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ENGINEERING EDUCATION AND REAL SECTOR OF ECONOMY: WAYS OF INTERACTION

Editorial board

Dear readers!

The shift of innovation waves dominating the economy predetermines the dynamics of scientific and technological progress in the real sector of economy. At the same time, real production shows significant delay in mass exploitation of newly developed technological solutions and approaches. One of the reasons for such delay is the inertia of society's thinking, which, overall, is determined by the level of its technological culture, technical perceptivity, and in particular by the level of engineering specialists' training, the quality of engineering education.

Thus, the pace of Russian economy's transition from the forth to the six wave of innovation, undoubtedly, depends on successful operation of engineering HEIs and state policy regarding development of higher engineering education.

Two main lines of action can be seen here.

Firstly, it is the increase of technical readiness of the wider population to perceive and exploit advanced technologies, high-tech products, which after all results in a higher level of technical literacy (competence) and technological culture of the society.

Secondly, it is the significant alteration of the study programs' context, teaching and learning methods and forms of engineering education organization. The latter one anticipates a significant improvement of the training quality of specialists with higher education for engineering professions, mobilization of scientific, educational and engineering communities' efforts towards training engineers with abundant competences needed for assuring technological progress.

Two communities, the scientific and educational one and the engineering one, are mentioned for a reason. One should not be expecting to see a significant improvement of the quality of modern engineers' training if applying the organization forms, means and methods, used in the framework of the forth wave of innovation and centrally planned economy. Attracting the potential of acting engineering staff and industrial capabilities for training future engineers' pool can be the core factor of significant improvement of the trained specialists' quality.

Clearly, positive results can be achieved only if there is an adequate counter-motion of the managerial, scientific and pedagogical HEI networks.

To solve the identified problems we need more than just the development of new educational programs with updated and constantly renewing, adaptive contents, advanced technologies and educational methods; we also seek for development and exploitation of new principles for organizing educational process allowing to grasp the opportunities of the real sector of economy.

All these will require not just the improvement of qualification of managerial, scientific and pedagogical staff of HEIs, but also the development and introduction of expansionary actions for Russian engineering staff.

The current issue of our journal is dedicated to the topic "Engineering Education and real sector of economy: ways of interaction"; authors present articles on their best practices of engineers' training that involve the potential and capabilities of real production.

We hope that the published materials and the expertise of our colleagues will be of use for our readers.

We also believe that they will serve as starting points for productive scientific discussions and exploration of new ways to improve the quality of engineers' training for the real sectors of Russian economy.

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

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UDC 330 + 378.4

Elite Engineers for Economy. Who is the Highly Demanded Specialist of Today and Tomorrow?

Tyumen State Oil and Gas University
V.V. Novoselov, V.M. Spasibov

One of the deterrents of the economy, nowadays, is the shortage of qualified staff and insufficient qualification of university graduates. While the sixth wave of innovation is actively spreading across foreign developed countries, Russia is stuck at the fifth wave with the level of science and education 15-20 years behind the world's development level. The attempt to jump on the last carriage of the leaving train is a remote possibility. We need to rush ahead. Today, to get leading positions Russia must master convergent technologies and multi-disciplinary approach in development of science and education. Issues of higher education institutions and challenges of training new-type specialists are analyzed in the article.

Key words: convergent technologies, interdisciplinary organization of science, research engineers, scientific schools, dual system, corporate department, learning paths, network university.

What kind of specialists will be required in our region by industries in five or ten years' perspective? «It would, of course, be nice to look further at a more distant perspective of, say, 20 years. Although we are all aware that life runs forward so fast and technologies change so rapidly that it is difficult to predict, what will be going on in 20 years, but the further we can make prognosis, the better. We should look ahead in order to clearly understand which industries can become the growth drivers for entire regions, such as Siberian, Ural, or Arctic regions, and pay precise attention to the areas that will or are already determining new waves of innovations»[1].

In the near and foreseeable future the economy of Russia will primarily depend on oil and gas industry and, above all, on the Fuel and Energy Complex of West Siberian region. What are the areas of its growth?

Idle talks of oil reserves in West Siberia dwindling away in 20 – 30 years are absurd. Residents of the large Tyumen region can be sure of a stable future of their children and grandchildren. There is enough work to do in West Siberia for couple other centuries. Texas is an example of a place, where after a hundred years of intense extraction of resources not a single field has been closed. Emerging improved technologies permit for endless oil extraction. Today, LUKOIL, PJSC, is going to open a new page in developing of West Siberia by establishing joint company together with French company "Total" in Kogalim. The company will be dealing with layers of Bazhenov group. This layer of geological material at the depth of approximately 2000 meters occupies territory of more than 1 million square kilometers. Resources located within the territory of Tyumen region, based on theoretical evaluation, are enormous – about 127 billion tones. Thus, the new project will require specialists of a new formation.

Extreme North is seen as a perspective territory for the oil and gas industry. Today we can observe a new stage in the development of West Siberia. A strategy of Arctic and Subarctic regions exploration is

b development. The launch of the world's largest Bovanenkovo gas field created a multiplicative effect – thousands of workplaces, development of marine and land transportation, extension of rolled steel and tubes production, opportunities for implementation of new infrastructure projects. Construction of a liquefied natural gas (LNG) plant and a seaport Sabetta have been started recently; the project «Northern latitudinal railway» is in progress; new deposit Kamennomysskoye Sea on the cape Parusnyi is also at the development stage [2].

Severe climate of the Arctic region, trickery of the ocean shelf and the need for preservation of nature in the frontier territories necessitate application of high-tech equipment, which absorbs feats of engineering for oil and gas extraction, construction of fully atomized underwater plants for preparation, compression and pumping of gas, providing localization of the complete closed cycle of extraction and purification under water. Humanity still does not possess a truly safe technology for oil and gas production operations for extreme climate conditions of the Arctic region. Thus, we face new challenges, new requirements for the competences of specialists.

A new socio-economic area is to be developed in the northwest of the Tyumen region with its breakthrough mega-project of the 21st century «Ural Industrial – Ural Polar». This project will provide 70 thousand of jobs in the Yamal-Nenets Autonomous District. For the economic reasons this project is currently not in progress. However, the treasures of the Polar Ural will soon be involved in the economic development of the country. Ural remains the reference edge of our country.

In the south of the Tyumen region, on the border of the Uvat, Tobolsk and Vagaysky Districts, a project of comprehensive development of 26 fields with hardly assessable deposits is on the stage of elaboration. According to the forecasts term we will be able to increase the production of hydrocarbons from 10 - 11 to 30 million tons in the midterm, having a lead over Bashkiria and Tatarstan. To think of that, it was only 15 years ago that the territory of West Siberia was considered unpromising in terms of oil reserves. World energy trends are changing dynamically with the introduction of new technologies for deposits development.

Largest, even by world standards, petrochemical complex in Tobolsk allowed our country to switch from importing positions to becoming an exporter of polypropylene. Antipinsky oil refinery near Tyumen is developing; it is expected to provide the population of the region with high-quality fuel.

Technologies of dissolved gas extraction in groundwater, whose reserves only in West Siberia are estimated at 800-900 trillion cubic meters, are waiting to be discovered. So do the diatomite reserves, with the number of 500 trillion tons. It is all building material, crystal and silicon, which is ready for application.

Undoubtedly, the infrastructures of timber complex will also progress. Total timber reserves in the Russian Federation are estimated at 82 billion cubic meters (quarter of the world's reserves). Set calculated annual logging area is about 576 million cubic meters, and only 23% out of it is used.

Tyumen region, so to say, is going through the second wave of industrialization with its project «3D industrialization» and new emerging industries. In 2013–2014 21 plants were built; «investment portfolio» contains more than 280 projects with an investment volume of 1.3 trillion rubles, which promotes creation of 33 thousand work places. The profile of industries is very diverse, including even such unusual ones for our region as steelmaking.

Analysis of the development projects defines two directions for organization of vocational education in the region: training of specialists for most popular professions of the dominant sectors of the economy and «small scale» training of specialists for small and medium enterprises.

The first direction is aimed at staff and technological support for global innovation projects. Their implementation will require breakthrough developments in Russian science and technology, and training of specialists, whose qualification meets the accepted international standards. At the same time, these specialists should be capable of working in difficult conditions of the North and permafrost zone. We emphasize that all these breakthrough developments have to be "national achievements», whereas today in the economy, which is the platform for innovations development in Russia, over 65% of oil and gas services are carried out by foreign experts. While in the USA and China only national companies are operating in this sector. What will happen if foreign companies leave our market tomorrow? It can be a threat for the national security.

As for the major oil and gas industry of the region the list of professions and specializations is more or less traditional. Most demanded specialties are: Geology, Exploration and Development of Mineral Resources; Automation and Control; Computer Science and Engineering; Chemical Technology and Biotechnology; Energy, Power Engineering and Electrical Engineering; Life Safety, Environmental Engineering and Environmental Protection. At the same time, new specialties are in need, especially now with the introduction of sanctions against Russia and threat of their expansion. These specialties include Mechanics and Robotics; High Tech and Economy of Innovations; Software Engineering and others. The government of the country contributes to this. It is already in 2015, according to the statement of Vladimir Putin on the last meeting of the Council for Science and Education, that Russian universities will be empowered to provide applicants with state-funded places for new and promising, demanded by the region specialties that do not have state accreditation (it currently takes 5–6 years to get it).

Why are we in need of specialists with unique competences? The existing educational standards are based on the current level of knowledge and technology. However, the attitudes are changing and the most stable thinking models are being destroyed. Demanded specialists of the new formation besides an impressive knowledge background should possess unique technologies, currently hardly developed. Let us have a look at our trump card – the «black gold» – oil. Deposits are discovered following the traditional theory of hydrocarbons bedding, when we are looking for a certain lake, hidden natural reservoir, «super barrel.» Geophysics does not provide us with sufficiently accurate data on the structure of the subsoil and the presence of oil and gas. As a result, oil and gas industry spends huge amounts of money drilling significantly more exploration wells than would be necessary, if the new technologies were used. This leads to unpromising consequences: only one out of 4 or 5 drilled structures contains productive oil and gas reservoirs.

When conducting exploration in permafrost conditions the result is even less perspective as only one out of 5 or 6 drilled exploratory wells is productive, while the cost of construction of one well is about 300 million rubles. As Vladimir Vysotsky used to say: «...we are digging in the money in the Earth».

To learn how to discover oil in the earth's crust it is essential to understand the nature of its origin. According to the original theory of Robert Bembel, the Professor of Tyumen State Oil and Gas University, Doctor of geological – mineralogical sciences, there is no «barrel». «Instead there are vertical channels – geosoliton tubes. Hydrogen goes along these tubes under strong pressure from the planet's core forming hydrocarbon deposits on its way up» [3]. There is a major trunk and numerous veins like in a tree. Getting straight to geosoliton will significantly reduce costs. Professor Bembel is convinced: the richest deposit of Ugra – Priobskoe – would have been discovered 20 years earlier than 1980th but for the geological dogmas. Processes altering the structure, scope and quality of the hydrocarbons are continuously occurring under the ground. 3D seismic combined with high-resolution volumetric seismic can be a possible way of solving this problem during exploration. Or should we already think of a 4D, where time is the fourth parameter?

What do we see as a promising area of technology development? Science and education in Russia are almost 15-20 years behind the process of global development. We are stuck at the level of the fifth wave of innovations. While the train was moving, we were standing. We focused on introduction of «advanced» imported technologies and training of specialists for operating this foreign equipment with the involvement of foreign professors («The West will help us!» It turned out the help was without letting Russians know the secrets of their technologies and their expertise.) Establishment of specialized centers and schools is a weak attempt to jump on the last carriage of the leaving train. It is senseless.

«World leading countries, including the United States, associate the development of the sixth wave of innovation with the development of convergent technologies – NBIC (N – nano, B – bio, I – info and C – cogno). This trend should become a strategic vector of our development, which will allow Russia to rush ahead as we have done previously with nuclear energy or space» [4]. Development of such technologies requires multidisciplinary approach, whilst historically, for many years, science (both Russian and international) was developing within a highly specialized track. For hundreds of years people have built highly specialized system of science and education. On the one hand, this system is unique, because the modern civilization is built upon this system. On the other hand, it turned out to be a deadlock. The country, which will call for formation of interdisciplinary science and drive forward to the creation of a new system, will be among the leaders of the XXI century.

There is no alternative. We are standing behind and need a leap. For converged sciences professionals should be trained in a different way. We need broadly educated people, who can understand different areas of science.

We are not talking about elimination of highly specialized training. But it should take place in parallel with the formation of supradisciplinary specialists. This is crucially important for the formation of a new wave of innovation. The structure of the educational organization is conservative. Development of a university in this context requires its right to form its own standards, curricula and programs.

Nowadays, the duration of engineers' training is typically longer than terms of the technology upgrade. Consequently, the university should forecast the quantitative and, more importantly, contextual need for engineering specialists, especially in response to the changed geo-economic situation. On this basis, state orders and requests for training of engineers should be formed.

Student's future field of expertise should define the methodology of training, the set of competences of the future university graduate. The volume of knowledge and information is huge, but the study period is only 4 years. «Now is the time for the system of technical education to allocate three main roots of training: «linear» engineers, design and process engineers, researcher engineers» [1]. It seems that we can provide training of engineers demanded by industry in each direction by changing the forms of organization and the content of training.

Today, the biggest lack industry is experiencing is the lack of «linear» engineers, in particular, of production line supervisors and production engineers. Mass training of such specialists should be based on specifically developed, practice-oriented higher education programs. These programs should combine basic natural science and engineering training with practical professional training. A well-known system of a synergy of industrial plants and higher technical educational institutions with some qualitative improvements can become an effective method for practice-oriented learning realization. During such training a student acquires necessary skills on operation of modern equipment and application of technology, which reduce the adaptation period of graduates after graduation. A key principle of linear engineers' activity should be: «Organize and exploit.» It means that they should organize working activity of staff and efficiently exploit modern equipment. Of course, this system should be developed to provide advanced training of linear engineers taking into account specific features of regional industry.

The second and perhaps the main type of engineers trained by technical universities today are the design engineers and production engineers. It is assumed that for this category of engineers the main form of training should be the Project-based Learning, which is based on multidisciplinary project work in the framework of the CDIO concept «Conceive, Design, Implement, Operate». For training this kind of engineers the traditional forms of education should be moved towards the forms aimed at promoting creative potential of students and teachers. For instance, more attention should be paid to teamwork for R&D implementation for industrial companies.

Finally, the research engineers and developers. The mission of such engineers is to create new competitive products, develop convergent technologies through integration of achievements and innovations in various fields. They are the so-called Special operations troops of engineers, who master world-class technologies such as nanotechnology, technologies of supercomputing engineering, advanced technologies of digital production. Research engineers shall solve unsolvable problems and provide innovative breakthroughs for high-tech industries. Such engineers – leading edge and mutually reinforcing – should not be the mass product. Training should be based on the principles of inter- and multidisciplinary approach built upon, first of all, deep fundamental education.

Creating a competitive engineer is time consuming and expensive. It is possible only if having proper facilities and an established and well-developed scientific and pedagogical school. And its formation takes many years. Perhaps, the most important factor is the mentality of the university, its atmosphere. They differ for various types of universites. Classical university develops a cult of science, pedagogical one – a cult of children, technical university is focused on practical efficiency. Here we are talking about different values. These are the values, developed by traditions, which form the university. And the university brand guarantees the quality of a specialist. It is like a jar of pickle brine, whatever cucumber you put in it, you know the final taste.

Tyumen State Oil and Gas University historically established for oil and gas development performs training of specialists for mass professions of the dominant sectors of economy in West Siberian region. University has several world famous science and pedagogical schools: geology and exploration (heads: correspondent members of RAS I.I. Nesterov, A.R. Kurchikov); cryology of Earth (full member of RAS V.P. Melnikov); drilling; development of oil and gas fields; oil and gas processing; hydrocarbons transfer; automation and information technology. A system of continuous education has been launched: college, undergraduate, graduate, and postgraduate education, PhD and Doctor of Science thesis councils, centers for professional development and retraining, which all together execute the concept of Life-long Learning. To be in step with the progress you cannot stick to the principle «one life - one diploma» as it rapidly becomes outdated.

Tyumen State Oil and Gas University works closely together with 189 partner companies. About 60% of the engineers occupying positions in Fuel and Energy Complex are graduates of the university. For instance, more than 1500 employees of "LUKOIL-West Siberia", LLC, are graduates of the Tyumen State Oil and Gas University.

University is recognized as the basis and supportive organization for training qualified specialists for largest oil and gas companies: ROSNEFT, OJSC;

GAZPROM, JSC; LUKOIL, PJSC; Surgutneftegas, OJSC; TRANSNEFT, JSC; NOVATEK, JSC; SIBUR, JSC. Among 150 thousand graduates of the university there are recognized leaders of this industry: Council chair of the Union of Oil & Gas Producers of Russia Y.K. Shafranik, CEOs of large companies: Surgutneftegas, OJSC – V.L. Bogdanov; Gazprom dobycha Yamburg, LLC – O.P. Andreev; Gazprom dobycha Urengoi, LLC – S.V. Mazanov; Gazprom dobycha Noyabrsk, LLC – K.V. Stepovoi; LUKOIL – PERM, LLC – A.V. Leifrid; LUKOIL – KOMI, LLC – P.V. Oboronkov; Garpromtransgas Yugorsk, LLC – P.M. Sozonov, and others.

«Today, during the process of economy diversification in the region ... we are placing stakes on Oil and Gas University in training of engineers. We see, the University successfully copes with this problem»- said V.V. Yakushev, the Governor of Tyumen region.

Being aware of the current issues and forecasting directions of economic development of the region the University puts emphasis on training «linear» engineers by launching programs of applied Bachelor degree (20 students in 2012, 760 students in 2014). Dual system, where education takes place in two institutions, is applied in order to increase professional competencies of students. These two institutions are university and enterprise. This task is not easy as there are legal, financial, communicative and organizational issues emerging. Solution to all these problems can be the establishment of industrial departments on the basis of leading enterprises of the industry.

We find the establishment of corporate departments at large enterprises mutually beneficial and interesting. Companies invest their money and resources and attract their leading experts to the educational process not as charity, but for training engineers in demand for themselves. Companies know that their future depends entirely on the level of their staff qualification. Moreover, all graduates of such departments have an ensured position in the enterprise.

As for the training of research engineers and developers, our experience shows, that it is almost impossible to perform their training within Bachelor programs. Next level of education – Master programs – usually provides continuing education at universities in the same or related fields. However, it is the Master level of education, which is able to train research engineers by integrating a variety of Master programs. Master programs can and should deal with advanced training of engineers for development and application of advanced science-based technologies. Individual learning paths are specially integrated for this purpose. They provide additional training within a Master program of a different specialty including utilization of electronic and distance technologies.

The second direction of engineers' training is the «small-scale» training for small and medium enterprises. Currently, due to the multi-vector diversification of the region's economy, the demand for qualified staff by new enterprises is not fully satisfied. That is why the establishment of a modern Polytechnic College on basis of the Tyumen State University seems very reasonable. It is expected to meet the needs of the region in terms of engineering and technical personnel, and the vacant niche will be occupied.

Another option for comprehensive training of engineers of all types, considering the specifics of the regional industry, is the formation of network education system. It will bring together the potential and competences of universities of different profiles under the aegis of the Tyumen State Oil and Gas University with involvement of research institutions and leading industrial enterprises distributed among different regions of the country. Figuratevely, we would call such form a "structured Network University"; it would provide solutions for top-priority issues, assure the development of industry and training of specialists ready to perform professional activity without additional adaptation period.

Each of the above-mentioned problems and solutions is a subject for development and specification. Tyumen State Oil and Gas University understands the problems today and is already implementing a scope of measures to provide the region with new generation of engineers. Elaboration of the whole Tyumen region's economic development strategy for professional education, which binds together the strategy to the south, the Khanty-Mansiisk Autonomous District, and the Yamal-Nenets Autonomous District, is necessary for the breakthrough. It is essential to decide: whom to train, what is the number of these people and who will be doing it. The challenges of the XXI century urgently require it.

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Process Approach Application to Engineering and Education

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"You can't solve a problem unless you first admit you have one"
Harvey McKay

The article is devoted to the implementation of process approach to any kind of professional activity as declared by the ISO 9000 Norm. The importance of evaluating process features: its productiveness, efficiency and adaptiveness, is emphasized. The article underlines practicality of the process approach introduction to educational activities for training competent engineers, who will base their own professional performance on this approach.

Key words: process approach, productiveness, efficiency and adaptiveness of processes, product quality, quality standards.

Any type of action involves certain work functions: steelmaker melts steel in an electric arc furnace, accountant calculates employees' wages, professor teaches students to solve differential equations, etc. How can we envisage realization of all these functions as a whole? Most likely, it should be envisaged as realization of various interconnected actions that are conducted consecutively or in parallel. Today these various actions are generally recognized as processes. One of the founders of modern quality management, E. Deming, stated "Any action can be seen as a technological process and, therefore, can be improved".

Modern management of organizations is based on quality management systems. Ideology of such systems focuses on 8 principles of quality management. The central (ground-breaking) principle is the process approach: **expected outcomes can be achieved more efficiently, if actions and corresponding resources are managed as processes** [1, p. 2-3].

What is meant by application of the process approach? Let's try to understand it by looking at the examples of educational and production activities. Production activity here is the foundry production, which provides main rough materials for automobile, aircraft, machine-tool and tractor production.

Foundry production requires a multifunction technological process. Batch preparation, alloy smelting, foundry sand and core sand mixtures' preparation, casting form and core molding, die casting, cast processing – all are parts of foundry final goods' production lifecycle. When using other methods for cast production: die or ceramic mold casting or consumable pattern casting, such multifunction remains. This brings up a question: "How to achieve required quality of a product in the context of such multifunction?" Overall technological process is divided into sub-processes. Organizational structure of production process (production units, departments, divisions, services) is built upon these sub-processes. Each structural division is responsible for its own sub-process. This is a typical functional organizational structure. What are the draw-backs of such structure?

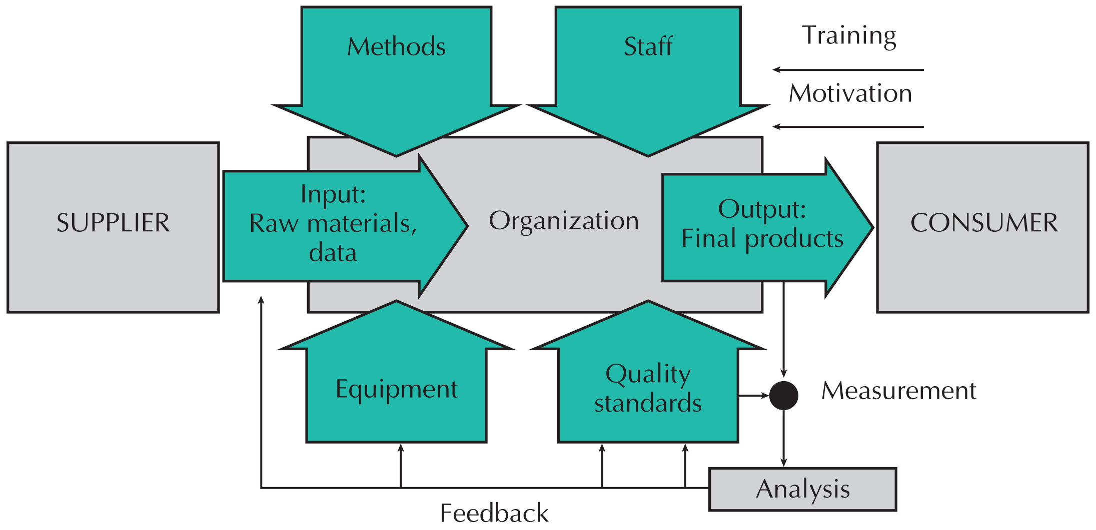
Let us provide a vivid example from the

personal experience. One of the authors happened to work at Leningrad Pipe-Rolling Plant after graduating university, first as a master, later as a head of smelting department. The main products of the plant were large-diameter cast-iron pipes for water pipe-line construction and underground tubing. Every now and then representatives of all departments, involved in production processes, joined at pipe and foundry units to review items rejected by the Quality Control Department. Each representative had a preset aim in mind: not to let QCD confirm that the damages occurred with the fault of his department, since it would have led to bonus shortcut for all the department staff. This was a typical functional approach (and we knew no other), when no one strived to identify real causes of faulty goods production and take further remedial of preventive actions.

But if all the departments involved in tubing (pipe) production worked on a single process (while remaining to be separate organizational structures) and had a common goal to achieve required quality of the products, then during the inspection of faulty goods we all would have looked for the cause of their appearance. And the occurring consequences of faulty production would have been split between all the participants of production process regardless of the "guilty ones". And this is the process approach. We are sure that the quality of produced goods would have been bettered constantly.

Now, let us turn to the educational process. Even within a single semester students are taught by different professors, each of whom follows a specific curriculum of the study course. But can we be sure that the contents of study courses correspond to one another; that all professors commit to the final outcome – graduates' mastership of competences needed for the professional performance? As a matter of fact, unfortunately, the majority of HEIs does not have that. Many professors (especially at the first years of study) are not extensively familiar with future profession

Fig. 1. Framework (model) of process performance



of graduates, do not know (and at times do not want to know) how the knowledge and skills, acquired by students while studying their course, should be applied later. This is a typical functional approach.

But what is the process approach? First, let us look into the process itself. In order to do so we need to address the ISO 9000–2011 Norm (Fundamentals and Vocabulary), concerning operations of Quality Management Systems of any organization [1, p. 9]. This norm defines process as a **"set of interrelated or interacting activities which transform inputs into outputs".**

Process can be presented in graphic form as shown on the Fig. 1, where Supplier – Organization – Consumer are all joined in one chain. This is how all the processes are executed: production process, service, data transfer, training and even nurturing.

We have required stock (raw materials) and data as inputs here, containing requirements towards final product, i.e. its quality requirements.

Technological process is performed using the provided equipment; it is conducted according to the developed technologies (methods); it engages the staff needed; it is organized and controlled in line with the internal quality standards.

A complex multifunction process of an organization, for instance, the mentioned process of foundry die production, is divided into sub-processes and operations (Fig. 2). A process results in transformation of input stock (raw materials) into output product. Acquired quality of final goods is the basis for process evaluation. Application of this principle allows for a clear definition of internal "suppliers" and "consumers", determination of their interaction areas, vesting power in them according to the level of taken responsibility. IDEF0 (ICAM Definition for Function Modeling) is widely used for visualization of process modeling.

Fig. 2. Multifunction process diagram

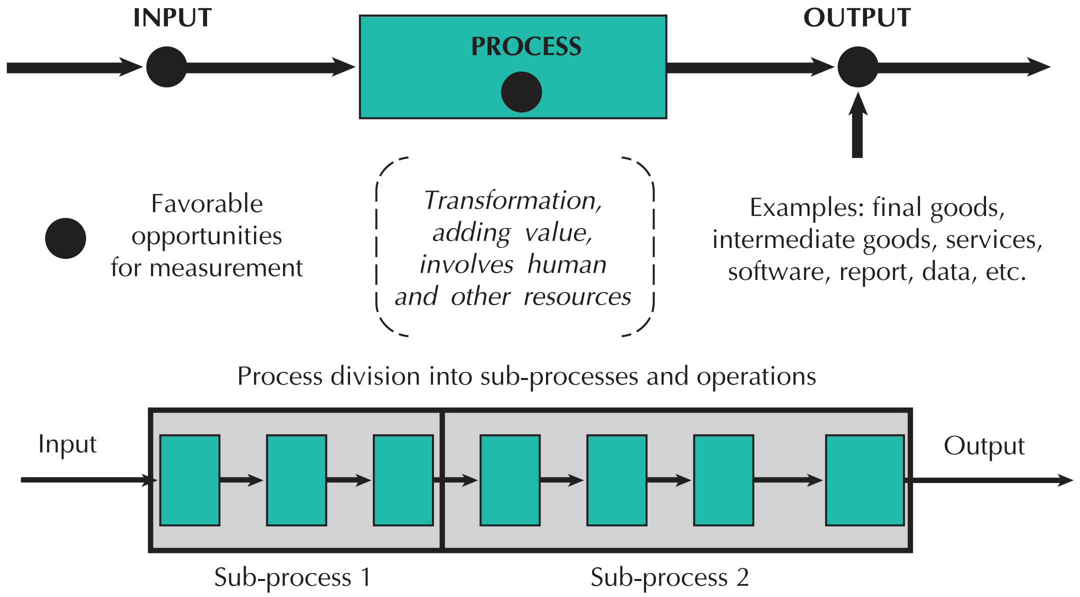
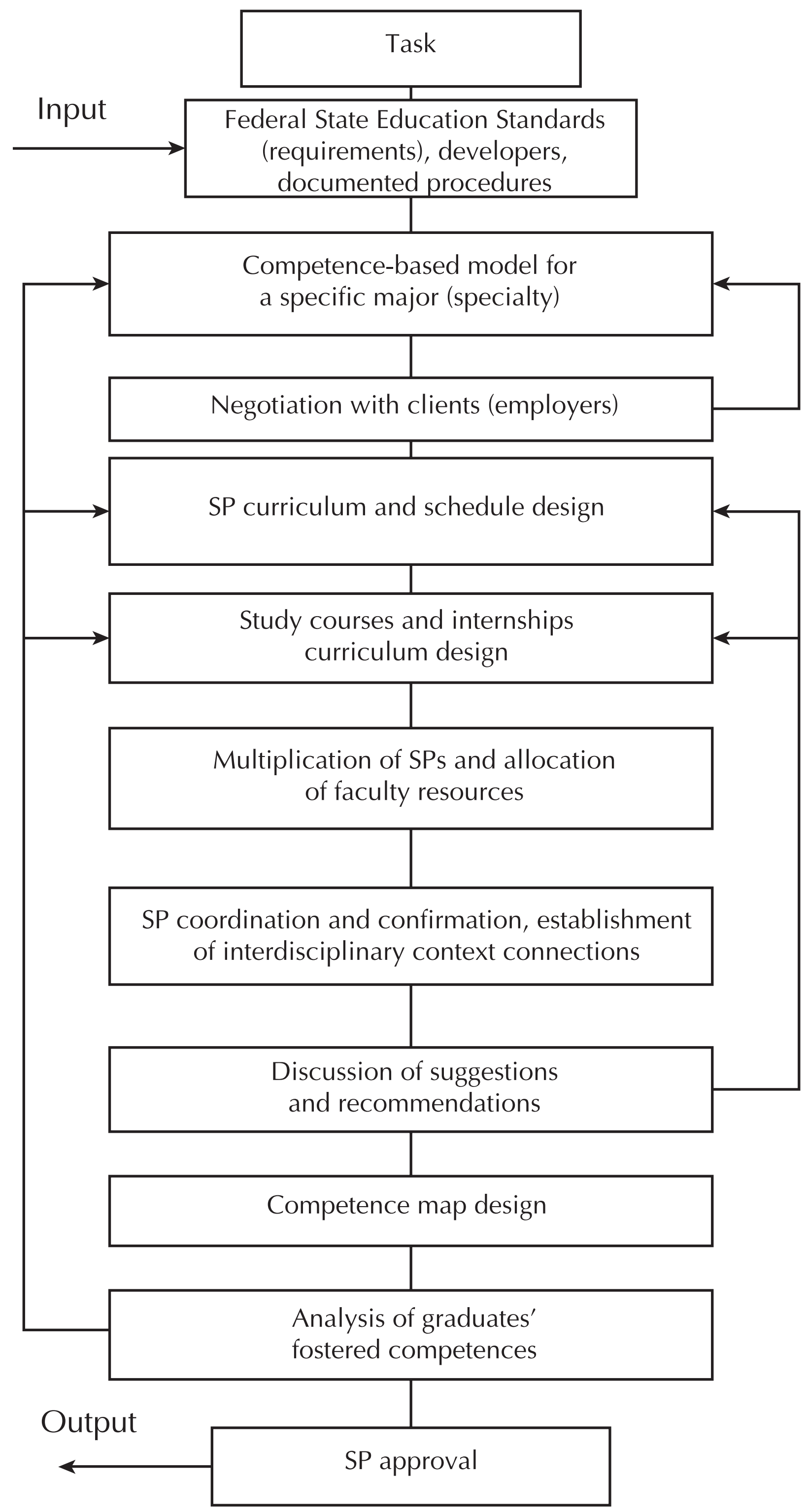


Fig. 3. Flow block diagram of SP design



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It is a vivid "language" for understanding the essence of a process [2, p. 160-166]. Presenting a process in the form of a flow block diagram permits to "see" it vividly with all the possible intersections [3, p. 5-7].

