chemistry of Natural Energy Carriers and Carbon Materials	AEER EUR-ACE®	2015-2020
17.	140400	FCD	Electrical Equipment and Electrical Facilities of Companies, Organizations and Institutions	AEER EUR-ACE®	2015-2020
18.	18.03.01	FCD	Chemical Technology of Natural Energy Carriers and Carbon Materials	AEER EUR-ACE®	2015-2020
19.	18.04.01	SCD	Chemistry and Technology of Basic Organic and Petrochemical Synthesis Products	AEER EUR-ACE®	2015-2020
20.	19.04.01	SCD	Industrial Biotechnology and Bioengineering	AEER EUR-ACE®	2015-2020
	Vladimir State University named after Alexander and Nikolay Stoletovs				
1.	150900	FCD	Technology, Equipment and Automation of Mechanical Engineering Productions	AEER EUR-ACE®	2012-2017
2.	230100	FCD	Computer Science	AEER EUR-ACE®	2012-2017
3.	200400	SCD	Laser Devices and Systems	AEER EUR-ACE®	2015-2020
	Volga State University of Technology				
1.	15.03.01 (150700)	FCD	Machine Building	AEER EUR-ACE®	2015-2020
2.	11.03.02 (210700)	FCD	Information and Communication Technologies and Telecommunication Systems	AEER EUR-ACE®	2015-2020

List of Accredited Programs, Republic of Kazakhstan (as of 01.06.2016)

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	D. Serikbayev East Kazakhstan State Technical University				
1.	050703	FCD	Information Systems	AEER EUR-ACE®	2011-2016
2.	050713	FCD	Transport, Transport Facilities and Technology	AEER EUR-ACE®	2011-2016
	L.N. Gumilyov Eurasian National University				
1.	050702	FCD	Automation and Control	AEER EUR-ACE®	2011-2016
2.	050732	FCD	Standardization, Metrology and Certification	AEER EUR-ACE®	2011-2016
3.	050901	FCD	Organization of Transportation, Traffic and Operation	AEER EUR-ACE®	2011-2016
4.	6N0702	SCD	Automation and Control	AEER EUR-ACE®	2011-2016
5.	6N0732	SCD	Standardization, Metrology and Certification	AEER EUR-ACE®	2011-2016
6.	6N0901	SCD	Organization of Transportation, Traffic and Operation	AEER EUR-ACE®	2011-2016
	Innovative University of Eurasia				
1.	050701	FCD	Biotechnology	AEER EUR-ACE®	2010-2015
2.	050718	FCD	Electrical Power Engineering	AEER EUR-ACE®	2010-2015
	Kazakh National Technical University named after K.I. Satpaev				
1.	050704	FCD	Computer Science and Software	AEER EUR-ACE®	2010-2015
2.	050711	FCD	Geodesy and Cartography	AEER EUR-ACE®	2010-2015
3.	050712	FCD	Mechanical Engineering	AEER EUR-ACE®	2010-2015
4.	050718	FCD	Electrical Power Engineering	AEER EUR-ACE®	2010-2015
5.	050723	FCD	Technical Physics	AEER EUR-ACE®	2010-2013
6.	050713	FCD	Transport, Transport Facilities and Technology	AEER EUR-ACE®	2011-2016
7.	050716	FCD	Instrumentation Engineering	AEER EUR-ACE®	2011-2016
8.	050719	FCD	Radio Engineering, Electronics and Telecommunications	AEER EUR-ACE®	2011-2016
9.	050720	FCD	Chemical Technology of Inorganic Substances	AEER EUR-ACE®	2011-2016
10.	050721	FCD	Chemical Technology of Organic Substances	AEER EUR-ACE®	2011-2016
11.	050722	FCD	Printing	AEER EUR-ACE®	2011-2016
12.	050724	FCD	Processing Machinery and Equipment	AEER EUR-ACE®	2011-2016
13.	050729	FCD	Construction	AEER EUR-ACE®	2011-2016
14.	050731	FCD	Life Safety and Environmental Protection	AEER EUR-ACE®	2011-2016
15.	050732	FCD	Standardization, Metrology and Certification	AEER EUR-ACE®	2011-2016
	Karaganda State Technical University				
1.	050702	FCD	Automation and Control	AEER EUR-ACE®	2010-2015
2.	050707	FCD	Mining Engineering	AEER EUR-ACE®	2010-2015
3.	050709	FCD	Metallurgy	AEER EUR-ACE®	2010-2015

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
4.	050712	FCD	Mechanical Engineering	AEER EUR-ACE®	2010-2015
5.	050713	FCD	Transport, Transport Facilities and Technology	AEER EUR-ACE®	2010-2015
	Kostanay Engineering and Pedagogical University				
1.	050713	FCD	Transport, Transport Equipment and Technology	AEER EUR-ACE®	2011-2016
2.	050732	FCD	Standardization, Metrology and Certification	AEER EUR-ACE®	2011-2016
	Semey State University named after Shakarim				
1.	050727	FCD	Food Technology	AEER EUR-ACE®	2010-2015
2.	050724	FCD	Processing Machinery and Equipment	AEER EUR-ACE®	2010-2015

List of Accredited Programs, Kyrgyzstan (as of 01.06.2016)

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	Kyrgyz State Technical University named after I. Razzakov				
1.	690300	FCD	Communication Networks and Switching Systems	AEER EUR-ACE®	2015-2020
	Kyrgyz State University of Construction, Transport and Architecture named after N. Isanov				
1.	750500	FCD	Industrial and Civil Engineering	AEER EUR-ACE®	2015-2020