This visualization tool is convenient for any process participants' training in the form of business games. Operational division of a process allows for determination of control points during the process performance.

It is worth mentioning that final outcomes hinge on the level of staff qualification and motivation. Process approach in QMS is considered to be the fundamental "pole" of the quality ideology that has to be encompassed by all personnel of an organization.

An example of a flow block diagram application for development of a study programs (SP) for engineers' training will be introduced further (Fig. 3). But first of all, the content of an SP will be agreed as follows:

- Competence-based model for training graduates of a particular major (specialty);
- Curriculum in Study Program;
- Curriculums in study courses;
- Curriculums in internships;
- Study schedule;
- Guidelines, recommendations on organization of a study process common for all majors or for a particular major.

When creating a competence-based educational model, besides competences specified by the Federal State Education Standards, HEI includes requirements of employers and the HEI itself, inter alia the requirements of professional standards on corresponding majors. It is reasonable to mark a specific block in an engineering training model – a block of tooling (instrumental) competences, i.e. skills that allow using tools and equipment, conducting measurements and presenting results, applying IT, etc.

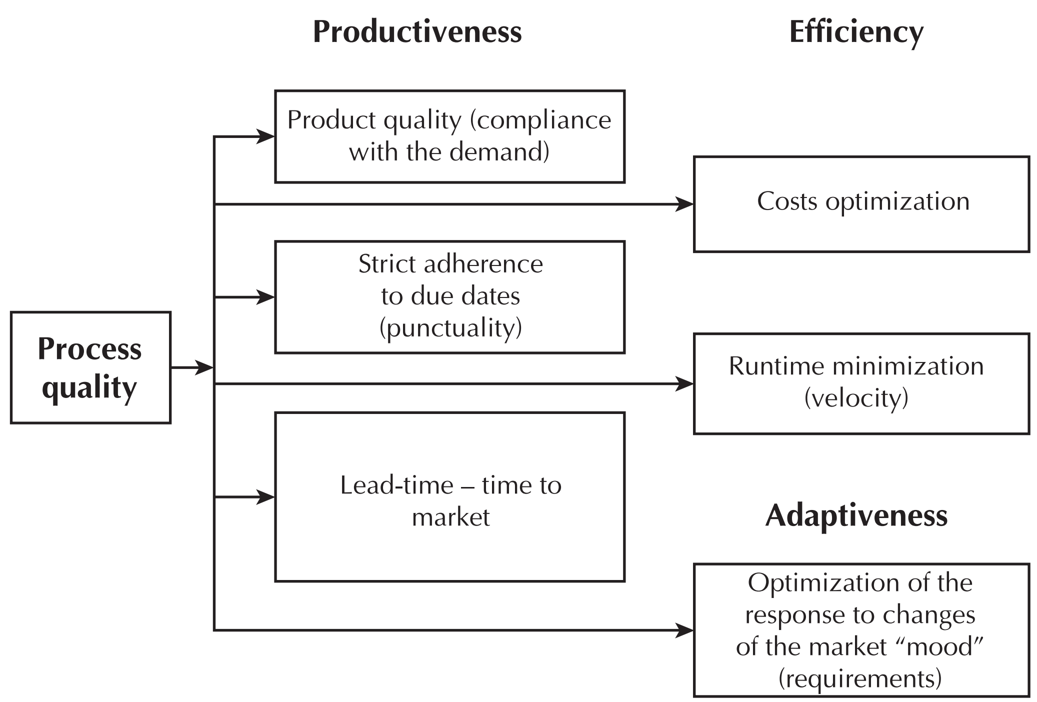
Thus, a flow block diagram presents the whole process of input-output transformation as a finalized SP. In fact, SP design process is conducted in line with a set procedure that documents performers of each operation and due dates, provides necessary document forms and procedures for coordination and confirmation. Teaching materials are developed for conducting educational process on each study course. They normally include:

- Course work programs;
- Synopsis of lectures;
- Supportive notes (student's work-book);
- Presentation;
- Classwork scenario;
- Lab case-studies;
- Workshop textbooks;
- Guidelines for studying the discipline;
- Diagnostic tests;
- Questions for assessing knowledge, skills and fostered competences.

Each professor develops teaching materials for his/her own study course. Future engineer's study curriculum includes more than 40 disciplines. Therefore, there will be 40 disciplinary sub-processes of an integrated curriculum for specialist's training. The scope of process approach application to educational activities is disclosed below.

Any process is assessed-based on three features, as shown on Fig. 4. **Process productiveness** defines achievement of set goals; most commonly those are the requirements of a client, determined by an agreement; and for the education those are the requirements of the Federal State Education Standards. It is definitely a key indicator of the performed process. **Process efficiency** concerns rational utilization of planned resources (material, financial, information, human) for the achievement of a set goal. **Process adaptiveness (flexibility)** plays an important role in the market economy relations, since there is a constant process of product and production improvement in the context of high competitiveness. In education it is also

Fig. 4. Features of any technological process



necessary at times to introduce changes that should correspond to the innovations in educational contents and teaching methods.

Unfortunately, many national articles and speeches assess processes (and many other things) using a widespread and familiar term “efficiency” without specifying the distinction between assessing achievement of goals and used resources. Such approach complicates determination of possible mismatches that occur during process performance, as well as causes troubles in taking necessary remedial of preventive actions.

Most Russian enterprises and organizations exploit functional management, when managers do not have the full authority to make decisions on their level of management.

These organizations remind an armful of sheaf, where each sheaf is a functional division. This is exactly the way an educational process can be pictured; where each discipline and its provider are the sheaf that is separate from any other discipline.

And the main issue of management, especially quality management, is to transform these separate secluded structures into an integrated whole in the context of overall technological process performance. In the functional approach each unit is an entity that runs its own activities, but in the process approach units are used only for the convenience of planning and resource accounting [4, p. 218-220].

When transiting to the process approach it is necessary to allocate the process “owner”, who will be endowed the required rights. A process “team” is created regardless of staff’s official positions. Process owner should manage the chain of product lifecycle processes from market analyses to product’s realization to the consumer. Interaction of processes may lead to the development of a multifunction process structure in an organization, which would permit to eliminate existing functional barriers of the management structure.

One of the authors, an expert of Russian Government Quality Award, had a chance to see the productiveness of the process approach (they called it project approach) used by metallurgical company “Severstal” when working on the construction of a complex for automotive sheets galvanization. The project team included heads of several production units and technical services, which, at the same time, were not released from their continuing duties. The person in charge (process owner), who joined all the participants for project’s execution, was a young and active economist, who had graduated the National University of Science and Technology MISiS only 5 years prior to the time. A clear evidence of the project’s success is the “Severgal” operating complex for HDG steel production.

In education the process approach is used, first of all, for making logical connections between the content of study disciplines. Each professor marks which blocks (study units) of preceding or parallel disciplines he/she uses in his/her course [5, p. 86-93]. Tab. 1 provides an example of finding connections between disciplines of a curriculum.

The developed matrixes will “show” application of knowledge and skills of disciplines from the whole period of study. Thus, tab. 2 provides an example of implementation of “Calculus” contents to other disciplines of a certain major’s curriculum. A sum of all references on each study course (horizontal bars) indicates application of specific Math topics in a particular discipline. Whereas, a sum of references in columns (vertical bars) indicates application of Math contents in various disciplines, i.e. its significance.

In such case each professor knows, what his/her colleagues are expecting of him/her. Everyone is tied in a single process of students’ training.

The result is the basis for managing mathematical, physical, chemical and other cycles of study disciplines of a major

Table 1. Matrix of interdisciplinary connections of study disciplines

Study units (blocks) of a preceding (parallel) discipline	Study units (blocks) of the analyzed discipline						Sum of ferences
	1	2	3	4	5	....	
1	x			x			
2			x				
3		x		x			
4	x				x		
5		x			x		
....							

Table 2. Consolidated matrix of discipline's content application

Subsequent (parallel) disciplines of curriculum	Study units (blocks) of preceding discipline (Calculus)						Sum of references
	1	2	3	4	5	....	
Physics	x		x		x		
Applied Mechanics			x		x		
Materials Science		x					
Physical Chemistry			x		x		
Thermal Physics		x			x		
Organization of Experiment			x				
Sum of references							

(specialty), by controlling the volume of fundamental knowledge application and reinforcement in other study courses. All these is necessary for assuring the quality of future graduates' training (the quality of education).

Planned curriculum of each discipline can be presented in general terms as a process map (Tab. 3).

A real process map would indicate names of the faculty involved, names of disciplines, list of fostered competences, guidance materials, performance dates. It creates a vivid system of actions that can be easily controlled, and paves the way to strive for the set goal.

When involved in the study process, learners should be bound up in it; they should feel all the operations of the process, its aims and outcomes. This will lead to the improvement education quality and cultivate process approach ideology in future specialist's mind.

Process approach together with team work is the life style of the cutting-edge organizations of the XXI century. It is the phenomenon of process thinking, i.e. such view of life that transforms the whole visible world into processes [6, p. 169-171].

Famous Japanese expert on quality, Kaoru Ishikawa, noted: "The ideal state of quality control occurs when inspection is no longer necessary".

QMS certification of an organization, first of all, evaluates the ability of its processes to guarantee required quality of the produced goods or services. Assessment of the level of management of technological and operation processes is the basic criteria for national quality contests, including the

Table 3. Terms as a process map

Discipline ___________________________

Process Input	Students with knowledge and skills, acquired while studying preceding or parallel disciplines
Process Output	Students with acquired knowledge and skills on this discipline (fostered disciplinary competences according to the course work program)
Process Suppliers	Professors of preceding or parallel disciplines
Process Consumers	Students, professors of subsequent of parallel disciplines, department administration, dean's office
Process Owner	Professor of this discipline
Process Aim	Fostering students' knowledge, skills, attitudes (fostering competences, including soft skills), students' nurturing (their "growth")
Administrative Actions	Faculty requirements (guidelines), orders of head of the department, dean, methodic council decisions
Resources	Professor's competency, guidance materials, lecture halls and labs, information support, educational environment
Assessment Criteria for Process Productiveness	Level of acquired knowledge, skills, attitudes of students (competence assessment); time for discipline learning
Methods and Means for Process Monitoring	Diagnostic and control activities, homework assignments, individual consultations

Russian Government Award instituted in 1996.

High competitiveness of many Russian and foreign organizations using process approach as a basis of their performance proved that implementation of the process approach is highly practical and beneficial.

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Engineering Education Development Paths for Innovation-Based Regional Economy

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The article justifies the importance of engineering education development for the innovation-based market economy both on regional scale and for the economic system as a whole. A set of actions for formation of a holistic engineering education environment in regions is systemized, encompassing the practices of Volgograd State Technical University (VSTU).

Key words: universities, engineering education, interaction quality, competency-based approach, development trends, economics.

Besides the phase-out of imports and retrenchment policy (in the face of external sanctions enforcement), the optimization of structure of state budget revenue sources (decrease of the income fraction of oil and gas export), and other, modern development trends of the Russian economy also intend commitment to development and commercialization of innovations as a result of R&D stimulation.

It goes without saying that from the position of national security and particularly economic security of the country, the key role is played by "engineering" (i.e. technical and technological) innovations that are expected to be developed by graduates of technical universities. Therewith, in this particular case we are speaking not only about future professionals of the military-industrial complex, but about other important societal spheres that involve theoretical and applied engineering knowledge, skills and attitudes. Competence-based educational concept is put into practice for successful acquisition of such knowledge, skills and attitudes.

Thus, for instance, the framework of national and economic security of Russia includes not only the issues of developing advanced types of various armaments, but also the issues of industry, production, quality assurance and availability of different types of food supplies and other fast moving consumer goods, quality and availability of medical and educational services, peacekeeping issues and many others. Nowadays, it is hard to imagine these and other societal spheres without scientific, technical and technological inventions, which, in their turn, arise from engineering activity and directly depend on the quality of engineers' mastership of soft and professional competences.

The importance of improving quality of engineering education for the economy of a country and assurance of its economic security, competitiveness, and focus on innovation development has been brought up repeatedly by modern practitioners and theoreticians of all the technical, financial, economic and socio-managerial scientific areas; by governmental officials from different branches and tiers of authority; as well as by representatives of various relevant associations and unions:

For instance, when bringing to light the practices of industrialized and economically developed countries, Pirumov A.R. argues in detail that "engineering is the basis of innovative economy". In leading European countries training of young highly qualified professionals for high-tech industries is set as a key objective for the nearest future…" [1].

Akatiev V.A. and Volkova L.V. state that "nowadays, in the context of sanctions concerning the embargo on high-tech equipment imports to Russia, there came an understanding that economic independence of Russia is tightly bound with a need to improve level of engineering education and technological reformations in Russia" [2].

Representatives of the Association for Engineering Education of Russia (abb. AEER), when specifying its mission for the forum of "New talents for Military-industrial Complex" program (2015), relied on thesis that "engineering education belongs to the nationwide strategic interests of the Russian Federation, and in the context of country's shift towards Sustainable Development engineers become key figures of the socio-economic sphere of the society" [3].

When speaking of the highest level of acknowledging the importance of engineering education for modern economy of Russia, it is worth mentioning the Meeting of the Presidential Council for Science and Education that took place on June 23, 2014 in Kremlin. It was then that Vladimir Putin, who chaired the Council, emphasized that in modern society "…the leaders of the global development (incl. economic development – authors note) are those countries that are able to create breakthrough technologies and form their own powerful industrial basis. Quality of engineering specialists becomes one of the key competitive factors of a state and, what is of utmost importance, becomes the basis for its technological, economic independence" [4].

The keynote idea of this Meeting was to find ways and methods to create and develop in the country such system of engineers' training that would to a big extent "…respond to the modern challenges, needs of economy and society, foster solutions of problems confronting today's economy, i.e. increasing competitiveness, technological re-equipment of industry, pivotal rise in labor efficiency…" [4].

Correspondingly, Rudskoi A.I., rector of Peter the Great Saint-Petersburg Polytechnic University, drew attention to the fact that "a need for improvement of engineering education is determined by the challenge of assuring global competitiveness of domestic products, and only then by the need for a quick phase-out of foreign products…" [4].

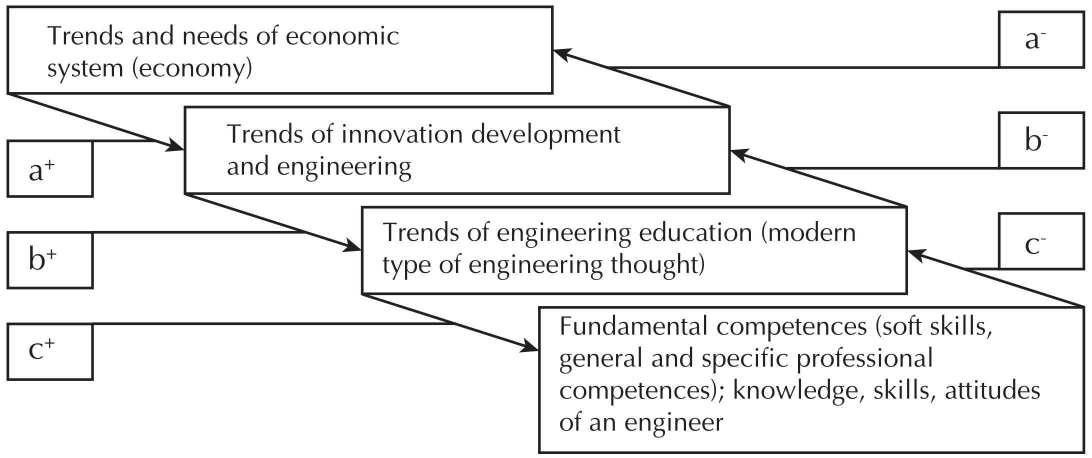
Thus, assurance and improvement of quality of engineers' training on a country scale ensures progressive development of its economy. Relatedly, as seen from the previous statements, it is impossible to assert univocally that this relation only has a one-side cause-effect root. These are not only the achievements of engineering thought, modern developments and intellectual 'products' of science and technology, engineering products that form the innovative economic environment. It is the economy that has to determine and stimulate the development of innovative environment, engineering education, by specifying "demand" for engineers and by creating conditions, prerequisites and incentives for development of engineering; it is the economy that has to be the driver of engineering education. In other words, relation between development of national economy and development of engineering education should be comprehensive, mutual, interconditional and reinforcing. Such cooperation is a close circuit, cyclic and synergetic.

Based on this, the conceptual model for determination of development paths of modern engineering education can be graphically described as follows on the fig. 1.

Besides objective factors, this argument can be supported by an opinion stating that a model of modern-type engineering thought (predetermining engineering), developed within the process of continuous education of future engineers and competence approach to educational process, has to be dynamic and adjustable due to the dynamics and specific needs, conditions of current economic activity.

As noticed by Lysak V.I., Gonik I.L., Fetisov A.V., Yurova O.V., Tekin A.V., "Due to an active and dynamic development

Fig. 1. Model for determining development paths in modern education to create innovative-driven regional economy



of modern technologies, commitment to innovation, acceleration and compression of production cycles, increase of scientific and data capacity of final products, amplification of local and international cooperation connections, a basis for modern-type engineering thought (in fact, modern engineer) is a dynamic, rather than static, economy encompassing a variety of trends and paths for further progressive growth" [5, p. 217].

As seen on fig. 1, the "a", "b" and "c" codes with upper index "+" in the framework of this model mark the quality of interfactor cooperation in an influencing direction "economic trends predetermine set of competences of modern engineers" on corresponding phases (between different stages of engineering education development paths with due regard for formation of innovation-driven economy). Correspondingly, the "a", "b" and "c" codes with upper index "-" determine the quality of cooperation in the context of interfactor connection chain, whose direction can be described as "Engineers' competences, knowledge, skills and attitudes form innovation-driven economic environment" on corresponding phases within preset scale and limited time period.

Comparing with cyclic model and evident synergy effect of engineering education quality improvement as a result of assuring cyclic sustainable cooperation of model factors, it can be argued that:

$$a^+ + b^+ + c^+ + a^- + b^- + c^- < Va^+a^- + Vb^+b^- + Vc^+c^-$$

Therefore, the following is fair:

$$SE = (Va^+a^- + Vb^+b^- + Vc^+c^-) - (a^+ + b^+ + c^+ + a^- + b^- + c^-),$$

where SE – synergy effect of engineering education quality improvement as a result of assuring cyclic sustainable cooperation of model factors determining development paths of modern engineering education with due regard for formation of innovation-driven economy;

Va^+a^- – quality of cyclic cooperation on stage "Trends and needs of economic system" determines "Trends of innovation development and modern engineering" and vice versa;

Vb^+b^- – quality of cyclic cooperation on stage "Trends of innovation development and modern engineering" determines "Trends of engineering education (evolving type of engineering thought)" and vice versa;

Vc^+c^- – quality of cyclic cooperation on stage "Trends of engineering education (evolving type of engineering thought)" determines

"Fundamental competences, knowledge, skills, attitudes of a modern engineer" and vice versa.

At this, quality parameters can differ (can be expressed through various criteria and indicators). It is important to assure uniformity and single direction of such criteria and indicators (they should define cooperation in equal variables, either positively or negatively). The higher the synergy effect of "positive" criteria and indicators, the higher the efficiency of engineering and the quality of provided engineering education for formation of innovation-driven regional economy, the higher the level and quality of fostered competences, and the competitiveness of knowledge, skills and attitudes of a particular engineer.

Similar effect can be seen in the opposite direction of interconnection within the proposed model.

Together with this, such cooperation of factors may have problems; some of them can be expressed as a system of specific restrictions typical not only for each phase of interconnection of the shown stages, but for the whole model as well (Tab. 1)

Based on the materials from Tab. 1, it should be noted that, for instance, macroeconomic factors work both for a whole system and for a particular phase of cooperation quality assurance between stages "Trends and needs of economic system" and "Trends of innovation development and modern engineering", since their negative influence (that lowers the quality of interconnection) shows up in a whole system and, most of all, on a particular stage. It is hard to control such factors even on a national level. They should be taken into account when making decisions on quality assurance of "a^+a^-" factors' interconnection.

Microeconomic factors can be partially compensated through certain economic and other efforts on regional scale; however, not in full.

Regional factors that can be influenced significantly are the most interesting ones in the view of action plan determination for increasing the quality of engineers' education process with due regard for formation of innovation-driven regional economy. It is the compensation of such negative factors restraining engineering education in regions that should be emphasized by all interested parties.

Aiming to minimize and partially compensate negative influence from restrictions typical for the "c^+c^-" interconnection, and based on practices of Volga State Technical University (VSTU), authors propose introduction of the following regional-scale actions on management of technical HEIs, organization of research and educational activities of engineers within educational process, assurance of cross-university cooperation with an aim to develop comprehensive engineering education environment in regions:

1. To develop together with leading technical universities (based on premises of one of them) regional monitoring centers on independent quality assessment of engineering education (anonymous surveys for all key interested parties – enrollees, students, graduates, employers, parents, academic community, professional organizations, etc.). Results of such monitoring and assessment can be a basis for development of employer-sponsored engineering study programs, can be used for conducting self-assessment and for evaluating efficiency, quality of education and, partially, for monitoring of HEIs' efficiency. Also, such independent assessment can become the basis for development of criteria system for creation of new regional and national ratings and rankings of technical HEIs.

It is especially important to use joint advanced developments in assessment and assurance of engineering study programs in real-time mode, when conducting such monitoring. Developments and results of international projects can be used. For instance, the ones of the Tempus EQUASP project ("On-line Quality Assurance of Study Programmes") that joins 12 Russian partners (including VSTU) and 6 international partners [6], or other similar projects.

Table 1. Basic restrictions influencing the quality of modern engineering education with due regard for formation of innovation-driven regional economy.

Phase of interconnection formation	Criteria decrease of interfactor connection quality
"a^+a^-"	Macroeconomic factors. Possible influence on regional level – minimal. Include: - sanctions pressure; - global market, economic, political restrictions; - downsides of market development model for global and national economies, etc.
"b^+b^-"	Microeconomic factors. Possible influence on regional level – midlevel. Include: - limited access to advanced technologies, technical developments; - obsolescence (mainly moral and ecological) of production facilities, loss of engineering knowledge' and skills' topicality; - limited access to investments, assets, etc.
"c^+c^-"	Regional factors. Possible influence on regional level – high. Include: - incompliance of engineering study programs with real demands of employers and regional economy; - lack of free access to best practices on regional scale; - low prestige of engineers, insufficient systems for regional support of talented youth and stimulation (popularization) of engineering, etc.

Software developed and piloted within the identified project, as well as the pilot monitoring of future engineers' quality of education, after all on the final stage of the project will transform into a comprehensive system for monitoring of study programs' quality in partner universities including VSTU (with due regard to monitoring and independent evaluation of quality of education by all interested parties). These materials (questionnaires, software) can be the basis for comprehensive regional quality and efficiency monitoring of study programs, and not just the technical ones.

2. Aiming to develop in regions a competitive education environment for engineers, it is possible to create (based on premises of a technical HEI) regional or international platform for cross-university best practices' exchange, in particular: innovative teaching methods for engineers, complex of means for learning outcomes' evaluation, best practices of technical HEIs' management, etc. Concerning the need to assure commitment to innovations of national and regional economies, cross-university cooperation in young researchers' and students' engineering innovations is also desired.

3. Organization of comprehensive and systematic work with talented

children (including basic and vocational professional education) and creation of specific conditions for stimulation of their training at regional technical universities aiming to preserve and develop human engineering potential for prioritized sectors of regional economy.

4. Organization of cross-university study courses (also delivered distantly) and internships is essential for development of academic mobility, exploitation of resource potential, development of scientific schools and regional scientific best practices' dissemination. It is also purposeful and essential to organize cross-university management of research and engineering work and projects for Master and PhD levels.

5. It is purposeful to jointly develop comprehensive interdisciplinary cooperation in order to fully foster all the competences relevant to a certain engineering specialty, as well as to foster allied competences, permitting to work successfully in different professional areas (transprofessional engineering education).

6. Due to increasing demands of employers and economy towards engineering graduates, and at the same time taking into account the need to comply with modern requirements towards engineering study programs in terms of formation of students' portfolio, when designing such programs it is important to: develop integrated rules for recognition of all types of prior education that has provided an official diploma, assure possibility to recognize acquired credits and all achievements of a student when designing his university learning path. Consequently, these actions may lead to a simpler implementation and popularization of the continuous education concept.

7. Aiming to improve the quality of education and competitiveness of regional HEIs within the national educational community, it is essential to develop a comprehensive regional program on competency assessment of technical universities' staff. Such programs should encompass not only the requirements for achievement of a certain level of faculty qualification set in line with the professional standards, but also the requirement for further personal and professional development (a list of achievements). Besides, such programs should envisage a certain level of qualification of the support staff and criteria for affirmation of this level (certification, competency assessment). In this case, the program should also include socio-economic disciplines (modules in the context of assuring high competitiveness of regional engineering education and developing regional economy on innovative "engineering" basis).

8. Aiming to preserve and develop human resource and engineering potential of HEI faculty in regions, to overcome a lack of regional human resources, it is necessary to develop (together with technical universities, employers, representatives of regional government) joint regional programs for formation and exploitation of human resource pool.

9. In the framework of technical study programs, it is important to develop a system of tests and competency assessment not just for the curriculum courses, but also the one allowing to evaluate all other (non-professional) competences that are interesting for the employers (a system of communication skills, personal attitudes, application of information and communication technologies, systems thinking, teamwork skills, etc.)

10. Form, on a regional level, an integrated approach to determination of engineers' basic competences (taking into account the opinions of all interested parties); it is essential to provide access to determination of engineers' competences on federal level assuring an opportunity to differentiate the set of competences according to the specifics of regional economy.

Undoubtedly, this set of proposed actions is not fulfilling and can vary according to the core economy focus and innovation potential of particular regions, the specifics of engineering education environment, the status of core industrial enterprises of a region and its public institutions (main employer, basic institutions, international institutions, etc.) At that, most of actions mentioned above are universal and practice-oriented and can already be recommended for implementation, for instance, in Volgograd region.

Particularly, during his official visit the Governor of the Volgograd region, Bocharov A.I., to Volga State Technical University, has underlined the importance of both engineering education and the need for cooperation between all interested parties for the development of regional economy. Thus, the Governor proposed perspective ideas for founding a nanocenter on the premises of VSTU, productive cooperation between HEIs and schools, development of a flagship university, and others [7]. As noted by RAS correspondent member, rector of VSTU, Lyisak V.I.: "The main aim is to attract [students] to the flagship university, which was the idea for its development, in order to facilitate the role of engineering education, to give it a new impulse…" [8].

Consequently, it should be noted that the pressure of sanctions, the dynamics of economic environment, the technological progress boost, the complication of economic connections, the need to assure economic development based on technological and product innovations in the context of limited financing, and many other aspects will bring up new, more complex and global problems for economists and engineers, will form a new system of restrictions that will allow for higher topicality of scientific and applied research in the framework of optimization of methodological approaches to engineering education management, the management of regional engineering education environment in future for assuring commitment to innovations of the regional economy of certain regions of the country.

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The Level Structure of Creative Class

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The article deals with the description of essential characteristics of creative class developed within technological creativity based on the modern engineering creativity methods – applied dialectics, or the theory of invention problem solution (TIPS). Evaluation criteria of creativity levels are suggested. The ways of increasing students' creativity level in the engineering education are studied.

Key words: creative class, creativity levels, creativity structure, TIPS, applied dialectics, TIPS-pedagogics, knowledge invention, innovative projects, CAI programs.

The term "creative class" was introduced by American economist Richard Florida, the head of "think tank" of "The Richard Florida Creativity Group". His famous book [1] not only reveals the fact of appearance of a new social group having new specific relation to the means of production but also is itself a means of intellectual production in different countries. The book details different social qualities of creative class, its subculture development, aspects of its interaction with the society in general, influence on the society.

R. Florida's investigations are of mostly social-economic, psychological, and philosophical character. In authors' opinion, the most essential idea of the book consists in the necessity of creative class for the modern society as a basis for social and economic advance, the role of creative class as a competitive advantage of those countries and areas where it has been sufficiently developed.

Following R. Florida's book, there was a number of other articles and books to some extent devoted to creative class, for example, [2–4] describing mainly its social-economic aspects. At the same time, though in [1] there is no reference to American philosopher and futurologist Alvin Toffler, the first chapter "Creative epoch" correlates sufficiently with the description of the Third wave in [5].

On the whole, all the mentioned and other works on phenomenon of creative class just state its fact, as the authors are mostly "observers" of its formation and development. A specified and managed character of this process as well as investments to be made is discussed about like a problem to be solved: "…creativity does not appear and exist by itself; it is to be cultivated. If we don't find a reliable technique, someone else will do it" [1, p. 345].

The crucial role of creative class for social-economic development in the modern epoch of global innovative society conditions the importance of its transition process from spontaneous to consciously governing one. In particular, it deals with technological creativity. At the meeting of the Presidential Council for Science and Education of the Russian Federation in Kremlin of 23 June 2014 the rector of Saint-Petersburg State Polytechnic University A.I. Rudskoy noted: «We are to develop engineering training of qualitatively new and complementary types … – so called engineering-technological special forces, I would say, modern, possessing the technologies of international level, … engineers-researchers capable of solving seemingly unsolvable problems and providing innovative breakthroughs in the high-tech industries" [6].

Thus, it is necessary to find that "reliable way", which was mentioned by R. Florida. For this reason, especially taking into account the necessity of technological creativity development and engineering approach to creative class formation, improvement of its qualitative indicators is also important along with social-economic one.

As a result of the analysis of some publications in the domestic and foreign journals on the issues of technological creativity, its development in the engineering education, the authors of the article noticed that specialists, often setting the task to develop creativity including that in engineering education, are not sufficiently aware of modern efficient tools and methods of creative thinking, though such methods have been developed and improved since ancient times, most intensively since the 20th century: maieutics (Socrates, the 5-6th centuries AD), heuristics (Pappus of Alexandria, the 3d century AD), "Lullian Circle" (Ramon Llull, the 13-14th century AD), in the 20-th century: the method of focal objects (MFO, E. Kuntze, Germany, 1926 improved by Ch. Whiting, USA, 1953), "Brainstorming" (A. Osborn, USA, the 30's), morphological analysis (F. Zwicky, Switzerland, the 30's of the 20th century – development of "Lullian Circle" idea), synectics (W. Gordon, USA, the 50's of the 20th century) and others. In the middle of the 20th century in the former USSR G. S. Altshuller developed the theory of invention problem solution (TIPS) [7 – 9], improved and expanded up to applied dialectics by the present [10].

Simultaneously, independently of the problem to develop creative class based on pragmatic consideration, design departments of the largest transnational corporations in electronics, mechanical engineering, aircraft engineering, power engineering etc. widely use the methods of creative thinking when solving problems, developing innovative solutions, at the same time, replacing such methods as morphological analysis, synectics etc. by TIPS. According to the growing demand for engineers possessing TIPS, this discipline is widely taught in the leading world universities including Massachusetts Institute of Technology, Stanford University, Oxford University, Strasburg University, universities of Japan, South Korea, India, China, Taiwan, Malaysia, Australia and others. Changing "think tank" of the previous generation: "RAND Corporation", "The Richard Florida Creativity Group", "The Adam Smith Institute" etc., which are mostly based on the Delphi method (combination of expert opinions) and solving problems by means of involving large number of highly-paid experts [11], there come "think tanks" of new generation solving problems by much less number of specialists and with much less expenditure due to TIPS application: "Oxford Creativity", "Gen 3 Partners", "Ideation International Inc", "Inventioneering Company", "Systematic Inventive Thinking Center" etc. There is also a growing interest at "Silicon Valley". In addition to Silicon Valley in California, USA, the conferences on TIPS with participation of leading world experts (many of which are Russian-speaking participants) are regularly held in "Silicon Valley" of Taiwan, in Hsinchu, in "Silicon Valley" of India, in Bangalore etc. [12]. The software of new type CAI (Computer Aided Invention) assisting users to apply TIPS is designed and widely used.

All described processes have not been noticed by the researchers of creative class up until now, but they are certain to enable its formation, though initiators of the processes do not set such a goal. Nevertheless, according to the information available to the authors, education and science authorities in some countries show their interest in techniques of creative thinking, particularly in TIPS.

The mentioned methods, particularly TIPS are based on fundamental laws of development studied by dialectics and specify those laws that allow solving not only problems of innovation solution generation, i.e. synthesis, but also problems of different system analysis, which is often required for the subsequent efficient synthesis. The authors of the article also apply those methods not only as a recommendation for creative class development, but also as a base for analysis of contemporary creative class conditions.

First of all, it should be noted that R. Florida's understanding of creativity is different from that of, for example, developer of intellect model structure J. Guilford, who distinguished two types of thinking – convergent and divergent – in the intellect structure. Besides, he believed the divergent thinking to be creative one, that is "going simultaneously in many directions", focused on generation of multiple solutions to a problem [13]. Divergent (i.e. "different") thinking, according to J. Guilford, is applicable for the problem solution suggesting several correct answers to one and the same question. Convergent (i.e. "similar") thinking, according to J. Guilford, is focused on finding the only correct answer to the question, i.e. it is efficient for the problem solution having the only correct option.

As summarized in R. Florida's book, a crucial feature of creative class is an ability to develop efficient solutions of problems including those of technology and engineering spheres. Hence, R. Florida, in fact, gives a functional definition for creativity. Though R. Florida does not use the terms of "convergent thinking" and "divergent thinking", nonetheless, it follows from the content of his book that his understanding of creativity corresponds to combination of those types of thinking. Indeed, actual engineering practice studied in detail by Russian TIPS developer G. S. Altshuller shows that engineering thinking always contains both divergent and convergent elements in different proportion.

Historically, solution of inventive problems is the initial and up to now widely used trial and error method mostly based on divergent thinking, and convergent thinking is involved only at the stage of efficient idea selection among all generated ideas. Such methods as "brainstorming", method of focal objects (MFO), morphological analysis etc. just accelerate the process of arbitrary idea generation, i.e. the process of divergent thinking still leaves convergent thinking for the final stage. To some extent synectics contributes to the convergent thinking using different types of analogies. But TIPS shows the most efficient combination of divergent and convergent thinking.

Intellectual efficiency, ability to generate innovative solutions sufficiently depends on the combination of divergent and convergent thinking. It is this base on which the authors suggest their creativity classification in terms of levels.

R. Florida notes that the structure of creative class includes the two elements: supercreative core (intellectual elite fully engaged in creative process) and creative experts (capable of creatively and independently combine the standard approaches in various definite cases). The classification is made on the bases of goals and results. The classification in terms of levels complements it.

The authors distinguish the following creativity levels (keeping in mind that this classification can be improved over time):

1. An expert's creativity using the trial and error method and generating innovative solutions as a result of spontaneously occurring "flashes".

2. An expert's creativity capable of rapid generating spontaneous ideas different from typical ones: either as a result of natural aptitude or due to the study of before-TIPS methods of acceleration of idea generation.

3. An expert's creativity capable of regularly finding innovative problem solutions: either as a result of natural aptitude or due to application of TIPS methods.

It is necessary to underline that application of TIPS methods fundamentally means development of intellectual talent [14], or, using the formulation of "Working concept of talent" [15], tapping (realization) potential talents.

Obviously, for innovative development of any country it is not enough just to increase the number of creative classes (which is limited by demands for working staff, service employees etc.), one should also enhance it structurally increasing the share of higher levels in its structure.

It is important to consider the issue on the methods of such structural improvement. Obviously, it is to be introduced in education and taking into a special demand for technological creativity – in engineering education. Besides, bearing in mind the psychological data on the highest efficiency in development of creative abilities from the school (or even before school) age, it is important to start applying the third level of creativity in the system of pre-university training for engineering specialization, at the same time continuing to develop it in university and post-graduate education. At present, in some schools there is experience of pre-university training in engineering specialties even in primary secondary school. But both in primary and upper school such training consists basically in acquiring additional knowledge on the existing engineering specialties. Pupils' creativity is motivated by competitions of ideas the number of which is growing. The third element should be added to this system – teaching the methods of TIPS thinking. In some schools it is performed even now, but does not become a widespread phenomenon. It is mostly explained by the demand for additional academic hours not only at school but also universities.

Solution of the problem with additional academic hours in both schools and universities includes innovative didactic TIPS-pedagogics technology of new generation [16–18] different from innovative education technologies of the previous generation in the fact that qualities of innovators are developed in students as a result of teaching innovations. It consists in integration of studying different (engineering, natural, and even humanitarian) subjects and disciplines with TIPS. Such an integrated training does not require additional hours, as TIPS concepts are included in common content of subjects and disciplines replacing the logical connections among their concepts by those of dialectic-logical. Following the method of creative problems [17] applicable for the stage of academic process dealing with problem solutions, the methods of knowledge invention and innovative projects have been developed [18] distributing the TIPS-pedagogics in all stages of academic process and project activity. The methods mentioned above have been repeatedly tested, the method of innovative project resulted in Krasnoyarsk schoolchildren's and students' inventions and a number of awards and prizes at the scientific conferences. The program based on these methods for teachers' upgrade course of different types and stages of education was developed and repeatedly implemented.

Considering the challenges of modern world social-economic development: depletion of natural resources, climate change etc., the necessity of the adequate answer to which is formulated by the United Nations Organization in the form of principals of sustainable development, by the authors according to the goals and objectives of the United Nations Decade of Education for Sustainable Development (DESD), 2005 – 2014, and continuing Decade of UNESCO Global Action Plan for ESD, the concept of TIPS was developed as a science of sustainable development, understanding of sustainable development and didactics of sustainable development based on TIPS-pedagogics (i.e. creativity) was accepted as a highest form of innovative thinking [19, 20]. Hence, the authors offer the 4-th creativity level as creativity of specialist capable of regularly finding innovative solution of sustainable development problems.

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On Necessity of Balance Between Professional Development and Rank Promotion of University Faculty Members

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To ensure successful professional development, a faculty member should plan his/her development trajectory that would be perfectly coupled with the career growth. Promotion of a faculty member is an effective way to encourage his/her professional activity, which, in its turn, would speed up the competence acquisition and allow a faculty member to pass through "the zone of incompetence". The career growth of a faculty member should be slow but steady in its progression.

Key words: professional competency, position, professional trajectory, criteria of competency, qualification and job position of academic teaching staff.

A modern tendency in staff (engineering) training implies that objectives for the educational system are to be set by labour market demands rather than by university's policy. In other words, both employers and a University should develop competence requirements for the graduates [10]. One of the basic conditions for the requirements to be met efficiently is highly qualified faculty staff having necessary competences [2; 3].

ANALYSIS OF THE ISSUE

Professional development of teaching staff is an "eternal" issue, with research competence being in focus nowadays, which is conditioned by the fact that fresh graduates should be ready for ever-changing technological environment producing new constituents, unknown before [11]. In this regard, a teacher should foresee any changes in his/her academic field and develop the competences that are necessary now and will be required in the nearest future.

To become a highly qualified teacher it is not enough to have field (operating) experience or scientific degree, it requires longterm and systematic self-development that facilitates professional, pedagogical and psychological competences development [2; 6]. It is only close professional collaboration that can ensure such self-development by implementing research- and training projects and other activities.

However, professional development of faculty staff needs to be regularly motivated. One of the effective motivations is well-timed career promotion, for example, as an award for scientific or teaching achievements. The promotion is somewhat conditional and is aimed at stimulating a teacher to overcome "his/her incompetence" to prove his/her adequacy for the position. It makes faculty staff acquire new professional competences and make comparison between competence levels of the present and previous positions in order to comply with new professional requirements. There is no doubt that successful development of "new area" results in teaching competence improvement, which leads to better quality of educational process. If the new professional competences fail to be improved, demotion to previous position can take place, which is typically followed by dismission for professional impropriety.

Thus, for effective professional development, it is advisable for the rector's office to make every faculty member design his/her career path with its official registration. In this case it concerns development of tools used to stimulate and motivate faculty members for long-term professional "life" with constant increase of scientific and education indicators. Only in recent times, however, has there appeared a formal relation between quality criteria and effectiveness of facul-ty member performance which is to be ensured by contractual system called "effective contract" [7].

It is obvious that the career path should include complex development of both scientific and teaching skills at every professional level of the career. Teacher's professional development should be well corelated to rank advancement and be accompanied by continuous gradual hierarchical promotion [5; 9]. The problem of faculty member rank advancement is out of attention in Russian education journals, which can be explained by particular ethic views of education society in the country.

BASIC COMPETENCE CONSTITUENTS

There is worldwide trend of substituting a notion "competence" for "knowledge", which means that such traditional notions as "knowledge" and "skills" cannot meet the growing cognitive demands of modern industries [14]. Nowadays, to solve professional task, an expert has to use scientific thinking and specific features of particular science rather than scientific knowledge [1]. Thus, "scientific character" of education is becoming its key parameter.

The contemporary higher education reform makes shift priority from educational activities of faculty staff to research, creative and innovative ones [10]. Teacher's professional level indicators can be conventionally divided into internal and external [1; 8]. External indicators usually embrace the number of monographs, training manuals, teaching guides, articles published in journals recommended by State Commission for Academic Degrees and Titles and international journals, patents and citation indices of scientific and industry journals and web-sites. These indicators show relevance of a faculty member's scientific achievements and somewhat characterize his/her scientific and teaching efficiency.

The internal indicators are personal qualities, such as social skills, state of mind, extensive knowledge, persuasive power, teaching tact, self-attitude, level of aspiration and specific features of professional interaction [11; 14].

Thus, teacher's professional competence is skills, knowledge and attributes that are necessary for successful professional performance in the frame of a position taken and higher school requirements. Up to now, there is still no standard classification of key competencies for faculty members of universities, however the essential basic competencies do exist [4; 14]. Scientific and subject-related, psychological, teaching, communicative, managerial, creative and informational competencies are regarded as the most important.

Scientific and subject-related competence. It is absolutely obvious that a faculty member is to be an expert in the scientific field in which he/she trains [1; 4]. To keep up and increase their competency level, faculty members should constantly keep their scientific and subject-related knowledge and skills up-to-date. It is also necessary to understand how this particular discipline contributes to graduate's competencies development [4].

Professional level of faculty member is usually measured in two basic dimensions – research and teaching ones with research being in more focus, since ideal education is based on science. Therefore, a faculty member should strive for professional development by writing monographs and manuals, doing scientific research works, defending a thesis, developing e- and on-line teaching materials and participating in scientific conferences and meeting. It should be noted that monographs and theoretical articles are the most valuable among the activities mentioned above.

There is no doubt that a faculty member who, apart from a degree and titles, has his/her research results regularly published, participates in conferences and reads lectures to inspire students' creative thinking, should be considered as the most "prominent" teacher.

Psychological and teaching competence. Until recently these aspects of faculty members' training have been regarded as secondary ones, with anecdotal evidence suggesting that scientific competence be sufficient enough to manage effective training process in higher education institutions. Nowadays, more and more faculty members are undergoing special training, since a teacher produces the most significant impact on students in terms of education goal achievement [2; 14]. Experience has proved that it is personal qualities of a teacher rather than a system of focused teaching actions that have a significant influence on students.

Communicative competence. Communication is a basic means of scientific and teaching activities, as well as a necessary condition for professional and personal development of a faculty member [14]. A teacher is expected to have a set of special communicative skills including social perception, adequate assessment of communicative situation and effective and adequate social behavior. Besides, a teacher should be good lecturer who can use verbal and nonverbal communicative means, hold an effective discussion and perceive a partner adequately, which causes credit and wish for collaboration.

Managerial competence. A teacher often has to be a leader and manager while holding classes, supervising students' research work, mentoring internships, diplomas, organizing public activities, etc. [3]. To succeed in these activities, a teacher should have managerial competence that includes a system of interrelated skills, knowledge, attributes, and personal qualities.

Creative competence. Creative competence ensures effective research work, systematic development of training in both content and methods, accumulation of scientific and teaching information, constant training analysis [12]. The value of creative activity is included in the ability of a person to produce and apply break-through ideas and new knowledge [1; 4].

Informational competence. Intensive growth of new knowledge and information flow have made computer user skills be one of the key personal competencies [13]. Informedia of the whole education environment has been dramatically changed by new technological means, such as telecommunication and IT-technologies used in educational process [10]. Moreover, according to the standard requirements, up to 20 % of classes should be held using multimedia technology, which makes informational competence one of the key constituents of a faculty member's professional competence.

Thus, the on-going higher education reform requires development of Teaching Big League of University, these are the experts trained for innovative teaching activities [13]. It should be stated that training of such teachers is a high-cost and science-based technology that can be implemented on condition that research and education activities are in good accord.

JOB RESPONSIBILITIES OF FACULTY MEMBERS

Professional activity of faculty members embraces training, research, scientific, methodical and educational constituents [3]. These activities require a definite degree of faculty members' training and form content of the competence. The amount and content of teachers' responsibilities depend on a position of a faculty member [9]. There are the following faculty member positions: lecturer, senior lecturer, associate professor and professor.

For successful implementation of an individual career path, it is necessary for a teacher to know the difference between job responsibilities of faculty positions and specific feature of each position. With staged and planned job promotion, new responsibilities will be fulfilled basing on

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systematic knowledge, experience and special training. As a rule, the intensive acquisition of new duties is characteristic of the first period after the promotion, with further keeping-up the required professional level.

Lecturer. This position is the first and basic stage of teacher's career development in a university, which starts with graduating from a higher education institution [12]. A fresh lecturer starts to work under the supervision of one of the leading professors or associate professors of the faculty who becomes his/her curator or sometimes scientific advisor. This position is well accompanied by post-graduate study which lasts 3 years. This period is enough to finish a post-graduate course and defend PhD thesis.

Among the professional competencies of this position there are the following: a lecturer should be able to give some forms of practical classes, manage research work led by the faculty, develop guidelines for classes, teach students and carry out occupational guidelines for [11].

Teaching activity of a lecturer should develop the following skills: to use active training methods including IT- and multimedia technologies; set goals and objectives of classes and tutorials based on competency approach; analyze and structure training materials, develop a class and a discipline (curriculum); design and manage students' research and independent work, develop and use modern methods of students' learning outcome assessment.

Research competencies of a lecturer are developed during post-graduate study. Besides, they should be able to present information and scientific results in different forms, such as scientific articles, conference abstracts, patents, scientific reports for enterprises and federal bodies as well as apply for different kind of grants.

To prove the competence, a lecturer should: know modern tendencies in training methods in Universities; be aware of new IT and other means of teaching, be able to manage research and independent work of students, be skillful in using different assessment techniques, be able to prove the choice of training techniques, analyze learning and cognitive activities of students. Personal qualities, leadership and team-working skills are to be developed as well.

Successful teaching activity, a certain length of teaching experience or PhD degree can be a reason for making a lecturer ready for further promotion. It is necessary to note that this position is characterized by the highest turnover of staff.

Senior lecturer. This position is the second stage of faculty member's career development [9]. This promotion is usually carried out after taking PhD degree. In some cases, which are characteristic of provincial universities, senior lecturers do not have PhD degree [7]. This period is aimed at developing a researcher, improving professional skills of a leading teacher such as managerial and teaching activities [12]. This stage does not typically exceed 5 years.

Educational activity of a senior lecturer involves deep knowledge of basic textbooks and training manuals, teaching and scientific approaches and concepts of a particular scientific field and reading of main journals. Basic professional activities of a senior lecturer are as follows: participation in curriculum (education program) development and implementation, giving all kinds of classes, including lectures. These activities require a senior lecturer to know basic manuals, teaching concepts and approaches in details, as well as be aware of newly published articles in subject-related journals. The basic teaching responsibilities of senior lecturers are the following: to take part in education program development and implementation; to give different forms of academic studies, including lectures, supervise term projects and graduate papers; to examine students; to plan and support students' independent and research projects; and to help lecturers with acquiring professional skills [9].

Scientific and research activities of senior lecturers (with PhD degree) can include being a leader of federal and commercial research projects, scientific advisor (consultant) of postgraduate students, opponent at the thesis defense, and supervisor of Master graduate papers. They are to be able to develop and implement research, innovative, commercial and other projects. Besides, this position implies writing research articles in the journals recommended by State Commission for Academic Degrees and Titles (SCADT), participating and reporting on scientific and methodological conferences.

General professional competence of senior lecturers should be based on methodology of scientific creativity and research in higher education institution, the ability to see and set a scientific problem, analyze research results, develop education programs and teaching materials and their on-line version, develop and apply innovative and author's education programs, and choose an optimal teaching technology [3].

Senior lecturers should be aware of innovation in higher education, managerial and teaching basis of education systems, education program and university accreditation and licensing procedure. They must be able to supervise research activity, new technology development, as well as develop personal leadership and team work skills. As a rule a senior lecturer with PhD degree plans a long-term activity in the university.

Associate professor. This position is considered to be a stage of effective professional and career development [9]. This career level is a level of the leading university teacher, associated with developed skills, such as the ability not only to give classes of high quality, but also to manage teaching, research and methodical activities of the faculty, basing on professional knowledge, skills and experience. The promotion to the position of associate professor should meet the following requirements: effective teaching and research activities, published teaching manuals, PhD degree, and several articles published in journals recommended by SCADT. This stage can last 10-15 years.

The basic associate professor's functions are planning and management of all kinds of academic studies, supervising students' independent and research work, coaching young faculty members, managing teaching and research projects of a faculty, controlling the quality of academic classes given by the faculty, applying innovative education technology, developing and testing new teaching materials, participating in education program development and accreditation, publishing monographs, research articles, reviews, and manuals [3; 12]. An associate professor should have developed teaching and methodical culture.

This position implies having the following competencies: to manage scientific and research activities, to lead and implement federal and commercial research projects, to consult and supervise post graduates, act as an opponent of PhD thesis defense, give academic studies of Master programs and supervise Master thesis. Besides, an associate professor should be a member of professional societies participating in conferences and meetings, and know the labour market demand for the graduates in the related industry. It is obvious that an associate professor should be known as a researcher in the subject-related area, and as a teacher in education society. A successful career path may be doubtful if this position has been taken for more than 15 years.

Professor. A faculty member can reach not only the position of professor, but also can be awarded with the academic status "professor" [15]. The status is awarded for high achievements in basic teaching activities, a good number of research, teaching and methodology works, as well as a number of PhDs defenses under his/her supervision or consulting doctoral dissertations.

This status is an objective indicator of constant professional self development of its holder. A professor of university has always belonged to the elite, being the source, translator and generator of knowledge as well as being a representative of real intelligentsia [8]. Moreover, a professor plays a key role in developing education and research activities of the university, in some cases being a University's brand.

The basic criteria for promotion from associate to full professor include a number of aspects. Firstly, they are scientific and research achievements that result in a big number of articles in top-rated academic journals, monographs, high citation index and Hirsch index, the amount/number of plenary reports on prestigious international academic conferences, the number of supervised candidate defenses, and doctoral degree. In some exceptional circumstances, associate professors with PhD degree used to be promoted to the position of professor in some regional Universities [5]. It is obvious that such a candidate must have met all the requirements mentioned above. The current regulations, however, prohibit an associate professor to be promoted to the position of professor without doctor's degree.

This position has no time restriction and is the most fruitful in terms of teaching and research activities, since it means that the professor is still "young" but already experienced and "intelligent". It is the period to plan and create fundamental monographs, reference textbooks, basic manuals of the federal level, as well as to found and develop a school of science. The school of science allows the faculty members to determine scientific interests and scholarly importance of the studied problems, develop professional competencies, use the obtained knowledge in education process, encourage students to conduct research, thus contributing to better training of the future specialists [15].

The most valuable results of professor's activity are original (author's) courses based on personal research or research conducted under professor's supervision by order of industrial enterprises or research institutes [8]. These courses should increase new knowledge and its distinctive feature is to direct the development of a particular scientific area, predict technical and technological development, and negative impact of problems in case they are neglected to be solved.

A scientific supervisor of post graduate students and a consultant of doctoral students is a specific characteristic of the position. Besides, having more than 20 years' experience in teaching, a professor can be a chairperson of education and methodical commissions, education quality control commissions, a member of the chairperson of Thesis committee and other university public unions [13]. A professor can also work in outside associations and committees such as Training and Methodology Committee, SCADT, be a member of Thesis Boards of other universities and research institutes, or act as opponent at the defense of candidate or doctoral thesis.

Being at the highest step of teacher career, a professor can be motivated by awarding such honorary titles as "Honored Scientist of the Russian Federation" or "Honorary Figure of Russian Higher Education".

DEVELOPMENT OF PROFESSIONAL COMPETENCIES

The reform of Russian education system and change of education goals induce universities to choose a corresponding science-based development path and train faculty members capable of following and implementing the university's development path. In this regard, the university administration has to improve the system of continuing professional development of faculty members. According to the existing regulations on faculty members' professional development, a teacher is to take a training course no less frequently than once every five years, which does not meet the requirements of the Federal State Education Standards.

Nowadays, the most widely spread further training courses for faculty members are those focused on eliminating gaps in professional knowledge and competencies, supplying additional job-related information, and ensuring adjusting to new professional conditions and requirements. Professional development can be on-the-job training or external courses. The latter is used in exceptional cases and usually accompanied by other significant work such as thesis defense, writing fundamental monograph or manual.

Thus, the university administration needs to organize and manage a system of continuing professional development for the main part of faculty members, for this purpose a corresponding complex program for faculty member professional development should be implemented in the University. The program should include special training course for fresh teachers and post graduates who need fundamental teaching training. Training courses for associate and full professors are tailored to "keep fit".

Continuing training implies availability of permanent theoretical teaching courses, science schools, research institutions and professional associations for faculty members in a university. To implement the competencies acquired while taking the courses, it is necessary for a teacher to carry out individual education projects in basic professional activities:

- research – doing research work fulfilling federal or commercial orders, carrying out grant programs, publishing monographs, articles or patents;
- teaching methodology – manual and text-book publications, participation in education program development, development and design of teaching materials; giving experimental courses, education regulations and requirements;
- teaching – interactive form of teaching;
- extracurricular – student club management; supervising students for conferences and competitions; managing university social, research and creative projects [6].

The results of teacher's activity should be analyzed annually, with the teacher reporting on conferences, faculty meetings or seminars, or giving "open lesson" [5]. In addition, a teacher is to give an essay to show that the work performed meets the university requirements.

Thus, in conditions of higher education reform, university efficiency depends on professional level of faculty members. Professional competence of a faculty member should correlate with rank promotion and be characterized by gradual but steady upwards motion the career ladder.

Professional development of a faculty member surely needs to be motivated. One of the effective ways of the motivation is well-timed career promotion. It makes a teacher acquire new professional competencies that are characteristic of the new rank position, thus improving the quality of the teaching process on the whole.

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Development of engineering graduates' competences

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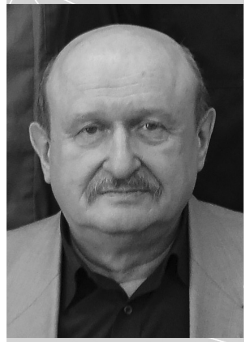


Yu.A. Krupin

Knowledge opens doors, but you have to step through.
D. Likhachev

The article proposes the use of competence-based approach in Higher Engineering Education. The proposed graduate's competence model developed in accordance with the Federal State Educational Standards, and employers' requirements makes it possible to unite all participants of education process in order to achieve a primary goal, i.e. high quality of engineering education. This would certainly raise the prestige of engineering education.

Key words: competence-based approach, education quality, active specialization acquisition, learning outcomes.

The future of the Russian Federation is directly dependent on development of innovation and knowledge-driven economy that is based on scientific and technological progress (real technological revolution). However, the ambition to achieve high economic performance alone is not enough. It is necessary to define the key factors to achieve such a purpose.

As stated by S.S. Naboychenko (Rector of Ural Polytechnic University), human intellectual assets play an important role in innovation-driven economy development [1, p. 7]. At the same time, it is the responsibility of High School to assist in preparing and guiding human intellectual assets that are currently of great demand.

There are a great number of economists, lawyers, and humanists. There is no doubt that these professions, especially educators, are of great importance, however, they do not produce any goods or items of value. Economy is built due to engineers and workers. Despite rising diversity of education programs offered by Higher Engineering School (production engineering, manufacturing, modeling and design), most graduates work as engineers or high-qualified workers. In most cases, they start their carrier upon completion of so-called "on-the-job training program". Is it possible for a bachelor student to become an engineer? B.A. Prudkovskiy, Professor of National University of Science and Technology «MISiS», has stated that engineering activity is confined to the three basic actions: to manage, to research, and to design [2, p. 5-6]. Therefore, according to the Federal State Educational Standards (FSES), fields of the professional activity for graduates with the Bachelor's Degree include:

- production and manufacturing;
- organization and management;
- design;
- engineering;
- research and development (analytical).

Basically, students can be adequately prepared within one or several fields. It is obvious that a graduate, even a bachelor's degree holder, can become a "real" engineer when he/she begins to accumulate qualifying engineering experience after graduation. This fact was clearly identified by V.S. Sheynbaym, Professor of Gubkin Russian State Oil and Gas University [3, p.15-28]. Therefore, universities are to be concerned not only about the quality of education, but also the readiness of labor market to accept a new generation of graduates. It is this fact that would raise the prestige of an engineer in Russia.

Already the ancient Greeks were aware of the fact that "If one does not know to which port one is sailing, no wind is favorable".