List of Accredited Programs, Tajikistan (as of 01.06.2016)

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	Tajik Technical University named after Academician M.S. Osimi				
1.	700201	FCD	Design of Buildings and Constructions	AEER EUR-ACE®	2015-2020
2.	430101	SCD	Electrical Stations	AEER EUR-ACE®	2015-2020

List of Accredited Programs, Uzbekistan (as of 01.06.2016)

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	Tashkent State Technical University named after Abu Raykhan Beruniy				
1.	5310800	FCD	Electronics and Instrumentation	AEER EUR-ACE®	2015-2020

List of Accredited Secondary Professional Education Programs
(as of 01.06.2016)

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	Tomsk Polytechnic College				
1.	131003	T	Oil and Gas Drilling	AEER	2014-2019
	Tomsk Industrial College				
1.	140448	T	Technical Operation and Maintenance of Electrical and Electromechanical Equipment	AEER	2014-2019
	Tomsk College of Information Technologies				
1.	230115	T	Computer Systems Programming	AEER	2014-2019

AEER re-authorization to award the «EUR-ACE® Label»

Meeting of the Administrative Council of ENAEE (European Network for Accreditation of Engineering Education) was held in Istanbul on June 23, 2015. During this meeting the Association of Engineering Education of Russia was authorized to award European quality label «EUR-ACE Bachelor Label» to accredited engineering programmes at first cycle level (bachelor) and «EUR-ACE Master Label» to accredited engineering programmes at second cycle level (diploma specialist, master) until **31st of December (http://www.enaee.eu/wp-content/uploads/2012/01/overview-WEB-of-all-authorizations-granted4.pdf)**

Following 13 national agencies are authorised to award the EUR-ACE® label to their accredited programmes:

1. **GERMANY** – ASIIN – Fachakkreditierungsagentur fьr Studiengдnge der Ingenieurwissenschaften, der Informatik, der Naturwissenschaften, und der Mathematik e.V. – www.asiin.de
2. **FRANCE** – CTI – Commission des Titres d'Ingйnieur – www.cti-commission.fr
3. **UK** – Engineering Council – www.engc.org.uk
4. **IRELAND** – Engineers Ireland – www.engineersireland.ie
5. **PORTUGAL** – Ordem dos Engenheiros – www.ordemengenheiros.pt
6. **RUSSIA** – AEER – Association for Engineering Education of Russia – www.aeer.ru
7. **TURKEY** – MьDEK – Association for Evaluation and Accreditation of Engineering Programs – www.mudek.org.tr
8. **ROMANIA** – ARACIS – The Romanian Agency for Quality Assurance in Higher Education – www.aracis.ro
9. **ITALY** – QUACING – Agenzia per la Certificazione di Qualita e l'Accreditamen to EUR-ACE dei Corsi di Studio in Ingegneria – www.quacing.it
10. **POLAND** – KAUT – Komisja Akredytacyjna Uczelni Technicznych – www.kaut.agh.edu.pl
11. **SWITZERLAND** – AAQ - Schweizerische Agentur fьr Akkreditierung und Qualitдtssicherung – www.aaq.ch
12. **SPAIN** – ANECA – National Agency for Quality Assessment and Accreditation of Spain – www.aneca.es (in conjunction with IIE – Instituto de la Ingenierнa de Espaсa – www.iies.es)
13. **FINLAND** – FINEEC – Korkeakoulujen arviointineuvosto KKA – http://karvi.fi/en/

European Network for Accreditation of Engineering Education

ENAEE

European Accreditation of Engineering Programmes

EUR-ACE®

AEER

Association for Engineering Education of Russia

is re-authorized

from 31 June 2015
to 31 December 2019

to award the EUR-ACE® Label to accredited
Bachelor and Master level engineering programmes

Brussels, 23 June 2015

ENGINEERING EDUCATION 19'2016

EUR-ACE label awards: Authorization Period

Status: 23 June 2015

Country	Agency	First Cycle	From	Until	Second Cycle	From	Until
DE	ASIIN	**X**	Nov 2008	**31 Dec 2019**	**X**	Nov 2008	**31 Dec 2019**
FR	CTI				**X**	Nov 2008	**31 Dec 2019**
IE	EI	**X**	Nov 2008	**31 Dec 2018**	**X Honors Bachelor**	Nov 2010	**31 Dec 2018**
					X Master SC	Sept 2012	**31 Dec 2018**
PT	OE	**X**	Sept 2013	**31 Dec 2018**	**X**	Jan 2009	**31 Dec 2018**
RU	AEER	**X**	Nov 2008	**31 Dec 2019**	**X**	Nov 2008	**31 Dec 2019**
TR	MÜDEK	**X**	Jan 2009	**31 Dec 2018**			
UK	EngC	**X**	Nov 2008	**31 Dec 2016**	**X**	Nov 2008	**31 Dec 2016**
RO	ARACIS	**X**	Sept 2012	**31 Dec 2017**			
IT	QUACING	**X**	Sept 2012	**31 Dec 2015**	**X**	Sept 2012	**31 Dec 2015**
PL	KAUT	**X**	Sept 2013	**31 Dec 2018**	**X**	Sept 2015	**31 Dec 2018**
ES	ANECA (w/IIE)	**X**	June 2014	**31 Dec 2018**	**X**	June 2014	**31 Dec 2018**
FI	FINEEC	**4Y Bachelor**	June 2014	**31 Dec 2018**			
CH	OAQ	**X**	June 2014	**31 Dec 2018**	**X**	June 2014	**31 Dec 2018**

ENGINEERING EDUCATION

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