Within the Higher Education System, "the port one is sailing" or "destination" of teaching process is defined by the graduates' knowledge and skill requirements. Today, these requirements are linked to graduates' competences (individual performance outcomes) which are clearly stated in FSES and education programs. This constitutes the basic characteristics of our graduates, i.e. the "product" of educators' work. It is obvious that upon completion graduates demonstrate different levels of skills and competences; however, they should have enough knowledge and experience to become a well-qualified specialist, a responsible, honest, and goal-oriented member of our society.

Unfortunately, most Russian universities just formally try to implement the FSES competencies without modernizing the education system itself. Therefore, the main goal of the current study is to propose the ways how to implement competence-based approach into education process.

Within new economic policy in Russia, Higher Professional Education is shifting from so-called "forever" education towards long life learning. This process is stipulated by the following social changes:

- significant technological advances which, in its turn, gave rise to new professions and qualifications;
- the increasing role of employees' horizontal mobility during his/her working life;
- decentralization of economic responsibilities and product (service) liability;
- changes in life styles at all levels: social, organizational, and individual;
- application of management techniques in Higher Professional Education;
- rising factor of dynamism and uncertainty;
- the increasing role of "personal development" ("long life skills") [4, p. 20-28].

The need to adjust to new social and economic environment urges the development of new approaches to training specialists who would actively participate in economic transition and reforms.

Within the described paradigm, the primary goal of higher education is to ensure that students are acquiring general knowledge and professional competences that are deemed to be essential to career success and future life. As goal is a backbone component, its transformation should involve the change of the whole education system, as well. Therefore, being regarded as a primary goal or/and outcome of learning process, the competence-based approach stipulates the development of a new education procedure. The education program courses and practice training are taken in sequence in accordance with the stages to develop the required competences. The credits awarded to students for course completion serve as indicators of the learning achievements for each course of the Basic Education Program (BEP) [5,p.77-81].

Thus, it can be stated that education program should be always based on the graduate's competence model.

In FSESs, BEP outcomes are regarded as competencies. However, at the stage of standard drafting, there were proposals to use two widely applied notions: "competency" and "competence". In the current research, it is of great importance to outline the main difference between these two notions and clarify authors' position on this issue.

Bologna Seminar: Learning Outcomes Based Higher Education – The Scottish Experience (Edinburgh, 21-22 February 2008) noted that there is "a lack of clarity and shared understanding about some of the key terms associated with the introduction of learning outcomes in different countries which is likely to impede effective implementation" [6, p. 134-138].

Following the idea of I.A. Zimnaya, we regard competence as a characteristic of the ability to apply knowledge and skills and demonstrate social and personal attributes. This characteristic is an employer's (consumer's) evaluation of education quality and graduates' ability to work [7, p. 15-17]. Competences can be referred to general personal features.

Competency is an ability to perform an action, in other words, it involves practical skills within a definite field. Thus, competencies are developed while completing each course, precisely, during student-teacher classroom interaction, practice classes, and research assignments. Unlike competences, competencies are referred to the definite and individual skills and knowledge of a graduate. The notion "competency" implies the idea of "know how to do".

The competence should not be opposed to qualification, at the same time it should not be identified with it. In the opinion of I.A. Zimnaya, a specialist is a person who specializes in or devotes himself/herself to a particular area of activity demonstrating high level of required knowledge and skills. Having deep knowledge and required skills within a particular field, a competent specialist demonstrates interpersonal skills, creativity, cognitive abilities and a good understanding of interrelated processes and/or phenomena. Thus, expertise can be regarded as a part of competence.

The FSESes (bachelor's degree program) have been recently modernized with due regard to the following requirement: all cultural and professional competencies, including integrated-professional ones that are related to the qualification to be acquired, should be integrated into the program learning outcomes. However, each university has a right to expand the list of competencies in accordance with the focus of the program. Thus, universities should develop a graduate's competency model for each education program. They should be used as the basis for education program design.

In addition, universities have a right to develop program learning outcomes on their own account. It means that each education program should include definite learning outcomes which, in our opinion, can be presented as graduate's competencies.

However, numerous competencies of education programs should be in strict relation with cultural and professional competencies of a graduate, his/her social and personal attributes, i.e. competence model. Therefore, we believe that a primary goal of education, i.e. learning outcome, is a set of competencies which together shape the competence of a graduate.

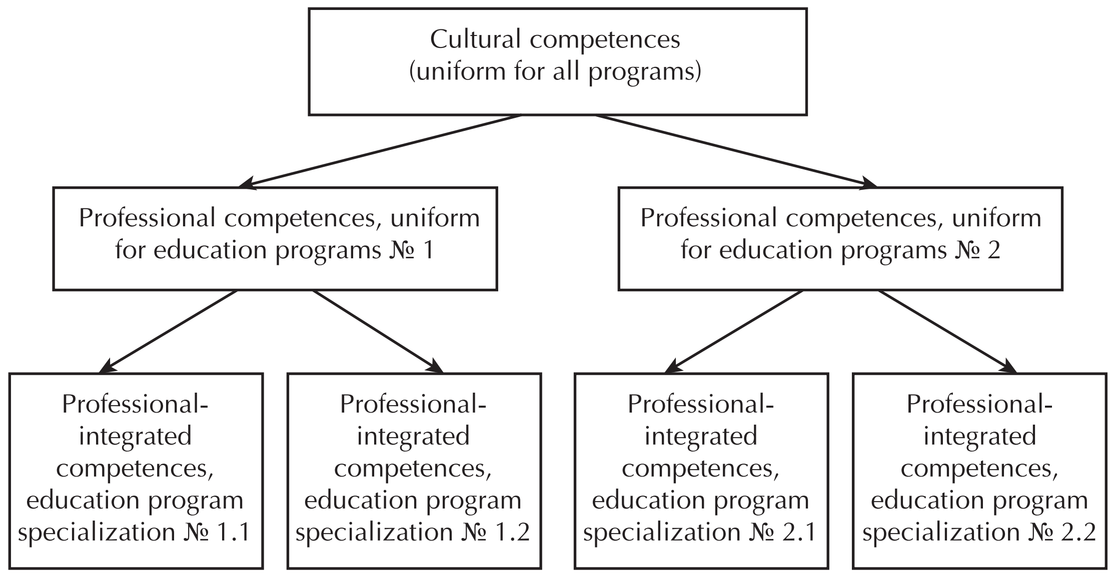
In case of engineering education programs (bachelor's, master's, specialist's degrees), it is possible to develop such a graduate's competency model that would include invariable cultural, professional, integrated-professional, and practical/instrumental competences, usually termed as general competences, without reference to the focus of the program (speciality). Cultural competencies of FSES for bachelor's degree programs (2014-2015) were modernized in light of the above statement.

As each university offers a great number of education programs, the following graduate's competence model is proposed (Fig.1).

In our opinion, the graduate's competence model should include a number of generalized attributes of a graduate which would fully reflect the diversity of the various education program competencies. Therefore, the FSES of Higher Education should be redrafted and revised.

Firstly, as the findings form the survey of employers show, the graduate's competence model must include intellectual abilities of a graduate, his/her social and personal attributes, such as responsibility, sociability, civic consciousness, initiativity, self-discipline,

Fig 1. The Structure of Graduate's Competence Model



and independence [8, p.145-150].

These attributes might seem, at first sight, to develop naturally over a long period of education. However, in fact, it is hardly to be achieved when there are no combined efforts of the faculty who should work within the definite system. As a result, most students fail to shape these attributes in full.

Secondly, in order to ensure focused training of students, it is necessary to divide *professional competences* (PC) into three groups:

- professional competences (identical to FSES competences within the definite education program) (PC);
- practical/instrumental competences, such as knowledge of equipment, mathematical tools, information technologies, research methods, and etc. (P/I C);
- integrated-professional competences that embrace all types of activity (IPC);
- specialization-related competence (SRC).

To ensure the quality of engineering graduate training and compliance with international requirements, the proposed competence model should be reviewed and approved by the potential employers. It needs to be weighed against the roles and responsibilities of engineering staff or professional standards.

The professional competence, as well as professional-integrated one, is developed within such courses as economics, material science, thermal engineering, and etc. The problem is that while developing education programs, faculty members from many different departments work independently despite the overall objective. Therefore, the only way to solve this problem is to develop education programs based on the graduate's competence model which integrates various competencies into a whole.

As an example, let us consider such practical/instrumental competence as ability to calculate and draw a conclusion (can be invariable) as a part of the graduate's competence model. Physical chemistry has traditionally given students broad training in thermodynamic and kinetic calculations, consequently, the learning outcome within this course can be defined as follows: ability to carry out physico-chemical calculations and draw a conclusion on reaction pathways. It is obvious that this competency is not the only one that is related to the ability to calculate and draw a conclusion. Therefore, it can be stated that the learning outcome of this course is related not only to the specific competency, but also to more general ability, i.e. ability to calculate and draw a conclusion.

In that regard, we believe that it is of particular importance to supplement education programs with the section "acquired skills and abilities (specific competencies) required for developing competences and personal attributes". Thus, the course "Designing, Running and Analyzing Experiments" includes the mentioned section in the following way [9, p. 11-14].

Abilities:

1.15 – to process experimental and statistical findings and to present them in the form of variation series and diagrams (L 1.1, L 1.2, PC 1) P/IC3.

2.15 – to evaluate reliability and importance of experimental data (L 2.1, L 2.2, PC 4) P/IC5.

3.15 – to evaluate experimental results

Table 1. Development of cultural competences (CC) while studying "Legal Science" course (education program "Thermal Engineering")

№ п/п	Learning outcomes (competences)	Corresponding cultural competences (CC) according to BEP
1	Ability to identify and analyze legal issues in scientific and professional contexts	Ability to analyze, identify, understand information and undertake problem identification, formulation, and solution(CC-1) Ability to acquire knowledge independently based on contemporary educational and information technologies (CC-4)
2	Ability to evaluate actions and behavior of people regarding legal environment	Ability to analyze, identify, understand information and undertake problem identification, formulation, and solution (CC-1) Demonstrate an understanding of ethical and legal norms in interpersonal communication (CC -9)
3	Ability to express logically one's own opinion on legal aspects of one's own profession in terms that customers, management and colleagues can understand and further cooperation	Ability to present and report the results of the work performed (CC -13) Demonstrate knowledge of business correspondence standards (CC -14) Demonstrate an understanding of ethical and legal norms in interpersonal communication (CC-9)
4	Ability to prove and define one's own opinion on the discussed legal problems	Ability to recognize the need for, and have the ability to engage in independent and life-long using the basic methods and technologies of social, humanitarian, and economic sciences (CC -5)
5	Ability to administer and execute legal regulations in decision-making within professional domain	Ability to apply basic methods and technologies of social, humanitarian, and economic sciences in solving social and professional tasks (CC-4) Demonstrate an understanding of ethical and legal norms in interpersonal communication (CC-9)

by functional relationships (modeling) (L 4.3, PC 5) PC8.

4.15 – to design experiments for building regression models of factor impact on quality indicators (L 5.1, L 5.2, L 6.1, PC 7-10), P/IC2.

The numbers and abbreviations in this example should be deciphered in the following way: numbers 1.15, 2.15 indicate the numerical order of the competency and "Designing, Running and Analyzing Experiments" course in the education program (15). L 1.1, L 2.1; PC 1, PC 4…, are assigned to lectures (L) and practice classes (PC) aimed at developing corresponding competencies (for lecture, the first number indicates the numerical order of the section, the second one is for the topic discussed; the practice classes are defined by class number). The abbreviations P/IC2, P/IC3, P/IC5, PC8 stand for the competences incorporated into the graduate's competence model. They constitute part of the following competences: P/IC – practical/instrumental competence, PC – professional competence.

Tab. 1 presents the learning outcomes (competencies) of "Legal Science" course. It is worth noting that each of the described competencies serves as an important element in shaping cultural competences (CC) enumerated in the basic education program (BEP) [5].

Education is a long process that successively provides learners with certain competences. However, it is not a simple summing of skills and abilities. It is development of such personal attributes and features that shape a student as a personality and expert.

Having developed the curricula of the courses that constitute BEP, it is essential to conduct assessment of its compliance with the final learning outcomes. In order to do this, it is required to build a "tree" that would represent a competence (Fig.2) or to draw up a table (map) of a competence (Tab. 2) [10, p. 77-81].

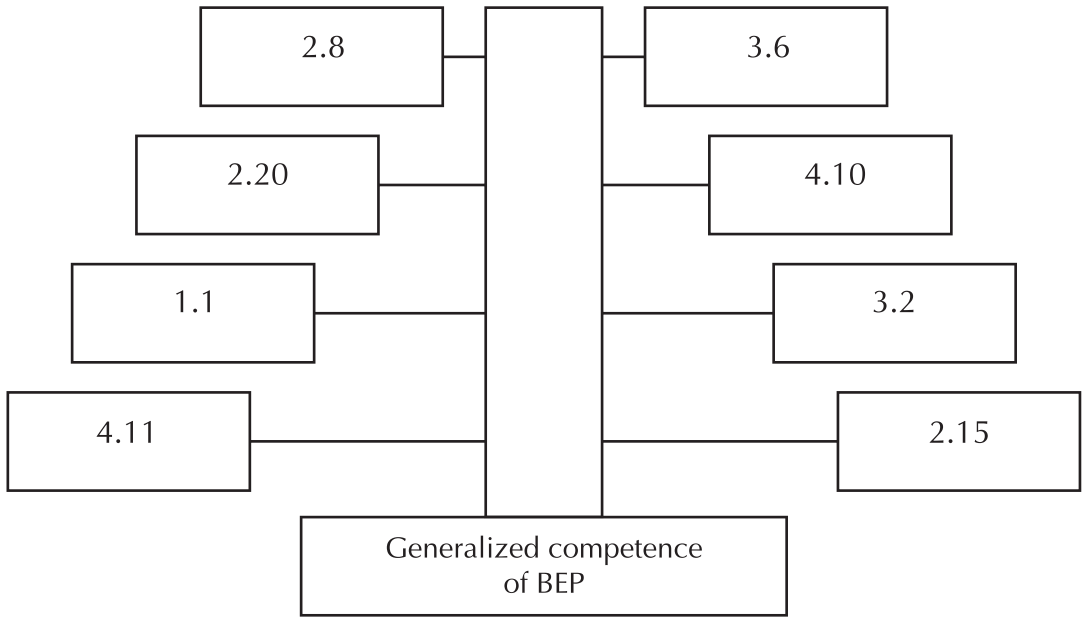
Each "branch" presented in Fig.2 indicates the competencies within different courses. These competencies, in one way or another, are related to the generalized competence. It is clear that the higher the number of "branches" in the "tree" or competencies in the map, the higher probability to shape the corresponding competence. The issue that arises then is what will happen if there are few competencies? There are two possible answers: this competence might seem to be unimportant or certain mistakes have been made during course curriculum development.

This kind of analysis allows educators to determine how fully graduate's competences will be developed. If necessary, it is possible to revise the content of definite education program courses or even introduce new ones.

Table 2. Map of graduate's competence development (education program "Metallurgy")

Competence	Course competencies (course code, competency code)	Courses (curriculum code)
Ability to manage technical process of continuous casting	14.3 ability to calculate heat exchange index during metal hardening	14. Thermal engineering
	18.5 ability to control steel quality	18. Steel Metallurgy
	10.4 ability to define structural components of steel microstructure	10. Material Science

Fig. 2. The scheme for plotting competence "tree" (numbers indicate the numerical order of the course and competency)



To develop such competence maps, we are planning to apply Bloom's taxonomy [11, p. 11-15] who distinguished six education objectives: knowledge, understanding, application, analysis, synthesis, and evaluation.

In order to determine learning outcomes in compliance with the mentioned education objectives, we have introduced the following verbs: knowledge – to present, tell, formulate, etc.; understanding – to classify, identify, etc.; application – to demonstrate, solve, etc.; analysis – to calculate, evaluate, etc.; synthesis – to compare, plan, etc.; evaluation – to discuss, judge, etc.

To align learning outcomes with future profession requirements, it is essential to draw up a "passport" or short description of each key competence. Tab. 3 gives an example of such a "passport", precisely, the description of the generalized competence "to manage technical process" which is most obvious in graduates' future professional activity. The comparison of the definite competencies with the competence features allows educators to define the focus of each course curriculum, including course projects, practical assignments, and student coursework.

For successful development of innovation and knowledge-driven economy, the specialists who possess such a key competence as "commitment to quality" are of great demand.

In our opinion, to ensure contemporary engineering training, it is necessary to resolve at least two tasks:

- each education program should include continuous quality training;
- the elements of quality management system (QMS) should be incorporated into teaching process, QMS principles and benefits being clearly demonstrated. It is desirable to involve students into the events and work related to QMS (inconsistency correction, preventive actions,

Table 3. Competence "passport"

Competence	Competence features	Teaching process elements	Ways to develop
Ability to manage technical process	1. Understanding of technical process principles 2. Ability to identify inconsistencies 3. Understanding of control action 4. Ability to correct the process 5. Estimation of system respond to external actions 6.Understanding of implications of taken decisions 7. Ability to train staff	1. Courses (list) 2. Practice training/Internship 3. Student coursework	Lectures Practice classes Labs Internship Workshops Engineering games Intellectual games

students and faculty satisfaction survey).

To resolve the first task, it is necessary to revise the learning outcomes of each course, more precisely, it is required to reveal whether they are aligned with the quality requirements. If necessary, the course content should be improved, as well. In addition, academic faculty, especially faculty members of graduating departments, have to study professional standards and requirements of their students' qualification, since the universities prepare students for future job responsibilities by means of well-organized practice classes and internship.

Under modern conditions, to ensure professional success, university leaders and decision-making personnel should always observe the key principles of the quality management system. The main goal of university training is to make students understand that these principles are vital in any professional activity. This can be achieved by introducing these principles into education process itself.

It would be a serious mistake to train bachelor's students within the definite specialization. In most cases, they have no any work experience and have no idea about their future occupation. Therefore, it is better for them to gain a broad understanding of industrial processes than to specialize in one specific subject. This would be to the benefit of a graduate development.

Quite a different approach should be applied to master's program development. In this case, all FSES aspects must be considered: field, object and activities. In our opinion, in master's programs two activities should be regarded as key ones: research and engineering projects. It is worth noting that managerial and organizational performance will be carried out in both projects. The following stages for developing master's program are proposed:

Stage 1. The analysis of the definite bachelor's student competence model.

The master's program should be designed based on the definite bachelor's program competences which can be further developed.

Thus, the master's program will be supplemented with the bachelor's program competences labelled BM.

Stage 2. Development of master's student competence model for a definite education program.

Stage 3. Based on the FSES requirements and competence model, the list of program courses, practice classes, and internships is made up.

Stage 4. The curricula of program courses, practical training, and internships are developed using competence-based approach.

Stage 5. The map of course-related competencies is designed for each competence.

Stage 6. The structure of professional activity (according to FSES).

1. Determination of master's student professional domain.
2. Selection of professional activity object.
3. Determination of the type of professional activity.
4. Professional activity objectives.

Stage 7. Development of master's program content design algorithm. Fig. 3 illustrates the algorithm for master's program "Material Science" design.

Stage 8. Determination of master's student learning trajectory.

The trajectory is defined on the basis of general training model. Let us consider the following example (refer to Fig. 3):

Professional domain – 1.1 – material analysis and new material development.

Activity objects – 2.1 – metal inorganic materials and 2.6 – ultra-hard materials.

Activity type – 3.1 – research-and-development 3.3 – managerial.

The master's program should be designed based on the above-described competence mode.

The proposed algorithm allows educators and master's students to choose any learning trajectory, to develop a specific graduate's competence model and corresponding education program.

It is desirable to provide engineering training on the basis of the system of active specialization acquisition (SASA) which was developed by V.A. Roments in 1990s at National University of Science and Technology «MISiS».

The main principles of SASA are as follows:

1. Focused training: students should gain career-related knowledge and experience, including not only specific subjects, but also the courses which equip them with scientific, engineering and humanitarian fundamentals. Methodologically, the SASA is based on the model of professional environment that imitates future professional practice.

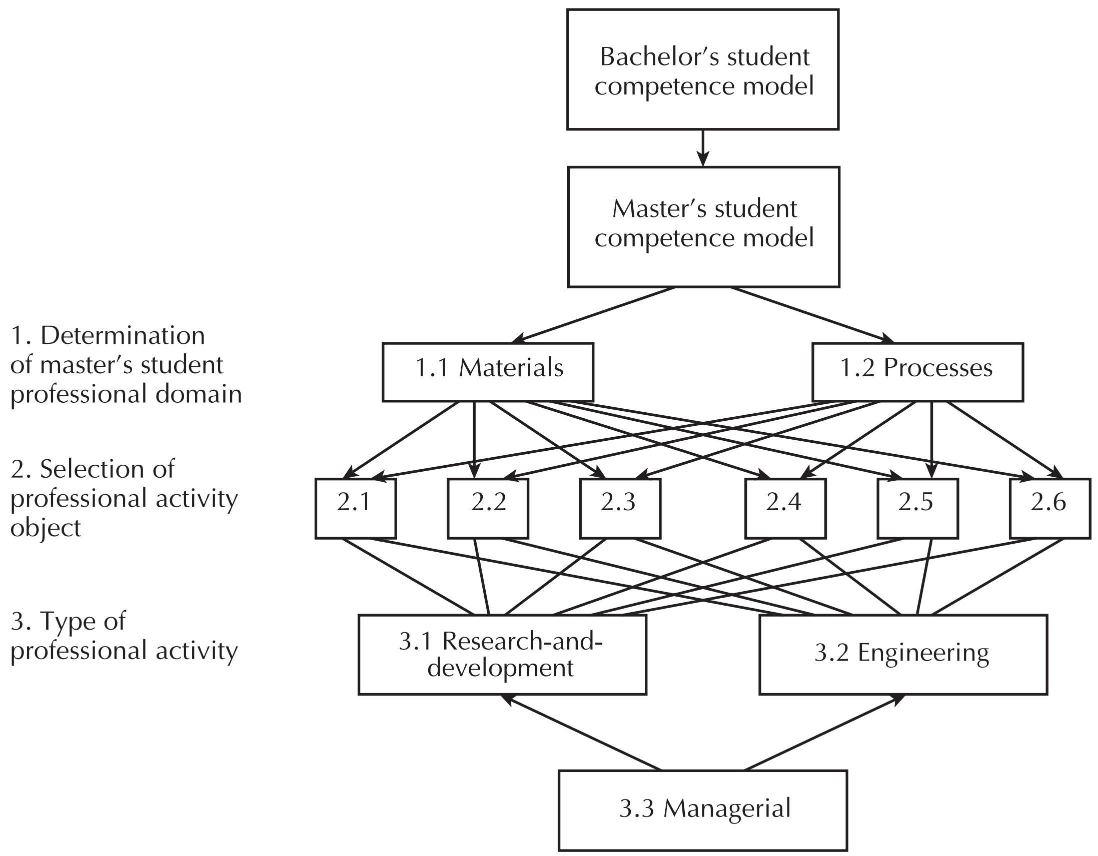
The model of professional environment is termed as a system description of the workplace conditions a graduate is expected to work in. It is designed to give learners opportunities to transfer gained fundamentals and recall the skills and knowledge in the imitated workplace, including difficult tasks and business educational games. The trainers can model any component of graduates' future profession: technological process, manufacturing site, lab, workshop, factory, and industry.

It is not a coincidence that at the Council for Education and Science held in June, 2014, the President of the Russian Federation V.V. Putin said: *"There is need to modernize the engineering education process itself by focusing on practice training, of course without prejudice to the theory"*.

2. Anticipatory training and education: the profession-related subjects should be introduced into the program starting from the first year of education in order to:

- tarting from the first year of education in order to:
- fully familiarize students with the fundamentals of their future profession;
- awake students' interest in their future profession;

Fig. 3. Master's program design algorithm



- show not only positive sides of the chosen profession, but also its challenges which require from graduates responsibility, deep knowledge in mathematics, physics, chemistry, mechanics, and other subjects. Therefore, students must study these subjects having a clear vision of their profession requirements. This would guarantee their good understanding of the key principles of the profession they have chosen. In this case, such subjects as physics, mathematics, etc. are no longer considered alien within the education program. The gap between completion of the enumerated subjects and transfer of the gained fundamentals into workplace environment is also reduced.

3. Independence and commitment of a student to acquire profession-related knowledge: students, more specifically, their professional needs, become a prime mover of the educational wheel. Lecture, seminars, labs, business games, automated systems are just support tools for an independent and highly-motivated student. There are ongoing changes in the content of student independent work: it does not only provide students with subject-related assignments, but is also intended for an active and motivated student who is striving to resolve all possible tasks derived from the learning outcomes that are stated in the education program and competence model. In addition, there is dramatic drop in students' dependency on external control, i.e. on various tests and exams. Every effort is made to carry out constructive work – to train a good specialist. The role of a teacher is currently undergoing conceptual change: the fundamental job of teaching is no longer to distribute facts and data, but to organize education process effectively. The goal of education is as follows: the focus is not on knowledge (it is an intermediate goal), but on professional skills and abilities **(through knowledge to competences).**

4. Individualized learning:

- the content of curriculum is defined according to students' needs and interests;
- instructional technology, pace of learning are based upon the abilities of each learner. Consideration of individual needs and abilities should also include compliance of personal features with the type of profession chosen.

Besides, supportive and you-can-do-it attitude of an educator is one of the most important motivating factors. One of the main tasks of a teacher is **encouragement and support.**

The system of active specialization acquisition (SASA) implies revision of course content and objectives. In addition, the course itself is regarded as an integrated system. The goal of a definite course is to provide a student with an integrated system of knowledge and teach him/her how to use this knowledge in profession-related task solving [10, p. 94-98].

The SASA is based on modern teaching technologies:

- design-based learning;
- problem-based learning;
- context-based learning;
- module-based learning.

The basic task of the faculty is to create favorable environment and equip students with the required competences. It is also important to align the applied teaching technologies with this task. The above-enumerated teaching technologies are not something new for a Russian teacher; they were widely applied not only at National University of Science and Technology «MISiS», but also at a great number of Russian universities. However, little attention is currently paid to the choice of this or that teaching technology. It is said that it is primary responsibility of a teacher to choose the method to instruct students. Despite this fact, we believe that there is an urgent need to explain modern teachers how to use well-known teaching technologies effectively. For this purpose, it is required to hold methodology seminars in various departments on regular schedule. Attendance at such seminars and workshops should be regarded as faculty professional development.

The discussed approaches to developing engineering graduate's competence model are primarily based on the experience of leading Russian universities.

Apart from strict requirements to profession-related knowledge, abilities and skills, employers place a special emphasis on student's commitment to self-education, his/her ability to work and solve problems independently, assume responsibility, and respond to crisis.

Within a two-tier education system, bachelor's degree programs create a foundation for further student independent work with the use of modern information technologies. Student independent work should be interwoven throughout the whole education program. No knowledge could be effective if it is not reinforced by independent work.

In addition, student independent work is of significant educational importance: it plays a vital role in shaping a number of crucial personal features of future specialists, i.e. persistence and determination. As stated by our distinguished scientist D.I. Mendeleev "There is no talent, neither genius without hard work".

In recent years, due to intensive development of information technologies the leaders of USA universities have been increasingly recognized that "face-to-face" education costs 30 thousand dollars, while the price for distance learning is 2 thousand dollars. This fact emphasizes the role of a teacher in shaping future graduate's personality. It is no coincidence that leading universities are hunting for the teachers who are popular among young people.

The positive effect of a teacher is rather essential as it helps to shape professional consciousness of a specialist who is now of great demand.

The foregoing leads us to the conclusion that it is essential to:

- make the borderline between such two terms as competency and competence;
- distinguish in engineering programs practical/instrumental competence;
- introduce "commitment to quality" as an obligatory competence;
- apply the elements of the active specialization acquisition system (SASA) in education process.

The study presents the examples of competence models development for bachelor's and master's programs. It also proposes the methods to plot the competence "tree" and compile the competence "passport".

The current study has revealed the need to revise the education process in order to ensure high quality of engineering training and effective development of graduates' competences.

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Measures Contributing to Publishing Activity of Faculty Members

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Today, publishing activity is one of the priority indicators in department faculty activity. In all international ratings the significant share of the integral indicator (from 30 to 50 %) ranking universities in their positions accounts for the evaluation of research activity performance. It is worth noting that most of department members of Russian universities face a number of challenges in developing their publication career due to insufficient level of foreign language and information technologies knowledge. The article presents the actions that should be taken in order to stimulate publishing activity of faculty members and increase their citation index.

Key words: publishing career, publishing activity, article, citation index, h-index, stimulation of publishing activity.

THE BACKGROUND

At present academic teaching staff (ATS) is the most valuable assert of any university as the efficiency of academic performance depends directly on its qualification, quality, and proficiency which is closely connected with university competitiveness [1, 10].

As is known, one of the key indicators of university performance is its teaching staff's publishing activity. Publishing activity is a result of an author's or a team's research activity or some corporate author's research activity realized in the form of research publication, for example, a research paper, article in a multi-author collection, report in scientific conference proceedings, an author's or multi-author book, research report [6]. In some cases, publication is a mandatory requirement, for instance, when applying for research grants or research fellowship, rewarding academic degrees and titles, certifications, as well as election of winners in various contests for proficiency [11].

In addition, in some educational and research institutions a number of positions require some publications as a crucial indicator of staff's rating score or performance evaluation. In present condition, the presence of submitted articles is not enough – career of any teacher or researcher depends also on their ability to publish their research results in the leading peer-reviewed journals included in the international Web of Science and Scopus databases [9, 11].

Not only teaching staff is interested in regular publications, but also institution authorities, since the number of publications is a key indicator in an institution accreditation for research activity, its rating evaluation among other educational institutions, tender application for research projects, and in some other cases [8].

It should be noted that, in spite of significance of the given indicator in a university teachers' performance, there is a lack of articles in the leading domestic journals dealing with the problem of teachers' publishing career development. The given aspect is consistently considered in the articles by P.G. Arefiev [5, 6].

QUALITY OF RESEARCH ARTICLES

One of the main laws of research activity formulated by Robert Merton and stated the "publish or perish" principle manifests itself everywhere and results in the situation when researchers are involved in a true publication race spending tons of paper and set "records" in the number of research articles [11]. In this case their quality is reduced in the pursuit of quantity of articles. However, it is the quality of articles, not their quantity, which is the indicator of a researcher's portfolio.

A researcher's articles that are in demand and cited among the scientific community constitute the basis for calculation of integral indicator of research activity, i.e. citation index. First of all, specialized periodicals are interested in high quality of the published articles, as the value of a journal impact-factor which defines its status and popularity among the scientific community depends on the number of references to the articles published in it [9].

As is known, in all international ratings the significant share of the integral indicator (from 30 to 50 %) ranking universities in their positions accounts for the evaluation of research activity performance in the form of research articles published in the leading peer-reviewed journals [5]. Besides, one needs to have high rate of citation for those articles, i.e. considerable share of a university in the international rating is acquired by both performance and quality of research, namely, publishing activity of its teaching staff.

To reach the higher score and be included in the international ratings is only possible due to the significant number of frequently cited articles and high-quality research product. There is a strict review system in the high-rating editions, so, second-hand articles or, all the more, plagiarism cannot be published here.

Hence, one of the major problems of modern Russian universities is an increase in research, which means publishing activity, i.e. increase in the number of works published in leading research periodicals, as well as increase in their citations [5, 12]. The Russian Index of Scientific Citation (RISC) is a basic information database for research data of the majority of Russian universities. The following indicators are used to analyze the publishing activity [4]:

- efficiency – the general number of published articles;
- quality of an article – the general number of references per one publication;
- performance – Hirsch's index (h-index).

To achieve the international level, take a reputable place in the educational market the Russian universities have to intensify their research activity and increase the quality of research product [5]. Among the priority measures contributing to knowledge and scientific resource capitalization one can distinguish the following:

- development of strategy in promoting the university research products at the national and international levels;
- design of the program for increasing the university publishing activity including forms of merits for actively publishing employees;
- selection of leading journals where the teaching staff's research results are recommended to be published.

To perform these tasks there must be qualified personnel with the appropriate competencies, namely [6]:

- a good command of Foreign language at the level sufficient for communication and writing research articles and reports;
- skills in working with electronic resources and experience in arrangement and management of personal knowledge. To have the staff of such a level, it is necessary to perform long-term and systematic work.

In the absence of such personnel it is appropriate to hold trainings and seminars for the teaching staff to upgrade their qualification. In particular, one needs to organize the upgrade course for research activity managers, research and teaching staff, library workers to develop information competencies as well as to teach them to efficiently search for and work with electronic information and analyze personal research results and the university outcomes in general.

Institution and publishing activity management is a complex and multi-aspect process. Therefore, one can solve the problems concerned with the growth of research activity performance only in systematic aspect. Separate, spontaneous measures without a system can only result in insignificant and short-term effect. Hence, the system of measures should be focused on development of performance reproduction that would guarantee a steady growth of university indicators.

To provide systematic organization, it is necessary for a university to have qualified research staff. University can maintain high publishing performance by introducing innovation which is closely connected with science and research development. The development of highly qualified research staff is possible by means of upgrading its qualification and acquiring "competences of wide application" [8].

ARTICLES AS A BASIC FORM OF SCIENTIFIC PUBLICATION

Scientific publications – abstracts, articles, monographs, methodical manuals – are the basic results and one of the crucial conditions for research activity performance. Publications are referred to those internationally recognized indicators that evaluate a university teacher's research performance. Judging by the RISC data, high publishing activity of university ATS does not always increase its citation index proportionally [7]. This fact shows that many publications are likely to contain information irrelevant to anybody, without any research novelty, or, perhaps, the articles are published in proceedings, which present no interest for scientific community.

The advance in science is known to be based on exchange of information. In this case a publication is a reliable indicator of research product quality expressed in knowledge units [11]. The first and simplest approach to evaluate research outcomes was the general number of the works published, but, unfortunately, this number cannot be a measure of knowledge quality which it contains. Many proceedings are not housed even in university libraries and not enjoyed by large readership. Notwithstanding, the given approach still remains the most common one for evaluation of a researcher's, team's, or laboratory's potential [7].

A researcher's career is strongly influenced by the number of his/her publications. The scientific community believes that the list of publications proves a researcher's performance. In this case it implies that all of them are of high quality. To increase the reliability of this premise to some extent, the list is often divided into "articles in the peer-reviewed journals", "ordered works", "proceedings", and other categories [8].

It should be stated that the bulk of presently published articles is just modification of previously written papers or devoted to the analysis of existing theories [11]. However, the key task of research journals is to promote the original ideas. The journal has to be involved in promotion of new ideas, but not in publishing article, where some known ideas are specified or some insignificant transformations are introduced into the initial concept. Such articles just demonstrate the fact that they do not always contain the original conclusions, but, virtually, can present the comments on other researchers' work. As a rule, "the life time" of a journal article equals 10 years, whereas "the life time" of a monograph is usually limited to two years.

Creative articles of "scientific masterpieces" origin form the level of international achievements and demonstrate the research potential of an institution, presence of infrastructure and staff capable of making discoveries and breakthroughs at the international level [13]. The fact that the articles immediately attracting attention of scientific readership are affiliated to a definite institution reveals that it has creative staff capable of developing and implementing the "breakthrough" ideas. The articles of "medium international level" demonstrate the general high level of the institution research, progressive research advance and recognized research leaders inside the organization – independent promising researchers and research teams.

There are different forms of presenting research in the form of abstract, conference reports, proceedings, articles, reviews, and monograph, however, the most common and representative one among the scientific publications is article. The other forms of publications are either distinguished by large volume (monograph), therefore, rarely published or are not informative enough such as abstracts or proceedings [8]. Articles presenting analytical evaluation or review of existing approaches to the solution of a definite research and/or practical problem are also quite acceptable for the research journal structure.

INFORMATION SKILLS NECESSARY FOR A MODERN AUTHOR

To correspond to the contemporary research level, teachers, researchers, post-graduates, and doctoral students are to acquire new information competences connected with searching techniques and processing of relevant and retrospective publications on a selected research topic as well as production, promotion, and evaluation technologies of research results. To estimate the quality of new knowledge reproduction, it is necessary to process a significant volume of previously published information. Modern researcher has to develop a capacity of navigating in the cyberspace of one's research sphere, be able to efficiently search for and process research information [5].

It should be noted that in all international and national citation databases the same condition is formulated for the authors: different versions of an author's surname spelling can cause the development of several profiles of one and the same author which would include his/her articles, if the surname coincides with that of the profile. Therefore, all research citation databases have opened special interfaces for the authors – author's profiles [6]. The key problem of author's profile is to provide an opportunity for the author to edit the data on his/her publications. The author can see the whole list of his/her works identified by the system under his/her name, point out different versions of his surname to the system, and include those publications that are not automatically included in the list.

To track the publishing indicators – the number of published works, citations, Hirsch's index and other parameters, the author should know and be able to work with the tools of monitoring and outcome evaluation of his/her research activity.

The most efficient way of increasing citation is to intensify a university's research activity. But when solving the problem of citation one can face some tactic errors made by both authors themselves and universities in this sphere the correction of which would allow for a university to improve its scientometrical indicators.

The open databases of many universities show that most of ATS, among whom there are Dissertation council members including even Dissertation council chairmen who are to define "a research image of university", is not registered in RISC and does not publish anything for years. Moreover, they have 1, 2 or 3 h-index that is appropriate only for early career scientist [7].

To improve the situation in citation index and university rating, it is necessary to change the authors' tactics, for example, to take a number of measures [6]:

- first of all, it is necessary to register every publishing researcher and teacher in RISC;
- authors registered in RISC have to carefully consider their list of publications.

RISC includes all publications with some delay. Usually, when author often publishes his/her works, each author has more publications than he/she has in RISC, [7]. It is quite possible for the authors, who now have "zero" publication in RISC, to have them actually be issued, but they are not included or shown in RISC. In fact, RISC registration on the same day improves the scientometrical citation indicators of both author and university. It is conditioned by the fact that the initial data of publication are not always precisely written when registered the materials in RISC. There can be a mistake in an author's surname or initials, article title etc. In this case, publications are included in the category of "unattached" ones or attached to another author with similar surname or initials.

To prevent this, every author should regularly track the registration of his/her publications, add the missing ones, and correct the mistakes. Such work with his/her personal data in RISC allows the author to specify and improve his/her scientometrical indicators [7].

A screenshot of his/her personal web-page of the official RISC site can serve as a documentary evidence of an author's publishing activity reflecting it fairly in all indicators and in aspects.

International publishing activity reflects the level of national science development in comparison with other countries, especially in the sphere of fundamental research where other results but publications are not expected. Publishing activity management is a rather complex, multi-factor problem which cannot be solved only by administrative methods or resolutions. In this case a systematic approach is applicable as it takes into account many aspects and the result can be achieved by the integrated systematic work, the effect of which is usually long-term.

High research outcomes, particularly, in the forms of publications can result in sharp increase in university indicators. It depends on the developed research base of an institution, efficiency of research work or, in other words, availability of previously performed research, i.e. the level of research fund development.

THE ACADEMIC WRITING UPGRADE COURSE

As is known, rather a limited number of specialists know foreign language professionally, i.e. at the level of free reading of original sources. Therefore, the level of submitting articles in foreign scientific periodicals in Russia is still extremely low. The number of Russian authors who can write research publications including articles in English is even lower [6].

To increase the quality of educational programs and ATS publishing activity, it is necessary to solve the problem of language competence. For this purpose most of Russian university ATS should have an access to the appropriate full-text and bibliographic databases, electronic libraries and achieves of the leading foreign and domestic editions to learn the latest achievements in the world and national science and upgrade their competencies in accordance with the present state of knowledge [4, 5].

To overcome the obstacle and increase university publishing efficiency, one should organize a center of specialized language training in universities. In this center ATS is to develop skills required for writing articles and other types of publications in foreign language to publish them in the international research journals taking into account specific nature of research sphere and definite scientific journals. In addition to specialized language training, the potential authors are to be taught in selection and evaluation techniques of the journals, where they are going to be published. Hence, the problems of upgrading courses and growth of university ATS language competence can be solved.

It is of interest that in Great Britain there was an experiment in teaching upgrading in the sphere of information technologies that revealed the socalled "the lost research generation", which was referred to the university researchers and teachers of older generation poorly informed about the perspectives and merits of information competences, skills in searching for and working with on-line information sources, i.e. ignoring their competitive advantages as teachers of the new research generation [6]. In Russia, "the lost research generation" includes not only university ATS and researchers of older than 60, but also significant number of younger specialists. It is explained by the fact that those researchers do not search for scientific articles in the Internet, but use only printed editions. Moreover, the opponents of electronic journals and books often read only those editions where their articles are published. For example, "Bulletin" of the university can be a basic source for their reading.

CITATION

The value of research is known to be defined by its results, the relevance of which depends on its demand and "surplus" value obtained. The demand and value, in their turn, are influenced by the sources where the research results have been published as well as how the results have been cited by the research community [13].

The key criterion for evaluation of research relevance, efficiency, and performance is citation, i.e. the number of references, which have been cited in the articles in the given research sphere published during a definite data selection period [9]. Frequent publication citation shows the relevance of performed research and its recognition by the research readership. In fact, this factor is a performance indicator [4].

Citation index demonstrates the number of references to a researcher's articles in publications of other researchers. This feature is sure not to be an absolute indicator due to various objective and subjective reasons, but the index is accepted in all European and American universities as one of the most important factors influencing the results of competitive selection for university teaching vacancies. Citation index of a researcher or university witnesses, at least, two factors.

First, it reflects the relevance and value of the performed research in the spheres, where definite experts or research teams are involved. If a researcher publishes a large number of articles, which are not cited, it, as a rule, means either low research level or lack of research community's interest in the discussed problem. Second, to some extent citation index reflects the rate of research community's recognition of a definite researcher's contribution to this or that scientific problem solution, serves as an evidence of researcher's work priority and relevance. The general citation index can add a significant value if authors publish great number of articles, though not so often cited [12].

In addition, it is noteworthy that due to the capacity of modern information technologies citation index is an ever-improving technique of quality evaluation of the published research results. High citation index indicates that new information in published articles is in demand by the scientific community.

In this case, in spite of being ever-improving (for example, h-index, and journal impact-factor), citation indexes, have some "innate" drawbacks [8]:

- the relevance of published results cannot always be accepted and correctly evaluated by the scientific community;
- scientists can quickly adapt to the system by using self-citation or mutual citation;
- citations do not always mean a positive estimation of publication. The article can be cited to criticize it or point out an error.

For example, researcher publishing his/her scientific results in English has much more possibilities to be cited than publishing them in Russian. But if a publication is focused, first of all, on the Russian readership, it is preferable to publish it in Russian.

Using citation indexes it is suggested that the higher the quality, relevance, and importance of a definite publication, the oftener it will be cited in the scientific literature. The presence of researchers having high citation index in a university demonstrates high efficiency and performance of university research activity in general. High citation indexes are sure to be evidence of researcher's active work, but the values of his/her results for science and technology can be determined by indexes only approximately. It is particularly difficult to apply them for comparing researchers' results working in different branches of science or in sufficiently different conditions. The range of numerical index values significantly differ when using different systems and for different disciplines.

It can be underlined that straightforward application of indicators for making management decisions, especially those connected with finance or personnel would inevitably result in decreasing personnel motivation and using indirect means. It is no longer in doubt that the citation indexes of the Russian universities striving to be placed in the top 100 world leading universities will grow in the nearest years, but it is not due to research activity intensification, but because of increased attention to this problem and ever-growing pressure of university rectorate [12]. It is not bad, of course, since this process will promote, to some extent, the Russian scientific prestige at the international level and desire of the university researchers to position themselves among the foreign colleagues.

It should be noted that low and low-quality citation is a chronic disease of Russian researchers, who do not possess skills in proper presentation of their research results in the attractive and beneficial form to promote themselves and their research results [5]. Russian researchers often publish their works in the low-ranked domestic and foreign journals, when the quality of the editions do not promote, but sometimes prevent from recognition of their credibility among the specialists [6]. Therefore, the articles of Russian authors often remain unrecognized and unexploited in comparison with high-quality foreign scientific periodicals and, hence, are condemned to be low cited and underestimated. Therefore, it is not quite appropriate for the author to submit articles in the journals of low level as the list of the researcher's work should include publications in highly ranked journals.

To achieve the maximum citation level is not a simple and short-term problem. There are some cases when article can be numerously cited during a short period of time if it deals with extremely urgent for the given discipline topic [12]. However, high citation cannot be of long-term, and such a work will be often cited at most.

The typical Russian authors' mistakes include their making the same references that have already been used by the previous researchers, i.e. make reference to the reference. In this case they do not cite some other significant work and often do not consider in detail the articles which they refer to in their publication or make general conclusion about the work based on just an abstract, especially if the article is published in foreign language.

I know from my personal experience that many university teachers rarely refer to modern books and articles from the current issues of the foreign journals. It suggests the absence of ATS's citing culture and high concentration of authors on themselves. Hence, the number of articles in domestic journals exceeds significantly the number of foreign ones, especially in the editions with high impact-factor.

To increase the citation index in universities, one should track the references to its ATS working in the same research sphere more thoroughly. In many publications there are often not enough references to the experts' works on the considered problems, which can be used to track the state of problems and the results achieved. Absence of sufficient citations can give rise to the idea of the author's superficial research and does not give possibility to track sources, history, and perspectives of the research problem

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solution.

The current state is partially explained by the simple reasons:

- insufficient level of most researchers' and teachers' foreign language knowledge;
- lack of competence in using Internet resources;
- absence of many leading foreign journals in the libraries or their arrival with considerable delay.

Every researcher is sure to have a complete list of personal publications published within the whole period of his/her research activity both in the country and abroad in the database. Besides, there should be complete data on the authors of the most significant publications in their research institutions that are the development centers of the given research sphere. The researcher should keep in touch with current publications as well as know whether similar articles or articles on closely related topics have been published.

It is necessary to pay attention to the issue date. If sources cited by an author are of 50 years old, it would be difficult to submit his/her article, as the problem he/she considers is not perspective [11]. The authors' failure of finding sufficient sources to be included in the references demonstrates the fact that they do not follow the tendencies in development of research problem in the sources. In case if other researchers are not interested in the given problem, it is unlikely to be a perspective area.

THE NECESSITY TO DEVELOP THE PUBLISHING CAREER OF UNIVERSITY ATS

It is known that it is rather difficult to submit an article in the international highly-ranked journal that has index in the international bibliographical databases such as Web of Science or Scopus, if an author does not have any experience in submitting articles to some Russian journal, i.e. to be successful in the research at the international level there should be definite author's career tested in the Russian journals [4]. It is impossible to write an article even of "a middle international level" without publishing experience in the Russian periodicals [13].

Decision about submission should be taken solely by authors taking into account the ideas contained in the article. Preparation of research article should be based on authors' desire to bring the results of the performed research to wide research community, demonstrate his/her competence and proficiency and gain the colleagues' recognition. Thanks to publishing the research results an author or a team secures the priority for the discovery of new properties or regularities, solution of research problem or development of new technology. Publications lay the ground for cooperation and communication among the scientists [9].

At the start of writing research article a researcher has to follow a number of rules that allow him to provide high quality of his work to be accepted in a definite scientific edition and, will further be in demand, i.e. read and cited by the research community. The first thing a researcher should think of is whether he/she should publish his/her results. For this purpose he/she has to answer the following questions [11]:

- is there enough facts on the research problem to gain the interest of professional readership as a result of publishing the article;
- to what extent do the materials and methods, obtained results, and drawn conclusions correspond to the set goals and objectives;
- to what extent are sampling, processing and analysis methods used in the research appropriate, whether the conclusions correspond to the results obtained.

If the author can make a reliable conclusion about sufficient quality and volume of collected data, about the relevance of the tasks set, methods used and results or conclusions obtained, he/she may start writing a research article.

To effectively communicate his/her publications and develop personal publishing career an author is to have a clear idea of modern scientific communication system, defining his/her own place in this system. A researcher is to know where, what, and how it is advantageous for him/her to submit, for example, personal research article – in the Russian journal or participate in writing multi-author monograph or allow the article for free access in the Internet.

Young teachers have to be explained that they are to enhance their professional competency, be inspired by development and realization of successful personal publishing career. In fact, list of publications is a cumulative base for author's achievements that can be efficiently developed all his professional life long. The publication list demonstrates clearly whether the author has achieved significant results in his/her career or not.

Certainly, university teacher is to be an expert in his/her research area as well as possess definite skills i.e. be familiar with current literature, competence in the sphere of management of personal knowledge, project, and time and know at least one of the foreign languages at the level sufficient for communication with foreign colleagues in real and virtual research environment as well as writing publication in foreign language [6].

Hence, ideally any university teacher has firstly to be a researcher in the subject area that he/she teaches [1]. One needs to understand that without science there cannot be education capable of contributing to economic modernization [1, 3]. Therefore, the necessary conditions for development of research in university should be maintained.

At the moment, the crucial problem of any university is that of selection and estimation of ATS performance [10]. It is not enough to estimate the teaching staff in terms of the general number of Doctors and Candidates. It is important to connect this indicator with their work results, i.e. place stricter requirements to ATS at vacant position competition. It is hard to accept that today more than 30 % of the Russian university ATS do not meet even the lowest requirements [1]. First of all, one should start with department heads, deans, vice-rectors, and rectors, each of whom, particularly, a department head is to be a research leader, a head of academic-research center for the research team.

At present the following fact is obvious: it is a teacher who is a university key player due to his/her competencies, professional knowledge, and commitment to teaching university graduates, which is the main result of university performance. New challenges faced by the Russian universities require efforts from not only university authorities, but also every teacher. It is quite obvious that it is time to estimate every teacher's performance. It is easier and simpler to estimate a teacher's job in terms of the rating [14]. Undoubtedly, university ATS rating should be developed according to international criteria, otherwise, the idea is lost and integration of Russian higher education into the world education environment is complicated.

It should be noted that not all ATS welcome the introduction of such indicators of teacher's research performance accepted in the world, as citation index, h-index, journal impact-factor, publications in peer-reviewed highly-ranked journals into rating. Many prudent and experienced teachers have no idea of the reasons for not including the articles submitted in the local research journals or handbooks in the efficiency criteria.

Hence, the rating evaluation system of ATS outcomes becomes a necessary tool for not only more equitable payroll distribution, but also increasing the performance of every university. In this condition rectorate is to demonstrate its achievements by their own example. In case of their absence it is rather difficult to motivate the staff to perform large-scale work. High personal indicators lay the foundation for the rectorate to require the same efficiency and responsibility from the staff in the sphere of research activity. In fact, rating indicators are a base to answer the question – is it necessary to support employees who do not seek for self-development and are passive in research and publishing activity? [14].

To increase teachers' proficiency, one should develop a special development and support program for the university research schools. The program has to provide the enhancement of material resources of departments and laboratories, send teachers to training in leading research centers of the country and world, and provide the possibility to communicate with leading specialist in definite research spheres [2].

The basic source of necessary skills, additional to the main teacher's activity and advisory for successful self-development as a modern researcher, is to be the upgrading program. To what extent these additional competencies are significant for a researcher can be demonstrated by the experience of Great Britain, where scientists have raised the problem of training highly-qualified staff for British science [4].

For this purpose the system of upgrading and additional education was developed. It is based on refreshing or selective post-graduate courses realized in every university or additional courses for teachers and researchers. When making their careers teachers and researchers are to provide upgrade certificates and acquire additional "skills of wide application" [6].

Hence, one can make an unequivocal conclusion: the contemporary realities make universities evaluated thoroughly the outcomes of every teacher's job and his/her contribution to the university rating [9]. Doing so, the rectorate has to plan in detail ATS publishing career. Let us give the examples from the personal experience. When interviewing new teacher, after his/her application for a position with the documents confirming academic degree and titles, there comes consideration of publication list and if there are not highly-ranked articles in the list, hence, an applicant cannot arrange his career, is not able to perform large-scale projects at the federal level. In this case it is no hope for possibility of the teacher's professional growth. There always appear a great deal of questions on why people do not want to develop their career, the success of which is directly connected with the level of remuneration, especially today, when there are no requirements for belonging to a party, when the rectorate of all universities is interested in growth of personal research indicators of all ATS. It is not clear why an employee does not promote his/her personal career, why he/she is satisfied with his/her being a senior teacher for 30 years. Why not to try once in a life to develop a manual of federal level, receive expert assessment, i.e. confirm his/her teaching competence in the subjects taught from the independent experts. Presence of such a teacher in the study room cannot motivate students to perform research activity as he/she cannot develop a student's intellectual potential.

There are some Doctors of Science in our university who publish low-ranked articles and do not feel any shame when they read lectures for the first-year-Bachelor-students and flatly deny working at graduate department, the graduates of which they are themselves, i.e. teach major at the graduate department, supervise graduate paper , and they are constantly complaining about large number of hours. They are often members of Dissertation council, and rectorate has to "provide" them with publications in the journals from Higher Attestation Commission list by means of including their names in articles of other post-graduates; they do not feel uncomfortable to include these articles in their publication list. It is necessary for such Doctors to create intolerable condition in the university with regular reports, when indicators of every teacher are submitted for common discussion. Unfortunately, there are Doctors of Science in our university without any independent research or relevant publication in the peer-reviewed journals.

Obviously that scientific and technical expertise and skills in the sphere of the subjects taught characterizing the teacher's scientific qualification are to be at the high level [1]. To maintain their competence, teachers are to upgrade and enhance their knowledge, enable their professional growth. In this case every teacher is to have a clear idea of how his/her subject contribute to a graduate's competence development.

Thus, implementation of the new education standards requires the university teaching elite – experts ready to work in the new condition, capable of using up-to-date technologies and taking responsibilities for the learning outcomes. It is well known that decrease in ATS professional level could result in irreversible effects and overall degradation of education system in universities that is quite unacceptable [2]. To maintain the necessary level of ATS professional training, one should manage the teacher's career that consists of two directions – research and academic-methodical. The preference is sure to be given to training of teaching staff in research direction as the ideal is the education based on science [1, 4].

PROMOTION OF PUBLISHING ACTIVITY

It is known that high research level of ATS activity is to be considered as one of the priority challenges, tackling of which is a base of the university rating. Therefore, much attention should be paid to the analysis of the problem and arrange some actions contributing to its solution in practice [2].

To solve the problem mentioned above means to take a set of simple and understandable measures promoting efficient research in university. The key result is submission of a research article. Therefore, it is necessary to take into account the number and quality of publications and take measures in authors' material incentive. Rectorate is to develop clear criteria of publication evaluation and exclude the articles published in the non-peer-reviewed journals from the report.

The most time-efficient measure is authors' motivation due to payments for their article publication in journals [5]. In this case it is initiated by the authorities, but the decision depends on the author. There are some bases for such decision. The main reason consists in the fact that the number of authors who regularly submit papers in the foreign highly-ranked journals is much less than that of authors who work in the Russian institutions of science and education and submit their papers in the national journals included in RISC.

It appears that there is authors' potential in the universities, but one needs to promote teachers' publishing activity in a proper way. Certainly, one can only make ATS write articles, but the effect would be better if there would be a limited combination of administrative measures with the motivating system [10]. The given combination can work with much greater effect, if an author is additionally paid 100-150 thousand roubles for one article published in the highly-ranked foreign journal that is included in the international bibliographical databases Web of Science and Scopus. It would rather inspire him/her to more efficient publishing work.

But it is not necessary to reward the author only by bonuses and payments; one can encourage publishing activity in another way [14]. For example, to pay for active author's participation in the leading international profile conference. The author gets moral satisfaction and has a chance to enhance research credibility in the international research community, establish working contacts as well as find potential co-authors. Or, for example, an intensely publishing teacher can be appointed for the industry or state awards or honorary title that would assist in receiving "Veteran of Labour" title, i.e. to apply moral incentive.

Awarding and incentives do not always produce a sufficient effect, but only under the condition that qualification level of the awarded employees allows for the expected outcomes. In this case, using awarding system, it is necessary to intensify the publishing process among those who are capable of writing articles in the highly-ranked journals promoting the university rating [7].

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Introduction of Modern Teaching Technologies in to "Metrology, Standardization and Certification" Curriculum

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The main trend of Higher Engineering Education is the use of interactive teaching technologies. Precisely, introduction of such educational games as business games, case-studies, etc. into the curriculum of "Metrology, Standardization and Certification" which is basically regarded as practice-oriented course allows educators to make teaching more interactive. The article examines the ways to use various interactive teaching technologies within the above course, the examples being provided.

Key words: standardization, metrology, certification, interactive teaching, business game, case-method, game teaching methods.

Modern educational technologies aimed to assist teaching are becoming more and more popular. It is explained by the fact that compared to the traditional teaching methods modern or innovative ones allow educators to ensure high quality of education.

Being regarded as a type of interactive teaching method, a business game is proved to be one of the most effective modern educational technologies. Business games can be easily used not only as a part of educational process itself, but also as core elements of challenging situation modeling to provoke students to find an appropriate solution.

Basically, business games are intended to place students into a real-world environment by replicating future workplace setting and decision-making process. This helps students gain clear vision of their future profession and develop systems thinking that is of great importance in any activity.

The interactive character of business games is due to the fact that participants cooperate throughout the whole game making various decisions, analyzing the actions that have been taken and discussing the obtained results. Therefore, business games foster students' communicative skills, unveil their leadership potential [1, p. 144-146].

The positive aspects of using interactive teaching methods are as follows: the growing interest in education in general and imitating problems, in particular; efficiency of education as it is based on the definite real-world examples; development of specific thinking; systematic approach to solving problems [2, p. 12-13].

Being interdisciplinary and of universally applied character, the course "Standardization, Metrology, and Certification" is a part of most engineering bachelor's degree programs. It is focused on practical application of the fundamental principles of such subjects as mathematics, mathematical statistics, physics, economics, legal theory, etc. in metrological support and technical regulation. The core of learning process consists of acquiring practical knowledge in legislation system, nominative documents, and basic sciences.

There are certain difficulties in organizing practical classes within this course. When traditional or passive teaching style is used ("authoritative"), practical classes are designed so that an educator simply explains the legislation acts applied in metrology and technical regulation and familiarizes students with the relevant documents. However, it is obvious that these issues can be easily studied as a part of student independent work. As a result, traditional teaching method does not provide students with clear vision of the subject, and, what is more important, it does not contribute to transfer of the gained knowledge to real-world professional activity, i.e. an obligatory stage of competence development in accordance with the educational standards. It is worth noting that these goals can be easily achieved by introducing interactive teaching methods. Moreover, certain sections of the discussed course (certification and quality management) can be hardly well studied without applying modern teaching techniques.

Being of practical character, the course "Standardization, Metrology, and Certification" is closely linked to real-world processes. Due to this, this course can be regarded as rather suitable for introducing modern interactive teaching methods. For example, certification is a complex process that involves a number of definite procedures and always rests on a wide legislation and scientific basis. Use of such an interactive method as business game helps learners do the "puzzle" from various laws, terms, definitions, procedures, methods, etc. and, consequently, provides them with clear and complex vision of the studied subject. In addition, it contributes to improving learners' team-working skills.

To be more precise, the section "Certification" could be taught by applying a number of business games that can constitute an integral concept or holistic perspective of the practical classes within the whole course. They are as follows:

- voluntary product certification;
- certification of product conformance;
- service certification;
- certification in eco-management;
- quality system certification.

The guidance is always included in each game design. It defines the goal and main objectives of the game, required level of learners' knowledge and skills. In addition, it describes the game content and its scenario (certification procedure), proposes the possible distribution of roles (when the number of roles is not sufficient, some learners can be appointed "experts" or "inspectors"). The guidance is given to learners in advance so that they can fill the existing knowledge gaps independently (the recommended literature is given by a teacher). Thus, the greatest effect is achieved: learners are aware of their actions; certification procedure is modeled maximally approximating reality almost without teacher intervention. The game results including the decisions that have been made are discussed by all participants. Besides, students are given an opportunity to assess their own work and results. The assessment criteria presented in the guidance are developed by a teacher in advance. Thus, it can be stated that educational business games combine cognitive, creative, and communicative components.

When designing the game scenarios for various education programs, it is required to consider the difference between the program contents. For the high variability scenario, it is essential to design beforehand the case studies (in accordance with each education program content) which would reflect the real-world certification challenges within the definite profession. The case study is randomly chosen by game players.

For "Metrology" section, educational business games can be applied when studying the legislation provisions in metrology. More precisely, they can be effectively introduced for modeling procedures of the state metrological control in commercial organization. Besides, accreditation of a testing laboratory can be also performed in a form of a business game when one group of students should prepare all required documents while the other should review the prepared documents and evaluate the readiness of the company to be controlled.

Within "Standardization" section, educational business games can be introduced for explaining the procedure of developing technical conditions on the basis of the existing All-Union State Standards for a definite product or for discussing the procedure of State Standard revision and amendment approval. In this case, students are given the outdated State Standards which they should amend in accordance with the established procedure and All-Union State Standard 1.2-2014 (the teacher assumes a role of National Standards Body member who has a right to approve standard amendments). Both scenarios are designed as a small group learning activity, with each group being made up 3-4 students.

In addition to the discussed business games, other types of interactive tasks can be rather effective. For example, the case-study method when students are asked to solve the tasks which do not have definitely right solution can be applied within "Standardization" section. As an alternative, students can be proposed to analyze the possible damage to the customer due to non-compliance with product requirements. To resolve this task, students should define the stage of product life cycle when the quality requirements have not been properly observed. They also have to determine the type of violation and identify a person responsible for it, to propose the actions that could be taken by the injured party and what type of compensation it can obtain, to find out what organizations can be called to solve this problem, etc. The students have to address the above issues independently, determine their own position with respect to the given case and propose the definite ways to tackle the problem. In most cases, the case-study method involves such forms of interactive teaching as discussion, brainstorm, exchange of ideas and views, etc. The main goal of the case-study method is to provoke students to propose as more solutions as possible to the given case and provide them with the clear understanding of the problem discussed. Thus, the focus is not on the acquisition of "ready-to-use" knowledge, but on active participation in the process of knowledge elaboration.

When studying "Metrology", a great diversity of terms, which have rather complex definitions and should be accurately interpreted, presents the main difficulty for students. To evaluate the students' understanding of subject matter, teachers in these cases often apply written or oral tests. However, they are not always effective. As an alternative, we believe that it is better to use such an educational game as "terminological ping-pong". According to the rules, the teacher should prepare the cards with the terms (without definitions). In class, he/she gives the selected cards to two students. One student selects a card and must read the term written on the card while his partner should give the definition to the same term. If the answer is correct, the second student should take the card and read the term for his partner to define it. The game continues until the first mistake. The student who gave a wrong answer is replaced by another learner. The answers are evaluated by all students. The game can be complicated by introducing more than two players simultaneously. In this case, the answers are asked around the circle forming so-called "marry-go-round". All students should be involved in the game: if some students have no cards to work with the terms, they should evaluate the answers of their groupmates, thus, checking their own knowledge. At the end of the class, the game results are discussed, the mistakes are analyzed, and student ranking is done.

Thus, application of modern educational games in teaching "Standardization, Metrology and Certification" helps to introduce interactive learning methods into education process, which, in its turn, enhances and contributes to student learning and improves the quality of education. Thus, it reinforces student engagement and interest in the learning process, precisely, in their independent work. As a result, the course materials are not mechanically learnt, but comprehend by students. This fact is proved by students' learning achievements and interim evaluation results.

It is worth noting that there is a great variety of interactive teaching technologies. The educational games described in the current article are just the example of how educators can improve the educational process by introducing modern interactive forms of teaching. Thus, interactive teaching technologies have a great potential to form the competences of future professionals.

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On-line Quality Assurance of Study Programmes: EQUASP Approach

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The description of the EQUASP model for quality assurance of study programmes, developed in framework of a TEMPUS project, is introduced.
The introduction section contains brief information on the concept of quality and quality assurance of study programmes along with the Tuning approach to the design of study programmes and the standards and guidelines for quality assurance in the European Higher Education Area.
The fourth section describes the EQUASP approach to quality assurance and pinpoints the necessary documentation for the quality assurance of study programmes. More specifically, the EQUASP standards for the quality assurance of study programmes are defined, followed with the identification of the fundamental processes for a quality management of study programmes together with the associated quality requirements and expected activities for their accomplishment.
The information and data which study programmes need to document in order to provide evidence of the quality of the educational service offered and therefore, to assure their quality, are established.
The standards and guidelines constitute the 'EQUASP Model' for the quality assurance of study programmes.
The fifth section introduces the EQUASP approach for monitoring of quality of study programmes perceived by interested parties (students, graduates, employed graduates and employers).
Finally, the sixth section summarizes the objectives already achieved and introduces the activities in progress for the completion of the project according to the established work plan, while the conclusions summarize the benefits of the EQUASP system.

Key words: study programmes, quality assurance, tuning approach, documentation of quality of study programmes, monitoring study programmes' quality.

Introduction

Quality of study programmes (SPs) can be evaluated by the level of fulfilment of the educational objectives or, in other words, the level of accomplishment of the quality requirements established coherently with the needs and expectations of all those who are interested in the educational service provided, i.e. the 'interested parties' (IPs).

In order to achieve the required level of quality as well as to identify areas for improvement, responsible units of the SPs normally use a quality assurance (QA) system as instrument. A QA system aims at accomplishing the desired requirements and expectations of all the IPs, including the identification and measurement of the level of accomplishment of stated requirements of SPs, as well as to ensure a feedback from the different IPs on the perceived satisfaction with the results of SPs execution. Furthermore, these results must be available to the public, so that QA is a tool to make SPs quality transparent and trustworthy for all the IPs. In other words, QA of a SP can be defined as the whole of activities (processes) for the management of the educational service aimed at achieving the established educational objectives and then at 'ensuring trust' in meeting the quality requirements to all the IPs.

An essential and necessary aspect of QA system of SPs involves a clear and complete documentation of learning objectives, educational process, learning context, programme results and management system. This is a requirement established by the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) [1], in which, in 'Part 1: Standards and guidelines for internal quality assurance - 1.8 Public information', is prescribed that "Institutions should publish information about their activities, including programmes, which is clear, accurate, objective, up-to-date and readily accessible".

The availability of information and data on the characteristics and expected results of SPs is essential for their transparency, one of the most important objective of the Bologna process, and in order to 'ensure trust' in the SP capacity to meet the requirements for quality. In other words, it is essential to assure SP quality, making possible the formulation of an informed judgment on the SPs quality by all the IPs, students and employers above all. The availability of information and data about the characteristics and results of SPs is also essential for their comparability at national and international level, which is another important objective of the Bologna process. On the other hand, the availability of information and data on the characteristics and expected results of SPs constitutes a powerful incentive to the improvement of SP quality (as a matter of fact, when a SP is required to document its quality, in case of bad quality it is also stimulated to adopt the opportune actions for its improvement). Finally, easy access to the information and data is necessary in every quality assessment and accreditation process.

Another key aspect of a QA system is IPs feedback on the quality perceived of a SP. This is a necessary and essential element for the assessment of SPs quality and for the monitoring of the SPs quality perceived by IPs becomes obligatory and of outmost importance in a QA system.

Tuning Approach to the Design of Study Programmes

The Bologna process, with the introduction of a three-cycle system, has produced a drastic change in the design of SPs. In a cycle system, each cycle should be seen as an entity in itself. In particular, the first two cycles should not give access only to the following cycle, but also to the labour market.

At present Higher Education Institutions (HEIs) are undergoing a 'student-oriented/centred' approach, which takes the student as the centre of the teaching and learning process.

The methodology for design educational programmes consistent with the Bologna process principles has been developed within the framework of the Tuning Educational Structures in Europe [2].

The quintessence of the Tuning approach [3] resides in the so called 'degree profile'. The degree profile must clearly define the aims and purposes of the SP, describe in terms of competences and learning outcomes what graduates will know, understand and be able to do by the time they have successfully completed the SP, spell out what can be expected of the graduates in terms of the kinds of tasks they are equipped to undertake, their level of expertise and the responsibilities they can assume.

Standards and Guidelines for Quality Assurance in the European Higher Education Area

Today the definition of suitable academic strategies in order to promote SP quality can rely on the standards and guidelines for quality assurance of higher education (HE) established in the ESG adopted by the Ministers of HE of 45 countries in the meeting in Bergen (Norway) on 19-20 May 2005 and revised in the meeting in Yerevan (Armenia) on 14-15 May 2015. They have found a generalised acceptance in the European context.

In the ESG, the term 'quality assurance' is used to describe all activities within the continuous improvement cycle (i.e. assurance and enhancement activities). The 'standards' set out agreed and accepted practice for QA in higher education in the EHEA and should, therefore, be taken account of and adhered to by those concerned, in all types of higher education provision.

The 'guidelines' explain why the standard is important and describe how standards might be implemented. They set out good practice in the relevant area for consideration by the actors involved in QA. Implementation will vary depending on different contexts.

It is important to note that the purpose of these standards and guidelines is to provide a source of assistance and guidance to HEIs in developing their own QA system, as well as to contribute to a common frame of reference, which can be used by institutions. It is not the intention that these standards and guidelines should dictate practice or be interpreted as prescriptive or unchangeable.

The standards are in three parts covering internal QA (Part 1), external QA (Part 2) and QA by agencies (Part 3). The standards for QA agencies regard the characteristics that should be fulfilled by QA agencies.

Implementation of QA models for SPs have been developed in the past. In the present we describe our contribution to the EQUASP Model developed in the framework of the EQUASP[1] project which general objectives of are:

- The promotion of the improvement of the quality of technological SPs through the implementation of a QA procedure, focused on the definition of learning outcomes, according to the Tuning approach to the design of SPs, and consistent with the revised ESG.
- The design and implementation of an on-line documentation of the QA of SPs and of an on-line monitoring of their quality perceived by IPs.
- Dissemination of EQUASP approach and the results achieved along with awareness on ESG among partner universities.

The following sections describe the design of EQUASP approach and standards, which could help to introduce and implement on-line QA of SPs.

EQUASP Standards and Guidelines for the Quality Assurance of Study Programmes (EQUASP Model)

Consistently with the Tuning approach to SP design, the ESG and with the models for the quality assessment and accreditation of SPs adopted by the European agencies, in particular, with the EUR-ACE Framework Standards and Guidelines [4], the EQUASP approach to QA of SPs assumes that in order to assure its quality a SP must comply with the national standards and requirements, as well as:

- Establish educational objectives consistent with the mission of the institution the SP belongs to and the educational needs of the labour market of reference, and learning outcomes consistent with the educational objectives.
- Design and implement an educational process adequate to achieve the learning outcomes, which embeds a student-centred learning approach, ensure a correct assessment of students' learning, keep under control its development and establish

[1] EQUASP is a Tempus project No. 543727-TEMPUS-1-2013-1-IT-TEMPUS-SMGR

appropriate regulations for students' admission, recognition, progression and attestation.

- Have teaching staff, facilities, student support services, partnerships with businesses, research institutions and other HEIs, and financial resources adequate to achieve the learning outcomes and keep them under control.
- Monitor the results of the educational process;
- Adopt an adequate and effective management system able to assure the SP quality and its continual improvement, and guarantee public access to the information on the SP.

These principles should inspire the design, development and control of every SP. Correspondingly, the EQUASP approach defines the five 'EQUASP standards' for the QA of SPs:

- Standard A – Needs and Objectives.
- Standard B – Educational Process.
- Standard C – Resources.
- Standard D – Monitoring and Results.
- Standard E – Management System.

The processes associated to each EQUASP standard to be considered fundamental for a management for quality of SPs have been identified again consistently with the Tuning approach to SP design, the ESG and the models for the quality assessment and accreditation of SPs adopted by the European agencies. They are listed in Table 1.

Then the 'EQUASP requirements for quality', i.e. needs or expectations for quality, associated to each identified process have been established according to the ESG, with the activities to be managed for their accomplishment. Furthermore, for each identified quality requirement the information and data to be documented by the SPs in order to provide evidence of the quality of the educational service offered, and therefore to assure their quality, have been established, again according to the ESG.

EQUASP standards, the EQUASP requirements for quality associated to each standard and each process, the information and data to be documented associated to each of quality requirements are reported in Table 2.

The complete set of standards for QA, quality requirements with the associated expected activities for their accomplishment, and documentation for QA with a description of the information and data to be documented constitute the EQUASP Standards and Guidelines for the internal quality assurance of study programmes in partner countries (EQUASP Model) [5].

It is important to note that the EQUASP Model assumes that the SP is the only structure in charge of the management of the processes associated to the quality requirements. In some cases, the structures in charge might be others, in particular the structure the SP belongs to. This does not imply any change as for both the quality requirements and the expected activities for their fulfilment.

EQUASP Questionnaires for the Monitoring of the Perceived Quality of Study Programmes

The EQUASP Questionnaires for the monitoring of the perceived quality of study programmes [6] propose a minimum number of questions for the collection of the opinions of the IPs that should be common to all SPs. IPs considered in the present model include students, graduates, employed graduates and employers.

The monitoring of the students' opinions regards the course units and include the following sections:

- organization of the course unit (in particular, lecture timetable, required workload, availability of educational material);
- teaching activity;
- facilities used by the course unit (in particular, classrooms and laboratories);
- interest and usefulness of the course unit.

The monitoring regards also the

Table 1. Fundamental processes for management of quality of SPs according to EQUASP approach

Standard	Fundamental processes
A Needs and Objectives	A1 – Identification of the educational needs of the labour market and other stakeholders A2 – Definition of the educational objectives A3 – Definition of the learning outcomes
B Educational Process	B1 – Design and planning of the educational process B2 – Admission, recognition, progression and attestation B3 – Realization of the educational process
C Resources	C1 – Identification and assignment of the teaching staff C2 – Identification and allocation of facilities (in particular: lecture and study rooms, laboratories, libraries) and support staff C3 – Organisation and management of student support (orienteering, tutoring and assistance) services C4 – Establishment of partnerships with national and international businesses, research institutions and other Higher Education Institutions for carrying out students' external education and mobility C5 – Identification of the needs and allocation of financial resources
D Monitoring and Results	D1 – Monitoring of the incoming students D2 – Monitoring of the students' learning D3 – Monitoring of the students' progression in their studies D4 – Monitoring of the students' opinion on the educational process D5 – Monitoring of the graduates' placement D6 – Monitoring of the employed graduates' and employers' opinion on the graduates' education
E Management System	E1 – Definition of the policy and organization for quality assurance of study programmes E2 – Definition of the management system of the study programme E3 – Review E4 – Provision of public access to information on the study programme

students opinions on the effectiveness of training periods outside the University and international mobility.

The monitoring of the graduates' opinions regards:

- the overall organization of the SP;
- the whole of the facilities used by the SP (in particular, libraries);
- the student support services (orienteering, tutoring, assistance);
- the effectiveness of the educational process.

The monitoring of the employed graduates' opinions regards their perception of strengths and weaknesses of their education compared to their working experience, while the monitoring of the employers' opinions regard their perception of strengths and weaknesses of the education received by employed graduates.

For each question, the EQUASP questionnaires propose a set of possible answers, based on four fundamental answers (Yes / More yes than no /More no than yes / No or Positive / More positive than negative / More negative than positive /Negative), among which students, graduates, employed graduates and employers shall have to choose their own answer. Of course, each university/ SP can add other questions of its specific/ particular interest.

Further developments within the EQUASP project

Definition of the EQUASP Model and Questionnaires have been the main outcomes of the first year and a half of activity of the project mentioned above. The second part of the project will be devoted to the design, production and implementation by a meaningful number of SPs of the partner Universities of the EQUASP Software for the on-line documentation of the QA of SPs and of the EQUASP Software for the on-line monitoring of the SPs' quality perceived by IPs.

The EQUASP Software for the on-line documentation will be resident in the site of the project partner CINECA and will be kept operative for at least two years after the end of the project for all partner Universities. The EQUASP Software for the on-line monitoring will be installed in each partner University. Both will be available for free to any Higher Education Institution of Russian Federation.

Conclusion

The EQUASP Model and Software (EQUASP System) introduced, it should be considered as a powerful tool which allows to:

1. promote the design of student-centred SPs, focused on the definition of learning outcomes consistent with the needs of the IPs;

Table 2. Standards, Requirements for Quality and Documentation for QA of SPs according to EQUASP approach

Standard	Quality Requirements	Documentation
Standard A **Needs and Objectives** The study programme should identify the educational needs of the labour market of reference and other stakeholders, establish educational objectives coherent with the mission of the institution the study programme belongs to and the identified educational needs, and learning outcomes coherent with the established educational objectives	**A1 – Educational needs of the labour market and other stakeholders** The study programme should identify the educational needs of the labour market of reference and other stakeholders. The educational needs should be identified in terms of professional profiles and/or functions/roles/activities expected for the graduates and associated required competences	■ Organisations/ employers consulted and Methods and schedule of consultation ■ Identified educational needs of the labour market ■ Identified educational needs of other stakeholder
	A2 – Educational objectives The study programme should define educational objectives in terms of professional profiles of the graduates and/or functions/roles/activities students are to be prepared for and associated key competences to be developed and obtained by the students during the learning process, consistent with the mission of the institution the study programme belongs to and the identified educational needs	■ Educational objectives
	A3 – Learning outcomes The study programme should define learning outcomes, in terms of what students are expected to know, understand and/or be able to demonstrate after completion of the educational process, consistent with the national qualification framework, if any, and the established educational objectives	■ Learning outcomes ■ Comparison with learning outcomes of other SPs of the same typology
Standard B **Educational Process** The study programme should assure students educational activities able to achieve the established learning outcomes through contents, methods, workload and times adequately designed and planned, promote a student-centred teaching and learning approach, assure a correct assessment of students' learning through suitable assessment methods and criteria. The study programme should also define appropriate rules covering student admission, recognition, progression and attestation and keep under control the development of the educational process	**B1 – Design and planning of the educational process** The study programme should design a curriculum and characteristics of the course units and of the graduation exam consistent with the established learning outcomes. The curriculum should embed a student-centred learning and teaching approach. The study programme should also define assessment methods and criteria able to ensure a correct assessment of the students' learning. Furthermore, the study programme should plan the development of the educational process in order to enable students to achieve the learning outcomes in the expected time, according to a gradual process and through coherent and coordinated educational activities	■ Curriculum ■ Characteristics of the course units ■ Characteristics of the graduation exam ■ Suitability of the curriculum to the achievement of the learning outcomes ■ Calendar and timetable of course units and exams
	B2 – Admission, recognition, progression and attestation The study programme should establish rules covering all phases of the student 'life cycle', and in particular student admission, recognition, progression and attestation	■ Admission ■ Recognition ■ Progression ■ Attestation
	B3 – Realization of the educational process The study programme should realise the educational process coherently with the designed and planned development and keep under control its development, in order to resolve any urgent and immediate problem and to check the adequacy of the assessment tests and of the final work/thesis to the learning outcomes and the correctness of the evaluation of the students' learning	■ Control of the development of the educational process ■ Control of the assessment tests and of the final work/thesis
Standard C **Resources** The study programme should have at disposal teaching staff, facilities, student support services, partnerships	**C1 – Teaching staff** The study programme should have at disposal teaching staff, including teaching support staff, quantitatively and qualitatively adequate for the achievement of the established learning outcomes by students. The teaching staff should be assigned according to pre-definite criteria of choice or selection and the programme should offer the teaching staff the opportunity to improve their teaching skills and the use of new technologies	■ Teaching staff ■ Teaching support staff
	C2 – Facilities and support staff The study programme should have at disposal facilities (lecture and study rooms, laboratories, libraries), with the associated equipment, and technical-administrative staff quantitatively and qualitatively adequate for the development of the established educational activities as designed and planned and able to allow the application of the established educational methods	■ Lecture rooms ■ Study rooms ■ Laboratories ■ Libraries ■ Other resources and special initiatives

Standard	Quality Requirements	Documentation
and financial resources adequate for the achievement of the learning outcomes and able to make easier the students' progression in their studies	**C3 – Student support services** The study programme should have at disposal student support (orienteering, tutoring and assistance) services relevant to the educational process and able to make easier students' learning and progression in their studies	■ Student administrative office ■ Orienteering service for incoming students ■ Tutoring service ■ Service for carrying out training periods outside the University ■ Mobility service ■ Job placement service
	C4 – Partnerships The study programme should have partnerships with national and/or international businesses, research institutions and other Higher Education Institutions quantitatively and qualitatively adequate for carrying out students' external education and mobility	■ Partnerships for carrying out training periods outside the University ■ Partnerships for carrying out mobility periods
	C5 – Financial resources The study programme should have at disposal financial resources adequate for the development of the educational process according to the designed and planned activities	■ Needs of financial resources ■ Availability of financial resources
Standard D **Monitoring and Results** The study programme should monitor the results of the educational process, at least with respect to incoming students, students' learning, students' progression in their studies and graduates' placement, the students' opinion on the educational process	**D1 – Incoming students** The study programme should monitor the incoming students in order to check its attractiveness	■ Assessment of the possession of the admission requirements *(only first cycle and integrated second cycle SPs)* ■ Enrolments at the first course year
	D2 – Students' learning The study programme should monitor the students' learning in order to check the effectiveness of the course units	■ Students' learning ■ Further monitoring
	D3 – Students' progression in their studies The study programme should monitor the students' progression in their studies (in particular: dropouts, number of credits acquired at the end of each course year, time to graduation) in order to check the effectiveness of the educational process	■ Enrolments at the different course years ■ Dropouts ■ Credits acquired by the students ■ Graduation time
	D4 – Students' opinion on the educational process The study programme should monitor the students' opinion on the educational process in order to check the perceived adequacy and effectiveness	■ Students' opinion on the course units ■ Students' opinion on the training periods outside the University ■ Students' opinion on the periods of mobility ■ Opinion of the final year students on educational process and support services

Standard	Quality Requirements	Documentation
and the employed graduates' and employers' opinion on the graduates' education, in order to check the adequacy and effectiveness of the educational service provided	**D5 – Graduates' placement** The study programme should monitor the graduates' placement in order to check the demand of the granted qualification and the correspondence of the educational objectives and learning outcomes of the study programme to the educational needs of the labour market	■ Graduates' job placement ■ Prosecution of the studies in the second cycle programmes *(only for first cycle graduates)* ■ Prosecution of the studies in PhD programmes *(only for second cycle graduates)*
	D6 – Employed graduates' and employers' opinion on the graduates' education The study programme should monitor the employed graduates' and employers' opinion on the graduates' education in order to check the correspondence of the educational objectives and learning outcomes of the study programme to the educational needs of the labour market	■ Employed graduates' opinion on the education received ■ Employers' opinion on the graduates' education
Standard E **Management System for Quality** The institution the study programme belongs to should have a public quality assurance policy and an effective organization for the quality assurance of study programmes. The policy should be put into practice by the study programme through the definition and adoption of an appropriate and effective management system, able to assure the quality of the study programme and the continual improvement of the effectiveness of the processes for the study programme management and of the associated results	**E1 – Policy and organization for quality assurance of study programmes** The institution the study programmes belongs to should have a public policy and an effective organization for the quality assurance of study programmes, and effective decision-making processes	■ Policy for quality assurance ■ Organization for quality assurance
	E2 – Management system of the study programme The study programme should implement an appropriate and effective management system, through the identification of the quality assurance processes and the definition of a relevant organisational structure	■ Management system of the study programme
	E3 – Review The study programme should periodically review needs and objectives, educational process, resources, results and management system, in order to guarantee their constant adequacy and effectiveness and promote the improvement of the effectiveness of the processes for the study programme management and of the associated results. Students and representatives of the labour market of reference should be involved in the review process	■ Management of the review process ■ Results of the review process
	E4 – Publicly availability of information The study programme should make publicly available full, up to date, easily acquired information, both quantitative and qualitative, on study programme objectives, educational process, resources, results and management system	■ Publicity of the documentation for the QA of the SP

2. bringing the QA process of SPs in accordance with the ESG;
3. enhance quality of SPs and increase their transparency and comparability, in order to enhance trust in the quality of SPs and make possible to formulate an informed judgment on the educational process offered by SPs;
4. promote modernisation of higher education through an on-line documentation of the characteristics and results of SPs.

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On Modelling Management Process in Engineering Schools

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The article considers an education process in an engineering school. Economic and mathematical approaches to education management modeling are suggested to build a new architecture of education process. The authors describe the application of Production Function Model to education process in a technical university. Special attention is paid to research management model and quality model for graduate training.

Key words: engineering university, educational process, the quality of education, simulation.

Education institution is an open system of interacting and controlled constituents (divisions, staff, etc.) with a particular strategy, mission, and limited resources. It is necessary to design structural and functional models to develop theoretical and applied aspects of management as well as to choose methods to forecast education processes in engineering schools.

While developing management models for basic processes in a higher education institution, the use of economic and mathematical methods has recently become an integral part of high technology. It is caused by the fact that most of Russian higher education institutions face such problems as weak marketing strategy, poor ad-justability of university organization structure to market conditions etc. These circumstances allow using the production function model for education processes of an engineering school [1; 2 et al.].

The analysis shows that basic products of higher education system are graduates (of different degrees and specialties) and scientific research (articles, monographs, dissertations, patents etc.). Production factors include staff (academic and non-academic), facilities (structures and constructions), and people entering the University. It can be expressed by the production function of the following form:

$$R = f\,(G, S, E, D) \qquad (1)$$

where R – product of education activity; G – number of graduates; S – staff; E – equipment; D – number of people entering the University.

To consider equation (1) as the production function, it should satisfy the efficiency feature, which means that at specified values of arguments, R should be on the curve of production capacity and reach the maximum in regards to other variables. Taking into account that there is a department aggregation in equation (1), the formula assumes that the resources are effectively distributed among the departments. It is obvious that this assumption is impossible in some cases. Thus, it is necessary to indicate a particular department with index i, which allows expressing the function for a University as follows:

$$R = \sum R_i = \sum f_i\,(G_i, S_i, E_i, D_i) \qquad (2)$$

To state the objectives of higher education is an important starting point of the analysis. It is natural to assume that the aim of a common competitive commercial entity is to maximize earnings. However, such comparison in terms of engineering higher institution is not sound enough. A part of higher education system is commercial in some countries, which makes earnings maximization be a possible goal of the University. On the other hand, universities are often regarded as non-profit and non-commercial organizations (in the USA and other countries), which gives them tax advantages to encourage education rather than commercial objectives achievement.

In particular, James E. [7] considered universities as organizations that with budget limitations tend to maximize some degree of benefits that depends on University image and a set of other variables of different values. The university image, in its turn, depends on basic academic factors, such as the number of graduates, research projects, etc., as well as on the quality of these "products" or factors. In this view, Universities are considered to be in competitive environment. They search for good students and funds for research, and their success depends on their image. Despite the approach be-ing developed for a university as a whole, it can be applied to separate faculties of engineering schools. Besides, the approach is reasonable to be used to analyze real system behavior and is determined by stimulation system and University funding. It is important to note that like all other organizations, technical universities try to survive, which is the best they can do under hard financial limitation. If in better conditions, a university has wider choice and can behave in the way described above. In this case, it is obvious that real choice is determined by the interaction of the production or objective function and financial limitation.

It should be specified that, as assumed in (1) and (2), the production function in the education system is similar to the production function of other goods and services characterized by a smooth threshold of substitution of production factors and output. However, the assumption is not fully applicable to the higher education system. Let us make some comments on it.

1. Research and teaching activities are mutually supportive rather than inter-changeable: students are informed about the latest research results, post-graduate are directly involved in research projects of their scientific supervisors. Thus, the S increase within some limits can lead to simultaneous increase both in G and R (which is in contrast to the assumption mentioned above).

2. The ability for scientific and research work and its efficiency are unevenly distributed among faculty members and research groups. As a rule, most of the research output is produced by a limited number of faculty members who need, however, organizational support including their colleagues' help. Thus, the relation between S and R depends considerably on efficient functional distribution with focus either on research, teaching or administrative activities.

3. The output (production capacity) of the higher education and research system is quite sensitive to small changes in motivations for research activity. But the top-rank position of a department (for example, according to the British system of research evaluation) depends on efficient distribution of highly qualified faculty members in each discipline. Thus, despite universities attempts to improve their images by attracting the best researchers, the final output of the system does not increase significantly.

4. The efficiency and value of different teaching techniques and methods for different student groups have not been well studied yet, though there are a lot of opinions on this point. Some of them think that the main thing for students is just being in a university for 3-4 years, with teaching methods having no importance. Others argue that it is particular teaching methods and techniques (students' reports, interactive study, essays, discussions, traditional lectures et al.) that play the main part in education process. In this regard, what teachers do and how they do, as well as their "availability" for students, are very important.

5. The "product output" of the higher education system depends on "quality" of enrollees. It is obvious that universities should attract more prospective students with better training, since it would somewhat guarantee good future learning outcomes: such students will be successful even without intensive training support in the university. Other universities, however, have to choose another way. The students enrolled in such universities may have rather poor academic performance at the beginning. But due to intensive training and effective scientific supervision they achieve good learning outcomes at the end of the course. Thus, if measured properly, the added value of the latter training is much higher than that of the training in traditional universities choosing the best enrollees. This situation can be described by equations (1) and (2), if the student factor D is measured properly.

6. There is an important intertemporal aspect in the production function of the education system. It is implicitly present in (1) and (2), since we have not made any supposition about the relation between G (the number of graduates) and D (the number of enrollees of a particular year). It is necessary to take it into account, otherwise, one and the same variable will be both the production and factor and product itself. In a stable condition, if D is constant G should also be constant, as it was mentioned above. Then (1) means that with a given number D the number of graduates G can be increased due to the increase in production factors, especially staff. To reflect the intertemporal aspect with large gaps between input and output, we should use multi-periodical form of the production function.

These conclusions show that though the concept of the production function can be applied to the system of higher technical education, the particular features of the system require revising the traditional form.

Taking into account that the objective of an engineering school (J) is the increasing function of its basic output products: training and research, we get the following:

$$J = k\,(R;\,B) \tag{3}$$

Besides, the real choice of a university depends on its financial limits. It has the following general form:

$$B = wS + E + c_1R + c_2G + H \tag{4}$$

where B – budgetary costs consisting of personnel wS; w – the average salary including all social insurance, pension and other payments to the staff; E – equipment in monetary form; c_1R – research expenses R (c_1 – expenses per research unit); c_2G – expenses to train G graduates (c_2 – expenses per one student); H – extra expenses not mentioned above (for example, building heating and lighting, computer service and library expenses, administration et al.).

University's objective, then, is to maximize J (equation (3)) with production function (1). This task can be expressed as follows: to maximize the function $J = k\ (R;B)$ at $R = f\ (G,\ S,\ E,\ D)$, $B = wS + E + c_1R + c_2G + H$,

Practically, the model based on (1), (3) and (4) should be added with some limitations in capacity. For example, no matter how profitable it is to enroll more and more students, the amount of students is limited with the number of university buildings, rooms, staff, equipment, and other education factors. Thus, the model should have a limit in the form $D < D^*$, where D^* – maximum possible number of enrollees, which obviously limits the number of graduates G). The model shows the particular features of the education process of a technical university.

Let us consider two examples: a management model for research and training process [5] and a quality model for engineering training [6].

It is important to note that the

management model for research and training process should be closely related to the education quality management system of the university. The education system comes to its stable functioning through successive changes of its constituents and assessment of environmental impact. This process presents a combination of activities of the system elements united by a common goal.

The modern university is being actively developed in response to new challenges to be overcome by means of new elements and more rational structures. The increase in information exchange and relations leads to growing scale of education systems, which makes them more complicated. There appear new levels, hierarchy, and self-organization, thus making the system dynamic in time.

Fig 1. shows the management model for research and training process in a university [5]. Economic parameters are identified in the basic blocks of the model to study the system's behavior temporally (1.2, 2.2, 3.2, 4.2). These parameters show the training cost, target profit, research and training process based on the target profit, economic efficiency and analysis of the economic performances [3; 4].

Quality of an engineer is of multidimensional character, it is the base to develop a quality management model for engineering training [6]. The quality of engineering training can be regarded as a vector $\vec{Q}(t)$. Then the requirements of the federal education standards and employers can be presented as the following inequation

$\vec{Q}(t) \ge \vec{Q}_{\min}(t)$, where $\vec{Q}_{\min}(t)$ – vector of minimal permissible parameters of engineering training quality.

As it was mentioned above, the quality of engineering training is closely connected with the quality of research and education process in a university ($\vec{q}(\tau)$) at $\tau < t$. Thus, it can be described with the following function: where $\vec{F}(\tau,\vec{q}(\tau),\vec{Q}(\tau))$ – the function:

$$\vec{Q}(t)=\vec{Q}(t_0)+\int_{t_0}^{t}\vec{F}(\tau,\vec{q}(\tau),\vec{Q}(\tau))d\tau$$

that determines a training process and development of a future specialist in research and education environment of a university. The starting level, the time of enrollment, is identified with t_0.

Functions $\vec{Q}(t)$ and $\vec{q}(\tau)$ are a mathematical expression of the management model for engineering training quality shown in Fig. 2. Management $\vec{u}(\theta)$ is determined by the optimization task solution:

$$\vec{Q}(t,\vec{u}(\theta))\to \max$$

In this aspect, management is regarded as a system of criteria focused on achieving maximal results in training process.

Thus, while modeling management process in an engineering school, it is necessary to take into consideration a number of sub-systems including:

- economic;
- organizational;
- methodological;
- innovative and education;
- technological, etc.

It should be concluded that the functioning of these sub-systems is ensured by the following processes:

- implementation of administration's responsibility (politics and strategy development, goal setting, paperwork management and analysis);
- resources management (staff responsibility, material support);
- changes, analysis, and improvement (monitoring of consumers and employers' satisfaction);
- education and information services (innovative training, school leavers enrollment, education, organizational and methodical activities);
- management of informational and technical resources, etc.

Fig. 1. Management model for research and education process of a University

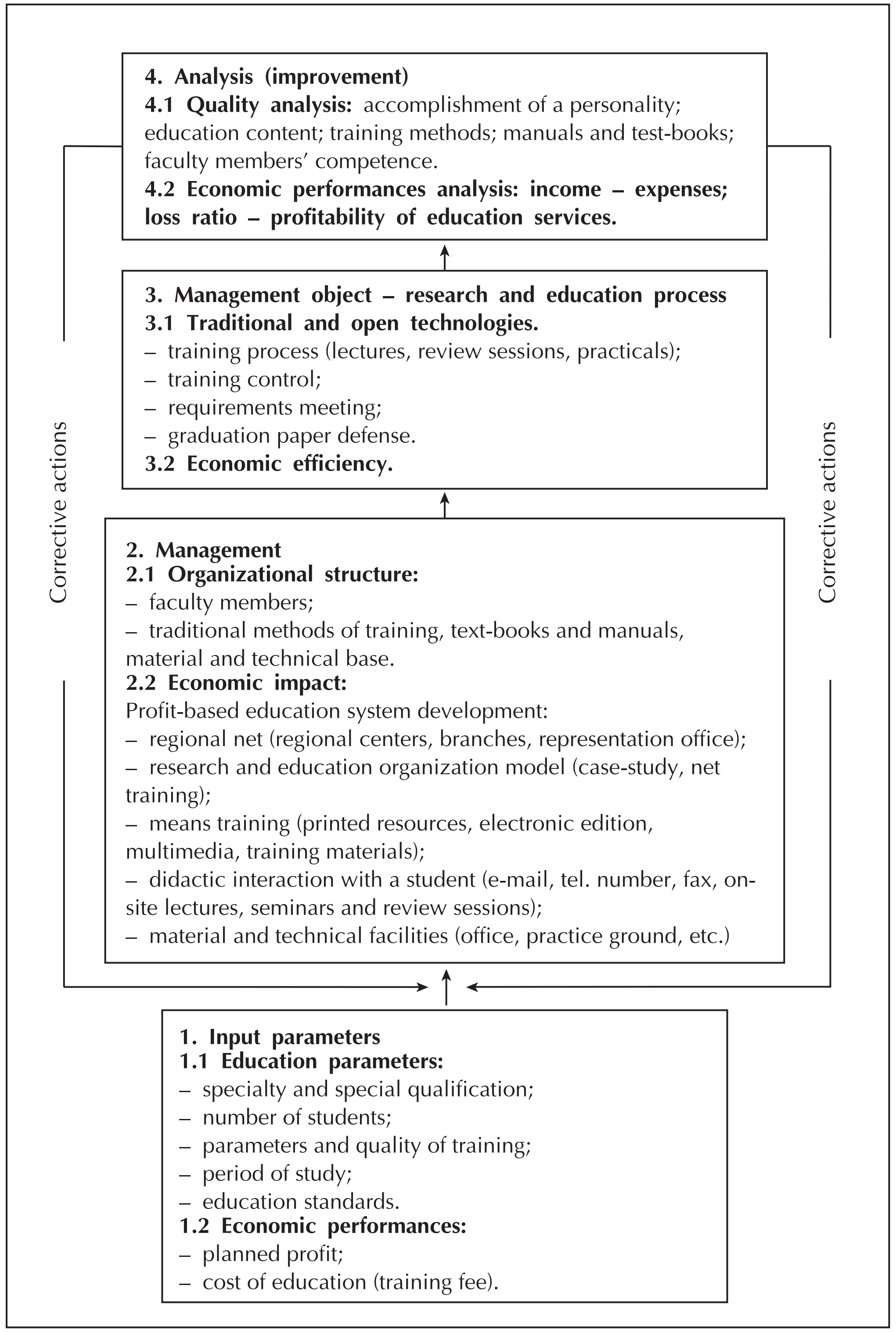
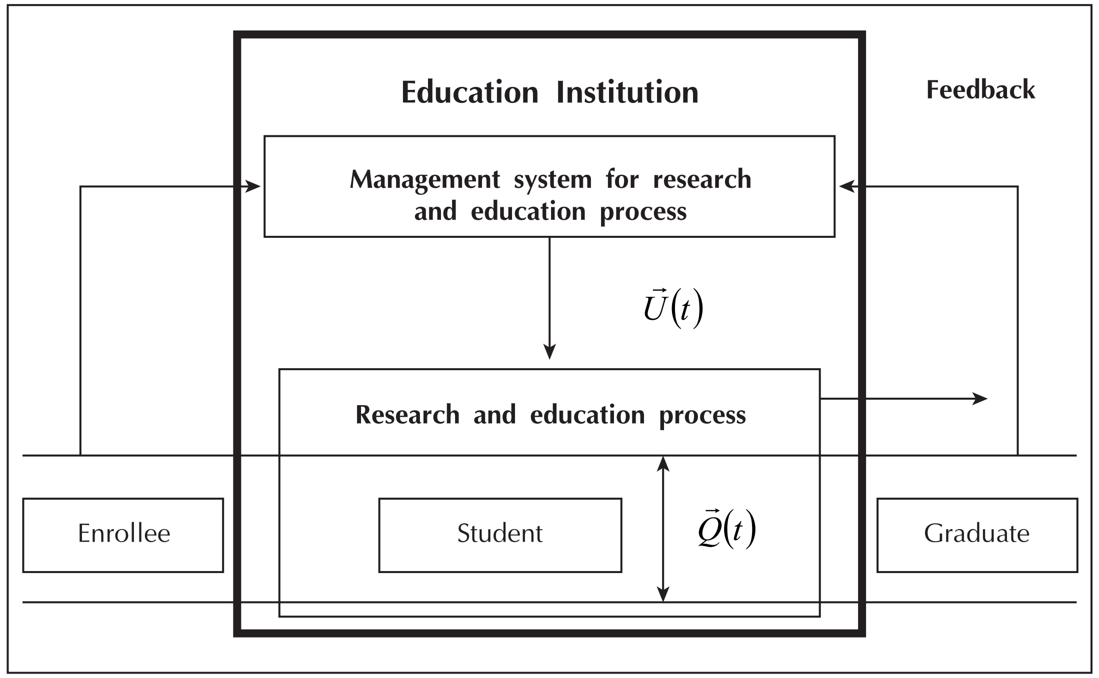


Fig. 2. Quality model for engineering training [3]



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Yakutsk State Academic Olympiad in Technical Drawing – 50 years

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The article is devoted to the current teaching problems in technical drawing in the schools of Sakha Republic (SR) (Yakutia), involving the 50-year background experience in organizing and conducting olympiads in technical drawing. The pedagogical achievements of the technical drawing teachers and olympiad winners have been described.

Key words: technical drawing, graphics problem-tasks, school, individual approach, out-of-class activities, Olympiad in technical drawing.

Since 1962-1963 school olympiads in technical drawing were organized and conducted under the supervision of N.S. Nikolaev in the Sakha Republic. The 50th Olympiad Anniversary was conducted in 2015.

The idea of conducting school olympiads in technical drawing started up in the 60s of the last century to improve the school teaching quality of technical drawing, as well as advancing teaching and learning standards in this subject.

What are the advantages of olympiads? It is a well-known fact that school-teaching should not be restricted only to in-class learning. Extracurricular activities are introduced to reinforce and increase student knowledge and skills obtained during classroom activities. Such activities reveal such aspects as student orientation, personality qualities, creativity ability and versatile interests. Extracurricular activities should be diversified, and, only in this case, a teacher would be able to win both recognition and authority. An interesting extracurricular activity is the olympiad, the target of which, is to identify and develop student interests and abilities and evaluate class and out-of-school activity results in this or that subject for an academic year. Another important aspect includes pedagogical issues. For example, initiating friendly ties and establishing business relations with different schools, regions, districts and republics. In the days of olympiads students do not only compete, but also help each other and intercommunicate.

Olympiads are both a popular type of student assessment and achievement and a tool in advancing the role and significance of this or that subject. New and new student groups are becoming involved in the subject after such competitions. Experienced technical drawing teachers (Yakutia) have proved conclusively that the fruitful efforts of olympiads flourish only under conditions of systematic out-of-school activities or become the starting point in their development. Excluding these factors could convert olympiads into simple go-to meetings without any benefit or results.

Every teacher knows that children strive for autonomy- a desire to try themselves in revealing their own creativity and to explore everything on their own which is typical for their age. However, this inherent motivation can not always be acceded within the framework of academic classes, while olympiads enhance more possibilities and broad options. Often students more distinctively and clearly reveal their individuality, demonstrate their personal characteristic traits and their own way of thinking when competing. Observing how students compete in olympiads could be interesting for a serious-minded teacher, i.e. could provide observation material. After olympiads round table discussions are conducted to share ideas and experience and to outline the possible paths in eliminating the existing gaps in the learning process itself.

As teamwork-based environment is typical for any subject olympiad, it could also be an important motivation element in teaching school students to participate and work in teams.

It should be mentioned that our Olympiad not only improved the teaching level of the subject- technical drawing and established new technical drawing classes, but also enhanced such student qualities as self-discipline, responsibility, commitment and autonomy. It is these olympiads that promote the training of present-day specialists in technical drawing.

What is the background? Numerous fundamental and timely papers in technical drawing were published in Republic newspapers by Yakutia State University senior lecturer N. S. Nikolaev (now professor of North-Eastern Federal University). These papers were devoted to the role and significance of technical drawing in the scientific-technological progress age. It should be stated that these papers advanced the further development of technical drawing (graphics) education in the Republic schools.

In 1956 Nikolai Spiridonovich Nikolaev graduated Moscow Printing-Publishing Institute (Mechanical Engineering Department) and became the first Yakutai mechanic-engineer, specializing in "Printing Equipment and Automated Complex." He moved to Yakutsk and began his employment career as mechanic-engineer in printshop, Yakutsk Republic Printing House (later, Acting Chief mechanic). In September, 1956 Yakutsk Sate University was founded, embracing technical (then, engineering -technical) department where Nikolaev started his part-time teaching in descriptive geometry and mechanical drawing for students of Mining and Geological Prospecting Faculty of Engineering -Technical Department, Yakutsk Sate University (North-Eastern Federal University n.a. M.K. Ammosov). He started from scratch- at that time there was not a single teacher in the education establishments (schools, technical colleges, technical high schools, etc.) having tertiary education in technical drawing within the Republic (Yakut Autonomous Soviet Socialist Republic).

Teaching technical drawing as a subject in schools was at a very low level: students skills and abilities in technical drawing did not meet the school program requirements. Nobody paid attention to this fact.

This could not go on. It was necessary to "overstep" this situation. Young engineer Nikolaev managed to convince many domestic education association workers in the Republic including Dep. of Ministry, inspector of Board of Education (Yakut Autonomous Soviet Socialist Republic), Local Education Authority, Yakutsk State University, etc. to change this situation.

Today, due to his multifarious activities, engineer Nikolaev (Hon. Veteran of NEFU, Hon. Professor of Education and Professional Development Institute, Correspondent Member of Russian Academy of Engineering, Laureate of Russian State Prize in Science and Engineering; author of 40 books and manuals published in Moscow and Yakutsk), promoted technical drawing teaching in all Yakutsk education establishments (schools, institutes, etc). Another important fact was that this subject was taught by specialists with higher vocational education (85%) and vocational secondary education (15%). Those that taught or are teaching technical drawing in Sakha Republic (Yakutia) involve one academician (full member of Russian Academy of Education), one academician of Petrovsky Academy of Science and Art, one correspondent member of Russian Academy of Engineering, 10 order bearers (including one Companion of Order of Friendship), 8 Companions of Gold Medal of Academician n.a. V.P. Larionov, 2 Hon. Teachers of Russian Federation, 9 Hon. Teachers of Russian Academy of Education, about 40 exemplary teachers of RF Education, Russian Academy of Education, 2 professors, 8 PhD and associate professors (pedagogical and engineering science) and other eminent specialists. Such teaching staff employment growth in technical drawing throughout Yakutsk and other regions of the Russian Federation is unique.

No wonder that the Education-Methodics Department, USSR Board of Education studied and discussed the experience of Yakutsk school Olympiads in technical drawing. Associate professor of Yakutsk State University, N. S. Nikolaev (1975, 1978) was the keynote speaker. This Department accepted special resolutions to advance Yakutsk experience.

Professor Nikolaev organized and conducted more than 50 Republic (State) school Olympiads in technical drawing during this period. Professor Nikolaev was Chairman of Republic Olympiad jury. More than 180000 school students from more than 300 schools of 32 Republic regions (settlements) participated in these Olympiads, among which 234- champions, 361- silver prizewinners, 536- bronze prizewinners and 531- 4th (top places), i.e. all in all, 1662 were prize winners. Howling success! More than 29 settlements, including 484 school students from Megino- Kangalasssk region- first place among regions. Second place among regions (248 winners) – Yakutsk. Third place (182 winners)- Ust- Aldansk region. Fourth (106 winners)- Tattinsk region, fifth place (99 winners)- Amginsk region, sixth place – Verkhoyansk region (cold Pole, one of the most northern regions! That's great!!!). We are glad that there are representatives from the northmost (tundra) Yakutsk regions, for example, Bulunsk region- 4 (1- winner, 3- bronze winners), Ust-Jansk region (1 champion, 2 bronze prize winners) and Anabarsk region – 1 winner, etc.

Many Yakutsk Olympiad winners in technical drawing have become leading statemen, for example, A.V. Migalkin (PhD in Philosophy) worked as RF Consul in Mongolia for many years; S.N. Nazarov worked as leading architect in Yakutsk; others- minister of Construction and Architecture (SR), Home Secretary (SR), Deputy PM (SR), First Deputy Prime Minister (SR), Chairman of the Government (SR), etc.; some worked as Under-Secretary of Ministries (SR),executives of industrial enterprises, etc.

Among Olympiad winners in technical drawing there are also scientists and academicians of world reputation, such as N.I. Germogenov, T.T. Savvinov; well-known engineers, architects, designers, etc. For example, one Olympiad winner is working as a designer in one of near Moscow production facility enterprises. We cannot disclose any information about this person. Another interesting fact is that one Olympiad winner worked at Baikonur, but now is retired.

During the last few decades a galaxy of talented people have emerged from teachers of technical drawing- not only engineers, architects, scientists, statemen of Yakutsk and Russia, but also distinguished innovative teachers, authors of books and manuals. It has been established that the authors of three manuals in technical drawing, published in Moscow Publishing House "Prosveshenei" have been approved by the Ministry of USSR Education: Yakutsk teacher V.N. Okoneshnikov (Technical Drawing Class, 1984, Moscow); N.S. Nikolaev (Conducting Olympiad in Technical Drawing, 1981 and 1990, Moscow) [2]. Book by professor N.S. Nikolaev (co-author) "Yakutsk: Records, the First, the Only"(Yakutsk: Bichik, 2004, copies 15000) - topped the first place in Russian Book Competition in 2004. This is saying something! The total edition is 138000 copies! This is quite a lot! Yakutsk authors (about 30) wrote about 80 manuals in technical drawing (including dissertation abstracts, PhD thesis), the total edition of which is 250000 copies, pages – about 500 printed sheets, including newspaper and journal articles, as well as articles printed in collections, books, posters, etc.

From the days of professor Nikolaev [1] a new generation and enthusiasts fortified by initial successes are emerging. It is encouraging that practically all school technical drawing teachers in Yakutsk (SR) have been professor Nikolaev followers.

We, teachers of technical drawing, descriptive geometry, engineering graphics of Yakutsk education institutions are proud of the fact that N.S. Nikolaev has been entitled one of 2900 Russian leading scientists and specialists in 2007- this can be found on Internet- encyclopaedia of Russia (www. famous – scientists.ru/1158). This is really true recognition- professor's achievements in Russian science. He received the badge "Eminent Scientists of Russia" and certificate INTERNET-Encyclopaedia "Eminent Scientists of Russia" (Sochi, 2007).

Professor N.S. Nikolaev was elected Russian Academy of Engineering delegate of the 1st Russian Congress of Engineers, which was held in the Kremlin Palace (Moscow, 2003). In May, 2004 he was invited to participate the 5th Forum Of World Engineers (Earth), in Paris (France).

Now there is a saying that "If you are a Yakut, you are a good drafter." This is the result of the gigantic work of all professor Nikolaev's followers. This is recognition of his service and works!!!! Professor Nikolaev in Yakutsk established his School (Nikolaev School). We have only briefly described the first achievements of this School.

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Engineering Staff Training – Issue of National Concern

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The article examines the quality of engineering education. It underlines the urgency of:
- implementing system policies regarding engineering education;
- introducing preferential treatment and incentives to the enterprises which are planning to contribute to engineering staff training through the cooperation with universities.

Key words: quality and professionalism, engineering education, industrial enterprise, national policy.

Mining industry creates a foundation for development of the manufacturing sector and strengthens the defense potential of the country. Through colossal common effort, Yakutia produced 116 tonnes of gold and more than 8000 tonnes of tin metal during World War II. Back during those years, gold of Yakutia, having become a strategic reserve of the country, was used to lease 80 thousands of fighting vehicles.

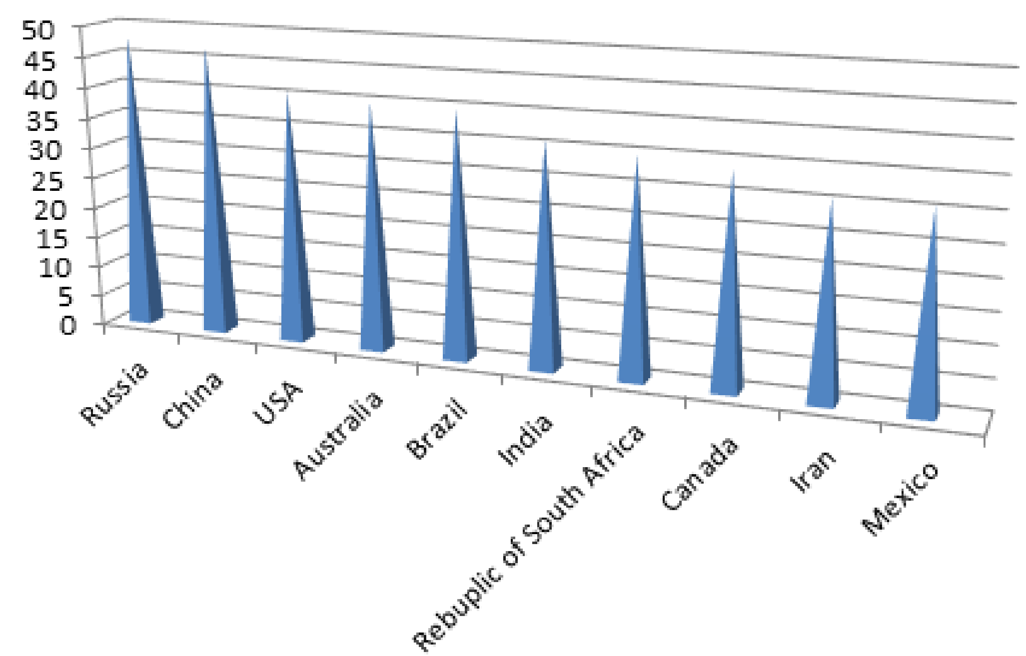
As reported in archival materials, the first gold mines of the well-known Lensky gold district were discovered in 1846. In 1898, 976 miners worked in the gold mines of Yakutia. In April 1923, by the decree of the Yakut Autonomous Soviet Socialist Republic, gold mining entered a new age when the first Yakut gold mining company led by Voldemar P. Bertin was established. On May 1, 1923, 18 staff members began their work in a remote taiga area and off-road conditions. In 1931, the state trust company "Yakutzoloto" was founded. Within two years the company's staff was equal to 14 523 people, with 6943 employees working in mining sector. In 1957, the "Yakutalmaz" trust company was established.

The backbone of modern mineral resource base of Yakutia was formed in 1950-70. However, a major breakthrough was achieved in 1974 as a result of the official visit by the Chairman of the Council of Ministers of the USSR A.N. Kosygin. Thus, in the Republic of Sakha (Yakutia), annual volume of mining in 1973-74 made up 4.5 tonnes of gold [1].

In the global context, there are only 10 countries, each of which mines more than 30 types of mineral resources. It is a well-known fact that development of mining industry is directly dependent on the amount of mineral resource extraction (Fig.1), precisely, the number of mineral resources types. The estimates of mineral resource production across the countries demonstrate that USA (15.8%), China (15.4%), and Russia (9.7%) take the leading position. In 2005, together they accounted for 41% of total world mineral reserves. It is worth noting that mining in the Asian part of Russia produces 33 types of mineral resources, and it would play an increasingly important role through the rest of the century. It is due to the fact that the most precious and valuable mineral deposits are found on the Asian part of Russia. However, there is lack of total staff resources [2].

Trying to meet the accreditation requirements, Russian universities have put special emphasis on the quality of training

Fig.1. Global distribution of resource extraction



programs and job placement issues over the past decade. The analysis of various materials including research papers and presentations has shown that the questions related to the job placement of graduates should not be discussed at university level only. A steady supply of mining staff is priority concern of the country. To cope with staff scarcity within the mining sector, it is required to develop an integrated approach toward engineering training and graduate job placement.

To prove the above statement, let us consider the academic activity of a number of departments of Mining Institute, North-Eastern Federal University (NEFU) in Yakutsk.

Today, NEFU's total undergraduate student number is over 20,000, with 30% being enrolled for engineering degree programs. The university is constantly revising the engineering programs and qualifications in order to match them with the priority goals of northeastern Russia development. Mining Institute of NEFU offers two basic degree programs: "Mining Engineering" and "Technosphere Safety", i.e. 7 qualifications (Tab. 1).

In 2012, first students graduated from Fire Protection Program. The students enrolled for the first time for Mine and Underground Construction Program graduated in 2013. "Technosphere Safety" program has been recently developed in accordance with the regional labor market needs. Precisely, the program was developed with regard to stiffening of safety and labor protection requirements stated in Article 217 of the Labor Code of the Russian Federation "On Work Safety Division" [3, 4].

Recruitment data of *Open-Pit Mining Program* graduates in 2014 are given in Tab. 2.

The analysis of the data presented in Tab. 2 and Fig. 2 shows that 100 % of graduates find a job. Each year, 3 graduates take post-graduate course or enroll for master's degree programs. 30 % of graduates are called upon to serve in the armed forces of the Russian Federation.

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IMPROVEMENTS IN UNIVERSITY

Table 1.

Qualification	Graduate number per year					Total
	2010	2011	2012	2013	2014	
Open-pit mining (OPM)	15	17	5	13	13	63
Underground Mining (UM)	10	19	13	12	10	64
Mine and underground construction (MUC)	0	0	0	7	8	15
Mining Machinery and Equipment (MME)	17	14	16	13	11	71
Process Safety Management (PSM)	18	14	17	10	12	71
Protection in Emergency Situations (PES)	16	21	22	18	14	91
Fire Protection (FP)	0	0	12	10	13	35
Total over 5 years						410

Depending on the specific characteristics of the graduates, each year about 6 graduates are free in their job search.

Since 2012 NEFU has collected an array of job placement information (Fig. 3). It is worth noting that regional enterprises do not always provide university career service with the data on further career changes of its graduates. Therefore, there is no clear vision of graduates' career paths. It has become obvious that it is a common place almost at all universities of the Russian Federation as there is no clear mechanism of information exchange between universities, employers, and corresponding Ministries. All these issues should be addressed at the federal level within various industries. Despite the fact that the accreditation requirements are approved at the federal level, they are still developed by one agency, i.e. The Ministry of Education and Science of the RF, which has no legal power with respect to other social spheres and industries.

The monitoring results have revealed that mining program graduates are basically recruited by the corresponding mining companies. 63% of graduates found job in mining companies and proved to be well-qualified specialists. For example, a graduate of 2013 was first recruited as a repair man by OJSC "Almazy Anabara". Over the first year, he upgraded his skills and was promoted to the position of mining engineer. Traditionally, all mining program graduates start their career as workers in mining companies. It is due to the fact that the specific characteristics of the mining industry require that engineering staff should know all stages of the hazardous production cycle.

However, job placement at mining companies today is still a challenge for graduates, which is caused by their lack of experience.

On November 10–15, 2014, there was an accreditation of NEFU by the expert committee. The students were asked about the places of internship and who is in charge of the choice. According to the answers of students pursuing the degree within Mining Machinery and Equipment program, in

Table 2.

	2014		
1	Arkhipov Boris Petrovich	**OJSC Almazy Anabara**	**overman**
2	D'yachkovskiy Lookut Alekseevich	**OJSC Almazy Anabara**	**overman**
3	Sleptsov Gavril Fedotovich	**OJSC Almazy Anabara**	**overman**
4	Surovov Sergey Vladimirovich	**OJSC Almazy Anabara**	**overman**
5	Maloshenko Andrey Andreevich	**«Aldanzoloto»**	**overman**
6	Svinoboev Evgeniy Anatol'yevich	Continue education in NEFU	post-graduate
7	Ayarov Dmitriy Dmitrievich	**Military service**	
8	Slobodchikov Dmitriy Dmitrievich	**Military service**	
9	Smetanin Nikolay Nikolaevich	**Military service**	
10	Fedorov Viktor Egorovich	**Military service**	
11	Filippov Artem Valer'yevich	**Military service**	
12	Sofronov Andrey Viktorovich	Administration of municipal unit "Momskiy natsional'nyy nasleg "	specialist
13	Kondakova-Zakharova Olesya Sergeevna	Administration "Deti Azii"	specialist

Fig. 2. Job placement rate over the past 5 years

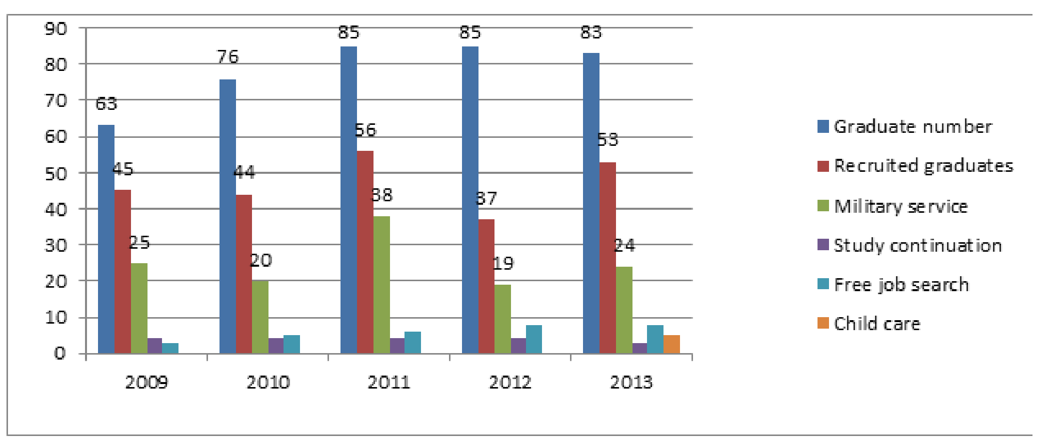
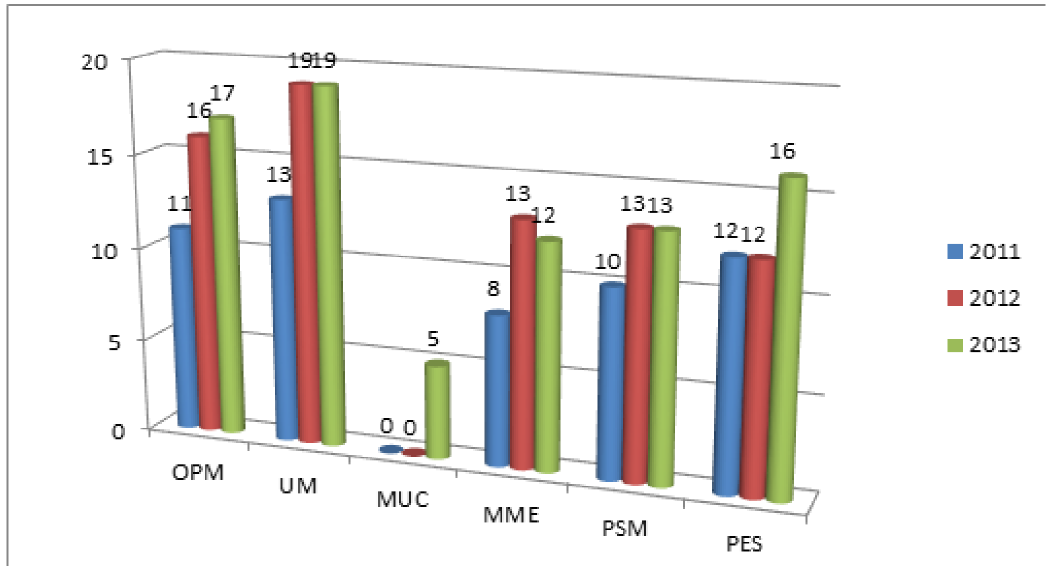


Fig. 3. Job placement data in 2011 - 2013



67% of cases the place of internship is chosen by the department staff while in the rest 33% it is for the students to choose. It seems that the percentage is approximately the same for the majority of engineering universities, and it is not bad at all under current economic conditions. Since internship placement is not regulated by the national law, it is determined by the heads of the departments and the Department of Student Affairs in close cooperation with mining companies. In this case, the internship quality totally depends on the company's interest in interns. For example, in summer 2014 three students pursuing the degree within Mining Machinery and Equipment program were on internship on the mine site "Denisovskaya" and worked as backmen.

All students had a qualification of repairman and profound theoretical knowledge in repair management, including the ability to understand kinematic and hydraulic schemes. However, the employer was not interested in students' professional development, and as a result, the internship outcomes were poor and the students failed to apply the acquired theoretical knowledge.

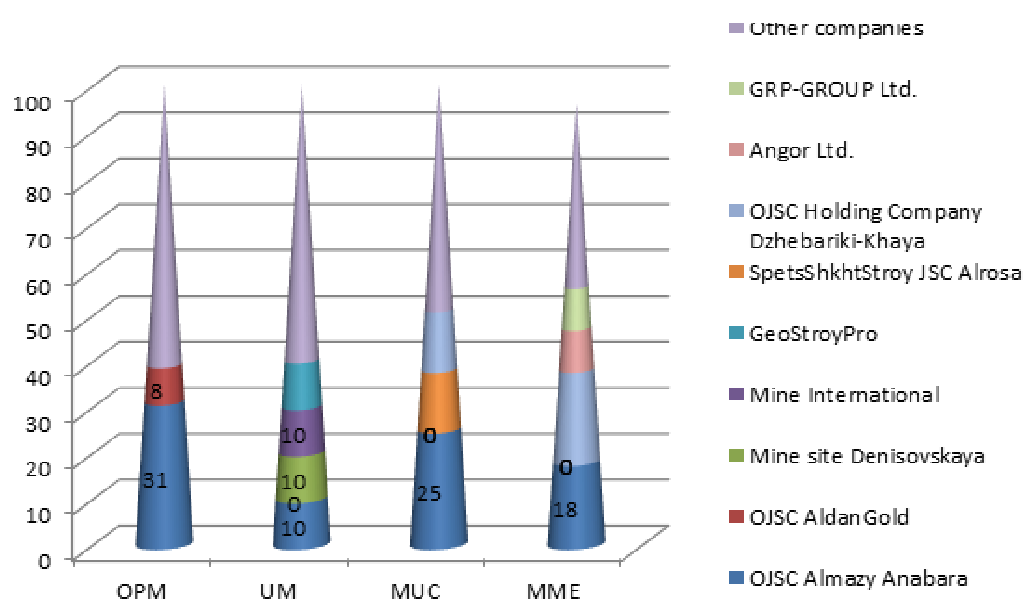
However, this situation is not the rule. For instance, the students of group MUC-10 were on internship on the site GKD 8 of the mine construction department, Mine "Mir". These students described their supervisor, Vladimir Alexandrovich Ivanov, being strict and demanding but interested in interns as he showed and told about all particularities of production process.

It is essential for professionals training, and engineers training in particular, to support theoretical knowledge with practical experience, which equips engineers with necessary skills and methods of work, familiarize them with production challenges.

As for the quality of training, the mining institute stuff currently includes highly qualified professionals who can ensure profound education, however, the mining companies are not interested in the development of human resources potential, which is caused by the current economic conditions, when the costs for professionals training are reduced. This undoubtedly has a negative impact on engineers training and educational outcomes.

Let us turn to the chart illustrating work placement of graduates in mining

Fig. 4. Work placement of graduates in mining engineering in 2014



engineering in 2014 (Fig. 4). It is clear that the graduates got jobs in different regions, and the majority of them were employed by OJSC Almazy Anabara. Looking ahead, we can say that next year the geographical area of work placement will expand. After the internship in 2014, upon the recommendation of the company overman, Igor Yuryevich Zhukov, the interns' supervisor, two students of group MUC-10 and one student of group UM-10 were employed in OJSC Apatite. Unfortunately, the issue of graduates work placement is still critical and it is for the department staff only to solve this problem.

Currently, one of the RF Government requirements is to improve engineering education focusing on practical experience, however, there are still no laws or regulations to prescribe the improvement procedure. We suppose that the Government should introduce preferential treatment, in particular, tax incentives, to the enterprises which are planning to contribute to engineering staff training, including student internship. Under the unstable market conditions, the declarative approach to higher engineering education improvement has negative impact on student internship quality, and as a result, inevitably fails in graduates work placement.

There are many risks potentially associated with the mining industry. According to the Government Statistics of the Republic of Sakha (Yakutia), every third accident involving injuries in 2011–2013 took place in the mining companies, including those with the fatal outcome [5]. Having analyzed these accidents, it is possible to conclude that the causes were both equipment disfunctions and poor work management, when the safety management system fails. It is worth noting that the real reasons for employees' unsafe practices are the lack of knowledge and skills, overlooking the instructions, missing trainings, studies and exams. This is also proved by the quality of works which students submit within the course "Mining equipment operation safety" [6]. In this regard, the qualification "Industrial safety" is up-to-date and in demand, however, due to poor organization of human reserve

development, these graduates have challenges in work placement.

"Forum FEC" is an outstanding event which was held in Yakutia on November 12-14, 2014. In the territory of the Republic, there are more than 30 companies involved in fuel and energy complex sector. It is clear that FEC comprises all organizations and enterprises dealing with production, refinery, and utilization of coal, oil and gas, which is declared in the Agreement on Cooperation in Fuel and Energy Complex between the Government of the RF and the Republic of Sakha (Yakutia). However, there are no FEC companies in the chart of graduate work placement (Fig. 4).

Currently, none of the FEC project documents considers the issue of NEFU mining graduates work placement, though there are open positions and vacancies on FEC official website [7] (Tab. 3).

Tab. 3 shows that professionals with the qualification "Production and technology safety" are in demand in FEC companies, though there is no strategy of professionals training. If we turn to the website, it becomes obvious that work experience is an essential requirement, but professional abilities and skills are developed only through experience and practice. Currently, there is no contract or agreement on student internship in FEC companies.

On the other hand, a great number of FEC enterprises are included in the list of high-risk sites, the list being presented on the Site of Yakutia government (www.sakha.gov.ru) [8]. According to safety requirements, there must be Health and Safety Departments, services of civil defense and emergency situations or there

Table 3.

Vacancy	Advertisement	Date	Company
Lead engineer for process safety	A big international company needs a production engineer. Requirements: higher education in technology or chemical technology safety system modeling (or the diploma of secondary technical training and solid work experience). Work experience in design, technology safety	30.09.2014	**FEC vacancy**
Head of occupational and fire safety department	Responsibilities: to provide occupational safety management; assist in instructions development at the companies departments; be in charge of occupational and fire safety department; be aware of laws and regulations on occupational safety, and be familiar with the relevant methodological support; manage the department work. Requirements: be aware of report preparation terms and procedure; be able to work with Word, Excel, 1S; work experience in big machine manufacturing companies	26.09.2014	**FEC vacancy**
Head of operational control and occupational safety department	Responsibilities: personnel work management in compliance with national laws and regulations; determine and present in written declaration the personnel responsibilities; make personnel know their responsibilities and duties within the integrated management system used to improve quality and environmental managements	23.09.2014	**FEC vacancy**

should be a specialist in fires safety (FS) or emergency situations (ES) [9]. However, no official companies' sources prove the demand for such kind of specialists.

The facts mentioned above show that graduates with degrees in "Industrial Safety" (IS), "Safety in Emergency Situations" (SES) and "Fire Safety" (FS) can and must be employed by FEC enterprises.

It should be noted that according to professional requirements, Industrial safety specialist is to have higher education degree in corresponding specialty [10]. Thus, the State declares the need in highly qualified specialists in this sphere. However, companies while advertising vacancies, deliberately or not, require work experience as the main factor. It is obvious that the enterprises are interested in existing staff retention, but government bodies do not check the compliance of staff's qualification with the requirements. For example, State Labour Inspection Service in the Republic of Sakha (Yakutia) has not yet taken any measures to dismiss the safety specialists who fail to meet the qualification (professional) requirements mentioned above. The existing labour policies in FEC companies is focused on unstable market and fail to ensure strategic monitoring of human resources.

In relation to mining industry, it should be taken into account that many enterprises employ their staff with the help of recruiting companies at a free market. They require particular qualification standards but offer worse labour conditions and social guarantees, which is explained by maximal reduction of manufacturing infrastructure costs. The mining infrastructure in remote regions of Russia is known to have been constructed in the Soviet time. Most of these companies became private over the past 15-20 years, companies in the Far East and North use fly-in fly-out (FIFO) work schedule, both factors having negative impact on staff quality.

The given examples prove that there is no strategic human resource(HR) planning with regard to development prospect in a big number of companies in the country including big enterprises. Either there is no efficient human resource management in remote mining companies or it is in embryonic state, which is conditioned by modern market state.

The RF Government Executive Order № 2037-р 15.10.2014 concerning Priority Development Areas (PDA) implies a special legal regime which can simplify employment of highly qualified foreign HR [11].

Besides, there is the President's instruction to Far East and North East Federal Universities jointly with state corporations and JSCs with federal shares exceeding 50 % to consider the following [12]:

- to facilitate development of specialized funds of these Universities;
- to ensure constant interaction in terms of staff training and use of prospective research results.

Nevertheless, the analysis shows that the suggestions in the frame of PDA consider only taking agreements. The prospect of attracting foreign HR can also have negative impact on the graduates' employment rate.

The absence of HR legal framework can further impede graduates' employment and students' internships especially in remote underpopulated regions. The administrative requirements to increase graduates' employment efficiency cannot be met without basic legislative acts and regulations and should not be the responsibility of the university only.

Robust HR management, including PDAs, is a State's strategic task. We consider the solution of the task to be closely connected with development of legislative environment to support companies having strategic plans of HR development. Such plans can include effective internships, professional competence development, graduates employment, i.e. the activities involving company-university interaction. It is necessary to develop a state complex and systems strategy in engineering education which would involve interests and opportunities of higher education and research institutions, industry and the economy in the whole. Efficient engineering training depends not only on developed industry and economy but also on intensive progress in science and technology.

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Development Trends of Military – Industrial Complex and its Interaction with Education and Science

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The article describes the major issues, such as shortage of qualified personnel, integration of educational and innovative processes, renovation and development of domestic military – industrial enterprises, as well as the development trends in the military – industrial complex itself.

Key words: military-industrial complex, specialist training, focused practice-oriented specialist training.

The immediate situation – shortage of qualified personnel within the military – industrial complex (MIC) – is stipulated by systemic problems. To solve these problems and overcome the existing crisis within this sector, an overall set of target actions are required which could either expand human resources or change today's personnel training system within the MIC itself.

Identifying the close interrelationship between professional education and R&D is becoming an important issue today. This fact has been considered in both research publications and the regulatory documents determining the governmental policy in this sector. Even today, the association of employers is only partially involved in implementing the national policy into the professional education domain, regulating the distribution of manpower resources and controlling the social-occupational mobility of human resources, which, in its turn, foster those problems relevant to university graduate placement.

In this respect, the Government of the Russian Federation proposed the strategies, dated December 28, 2007, in establishing n-tier continuous education system (K-12, secondary, higher and further professional education) within the military – industrial complex, including employee retention provisions in MIC organizations, development of core departments and laboratories within the framework of leading higher professional education institutions, as well as the establishment, and expansion of training professional centers for technical and engineering employees, and the generation of discipline-specific post-graduate training programs in R&D organizations for the period to 2020.

The national training academic researcher and specialist program for MIC of 2011-2015 was approved by Enactment N 421, dated June10, 2010 of the Government of the Russian Federation (stated in Corpus of Legislative Acts of the Russian Federation, 2010, N 25, clause 3180) [3]. Ministry of Education and Science promoted grants of the above-stated program for universities and defense enterprises. This could probably "close the gap" between current education programs and existing upgraded enterprises.

The updated RF Federal law of September 1, 2013 included a range of new provisions which were focused on the overall improvement in training human resources for MIC, i.e.:

- establishing on-the-spot core departments and other subdivisions within different enterprises;
- integrating sophisticated on-line program modules which would embrace the resource management of education organizations, industrial enterprises, engineering centers, etc.;
- introducing contract on employer-sponsored education involving two-sided commitment between employer and graduate. Such a contract would include full compensation of all expenses (i.e. doubled expenses) for both job placement and social benefits.

To solve the above-mentioned problems involving the shortage of qualified personnel, the President Act was signed to further the effective measures in state-financing backing of MIC organizations and project planning of state personnel training and development programs for MIC itself.

To enhance the personnel training quality for MIC organizations, the RF Ministry of Education and Science selected universities, based on competition results, and granted additional financing for employer-sponsored education, specifically focused on MIC enterprises, as well as improving academic process procurement. First and foremost, this government support is oriented on developing and initiating such courses that would provide target-focused training of employer-sponsored students for this or that specific enterprise. This involves the collaboration between different universities and military enterprises. Furthermore, this support includes purchasing training facilities and equipment (simulator systems, etc.) necessary in establishing engineering learning centers where employer-sponsored students would be able to undergo training on-site enterprises.

Due to the relatively ineffective material and technical facilities, numerous technical universities lack sophisticated license programs in product design, 3D-modeling of physical processes and other tools, which are essential in training future specialists being involved in advanced and knowledge-intensive industries. Other aggravating factors include underpayment, underqualified and ageing staff, declining social status of academic instructors, and increasing number of administrative-supporting personnel.

It should be mentioned that many universities have moved towards the so-called "strategic partnership", i.e. university-enterprise agreement. This strategy, being developed on the basis of the well-known Moscow Physico-Technical Institute (basic departments), has been implemented into St. Petersburg Electrotechnical University "LETI" in collaboration with leading radio-electronic enterprises. Another interesting innovative collaboration strategy has been developed within the framework of National Research University of Electronic Technology (Zelenograd). In co-development of academic programs, the above-mentioned universities take into account the requirements of relevant consumer-enterprises. Core departments, R&D laboratories, student technology design bureaus, different oriented centers, etc, are being established within employer-enterprises. Many leading academic instructors in the spheres of technological process automation, product design, robot (control) software programs, etc. in collaboration with students participate in the production of high-technology products [1].

To train specialists for MIC the FSBEI HPE Tambov State Technical University students of the following education programs: 11.03.03 "Design and Electronic Technology", 11.03.02 "Informcommunication Technology and Communication Systems", 11.03.01 "Radio-Electronics", as well as Master degree students of 11.04.03 "Design and Electronic Technology" and 11.04.01"Radio-Electronics" are involved in the integrated academic-production program which is based on the concept-focused practice-oriented training of specialists for MIC.

Focused practice-oriented training is an integration of theoretical and practical training of specialists for their professional activities within the framework of integrated science, education and production. Thus, professional specialist training corresponds to the employer requirements and the conditions for future professional activities. All in all, this is oriented on the personal development of the students via professional immersion, providing effective updating of the training content itself and based on development perspectives of different spheres and regions.

In this case, educational establishments have to reform the existing specialist training programs in response to enterprise-university interaction, which, in its turn, would further the development of relatively close-knit and sequential systems in core curriculum acquisition, corresponding to relevant enterprises and taking into account the changes in technological and social progress, innovative technology, organizations and content of the professional activities.

We have developed the concept-focused practice-oriented training of specialists for MIC within the framework of integrated science, education and production. This made it possible to consider not only the complications, but also the dynamic changes of external environment and requirements of MIC enterprises in order to further a more stable, flexible and effective professional training. The concept- focused practice-oriented training of specialists for MIC includes the following:

■ ***Set of targets****с* (external and internal prerequisites for designing these targets, i.e. implementing effective professional training of specialists for MIC within the framework of integrated science, education and production). It means that improving the quality of higher education, reflecting the requirements of today's society. Accordingly, there should be such educational innovations that would guarantee and further the modernization of higher education.

■ ***Theoretical-methodological background*** (includes interrelated methodological principles, approaches and principles to implement the concept-focused practice-oriented training).

To implement the concept-focused practice-oriented training of specialists for MIC within the framework of integrated science, education and production, it is advisable to apply the following integrated approaches: systematic (comprehensive), synergetic, environmental, integrated, competency-based, qualimetric, process, and cybernetic.

The methodological principles include the following: consistency, occupational, relevancy, personal alignment, personal fulfillment and self reflection, synergism, and innovation.

■ ***Organizational*** (includes "implementers" of set targets: transaction, functions and specific aspects of this transaction).

Within the framework of integrated science, education and production the practice-oriented environment is being developed, which, in its turn, advances the training (teaching) process towards the practical professional activities.

The "implementers" of these targets embrace the following three interrelated aspects: material-technical, social-personal and informative-tutorial having such specific features: (1) incorporating enterprise engineers and research scholars into the education process as full-fledged members; (2) engaging the material-technical and informative resources of core departments; (3) on-line updating of the training content in accordance with new regional development tendencies of MIC. All the components of practice-oriented environment are focused on the implementation of the following: educational, developmental, adaptive, informative, communicative, and technical-scientific functions.

The strategic element in the pedagogical system of focused practice-oriented training of specialists for MIC involves the integrated research-education-production structure (core departments).

■ ***Project module*** (includes the organization technology focused on practice-oriented training of highly-skilled new generation specialists who should possess a wide spectrum of required competencies to effectively work in extensive upgraded enterprise sectors. This, in its turn, would be relevant to the development trends and specific features of the enterprise sector, as well as meeting the education requirements of the population of this or that region. In this case, the established practice-oriented environment is relevant to professional environment and makes it possible to advance the teaching process to actual professional activities, which, in its turn, furthers the creative self-development of students and improves the academic level of graduates for MIC via applying such methods as active learning and immersion experience in profession).

■ ***Result-evaluation module*** в(includes qualitative documentation of experienced engineer-specialists to monitor the professional training effectiveness, assess the graduate professional training level, adopt flexible management decisions, and further adjustment, supplement or development of new education programs in collaboration with the employers. This could establish the foundation for Common Education Space based on the requirements of regional enterprises for human resources and implementation of educational paths in accordance with education requirements and student needs) [2].

To improve the professional training quality of human resources for MIC in Tambov State Technical University, the training process within the framework of the following areas 11.03.03 "Design and Electronic Technology", 11.03.02 "Informcommunication Technology and Communication Systems", 11.03.01 "Radio-Electronics" is conducted in compliance with developed concepts. This, in itself, incorporates the specialty and development trends of MIC enterprises in Tambov and meets the MIC requirements for highly-qualified and competitive specialists.

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ENGINEERING EDUCATION 18'2015
INTERACTION WITH REAL ECONOMY

UDC 681.518+378

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Strategy to Reinforce Employer Engagement in Engineering Education

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The article discusses the basic issues facing higher education, unveils the forms employer engagement can take, examines the stages of competence development within Basic Engineering Program. It proposes the algorithm of Basic Education Program design on the basis of the developed strategy to reinforce employer engagement into the engineering training process.

Key words: professional competencies, competence, information system.

Introduction

Considering the current reform of Higher Education, it is worth noting that the employer needs analysis is not carried out by the representatives of the Federal Government but by the universities themselves. In the Soviet Union, education programs were compiled in accordance with the uniform education standards. At the best of times, the specialists were ready to resolve all possible tasks. The job placement was also regulated by the Government. Today, universities train graduates who are relevant to the labor market of the same or neighboring regions. Most potential employers are the representatives of small business focused on extremely specific tasks.

The Minister of Education and Science of the Russian Federation advances the idea of closer cooperation with the employment sector in terms of employer engagement into the educational process as an educator, internship supervisor, member of the State Examination Board, i.e. so-called standard roles. In accordance with most of Federal State Educational Standards (FSES), the share of employers involved in education activities should not account for less than 10 %. Due to the above-mentioned standard forms of employer engagement, there is not always possible to consider employer's requirements to the graduates.

The development of professional and integrated professional competencies for various qualifications could hardly be effective without matching them with employers' needs and expectations, i.e. existing professional standards (PS). However, the final generation of FSES provides educators only with generalized definitions of both professional and integrated professional competencies. To achieve clear understanding of such competencies, it is required to carry out much closer cooperation with numerous employers. This work does not only involve employer survey, but also should facilitate the recognition of the existing competencies. It should be done within the limited time frame, precisely, prior to program enrollment.

The education process itself is a slow-response system. As a rule, the Higher Education Programs last 2 to 5 years. It means that during education period economic climate and especially engineering environment may change the emphasis employers are likely to give to graduates' requirements, i.e. competencies.

On the one hand, the generalized competencies stated in FSES provide educators with freedom in their understanding of professional competencies, precisely, in their choice of this or that skill or knowledge a student should gain. On the other hand, due to these generalized competencies, it is not always possible to reveal the skills and competencies that will be highly valued by employers.

Stages of competence development within Basic Engineering Program (BEP)

Basic Engineering Program (BEP) involves the following stages:

1) BEP design;

2) BEP delivery.

In order to reinforce employer engagement into the training process, it is required to introduce such sub-stage as program revision or correction. Within the BEP design stage, revision mostly concerns the curricula of professional cycle and integrated professional cycle courses. At the second stage, revision may involve the changes of the rest courses delivered within the same cycles. At both stages, competences should be matched with ever-changing employers' needs.

In order to specify the generalized competencies given in FSES in terms of the skills and knowledge related to the definite lecture and practical class content, it is necessary to design the so-called "passport" of competency (Fig.1).

The Strategy to employer engagement that is based on the engineering training stages involves the following stages:

The first stage implies design of BEP, i.e.:

1) insight into the competencies (performed by educator);

2) insight into job responsibilities (performed by educator);

3) design of competency passport (performed by educator);

4) design of BEP, i.e. in case of new qualification or degree (performed by program coordinator);

5) awareness of an employer with competency passports, FSES competencies, job responsibilities in accordance with professional standard (performed by educator or program coordinator);

6) development of employer's requirements (performed by employer);

7) BEP revision (performed by program coordinator).

The second stage involves the program delivery:

8) training delivery based on the program content (performed by educator);

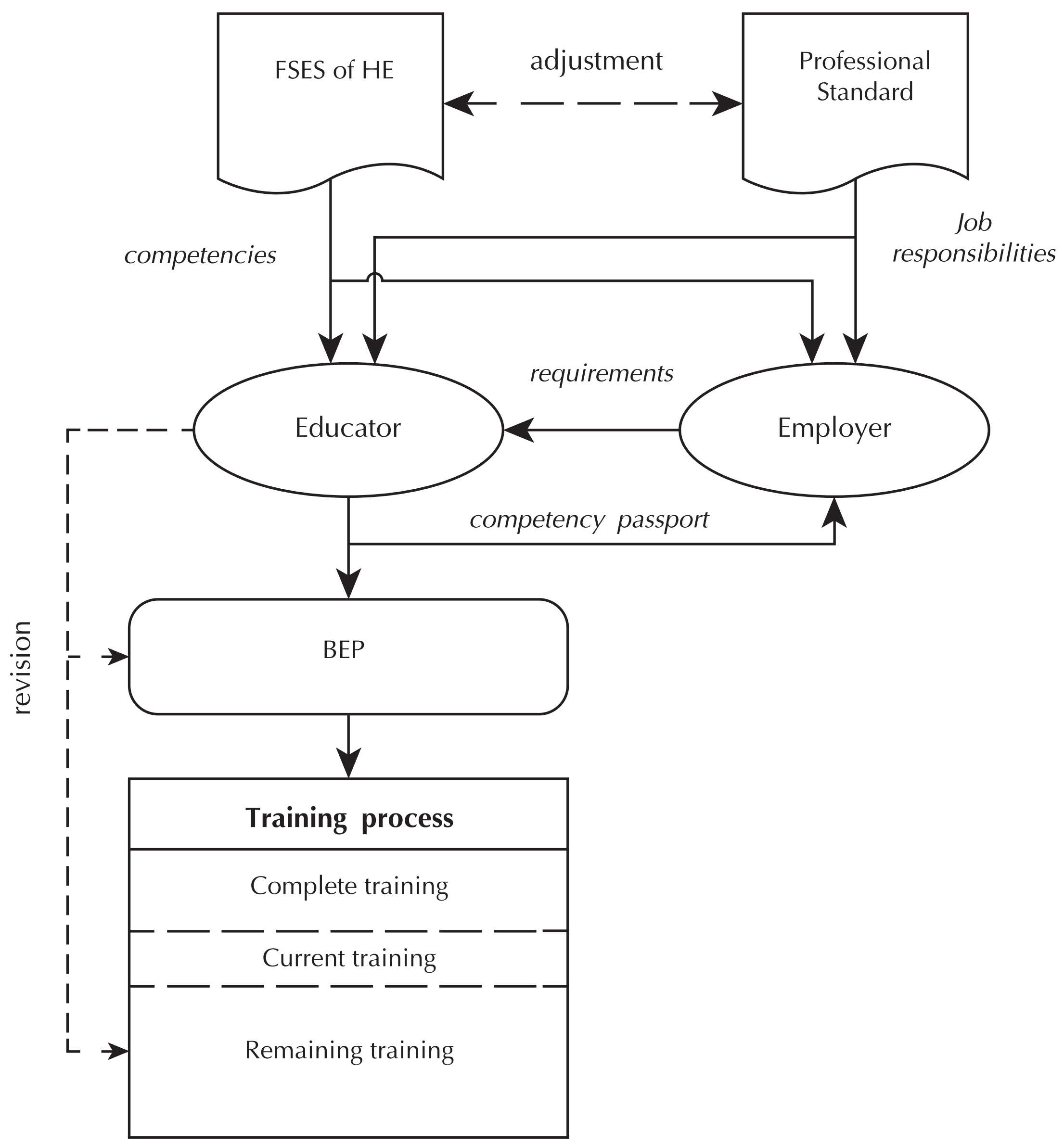
9) development of employer's requirements for the current training (stage 6) in accordance with the updated FSES competencies, job requirements stated in the professional standard, competency passports (stage 5) (performed by educator or program coordinator);

10) revision of BEP in terms of the remaining courses (performed by program coordinator).

BEP design algorithm

The first stage or start of this algorithm is conditional. Employer's and educator's data input is done simultaneously (block 1, 2). The program coordinator should choose the training trajectory among the existing qualifications. As an example, the diagram presents the codes of the integrated qualifications or education programs: 09.00.00 – Information and Computer Science, 15.00.00 – Machine Engineering, «other» other education programs offered by the university. In accordance with the selected training trajectory, the full description of FSES competencies, i.e. stages 1 and 5 of the Strategy, is provided. The Professional standards are matched in the same way (stage 2 and 6 of the Strategy). It is worth noting that stages 5 and 6 will be implemented simultaneously. Then, the coordinator should adjust and coordinate all the examined materials and data (block 7). The educator, in our case, course instructor, may himself/herself develop the competency passports in accordance with the course learning outcomes (block 10, stages 3 and 9 of the Strategy). Thus, BEP is designed (stage 10 of the Strategy). The competency passport is approved by employer (stage 5 of the Strategy). In addition, he or she should design the graduates' requirements (stage 6 of the

Fig. 1. Diagram of competence development within BEP

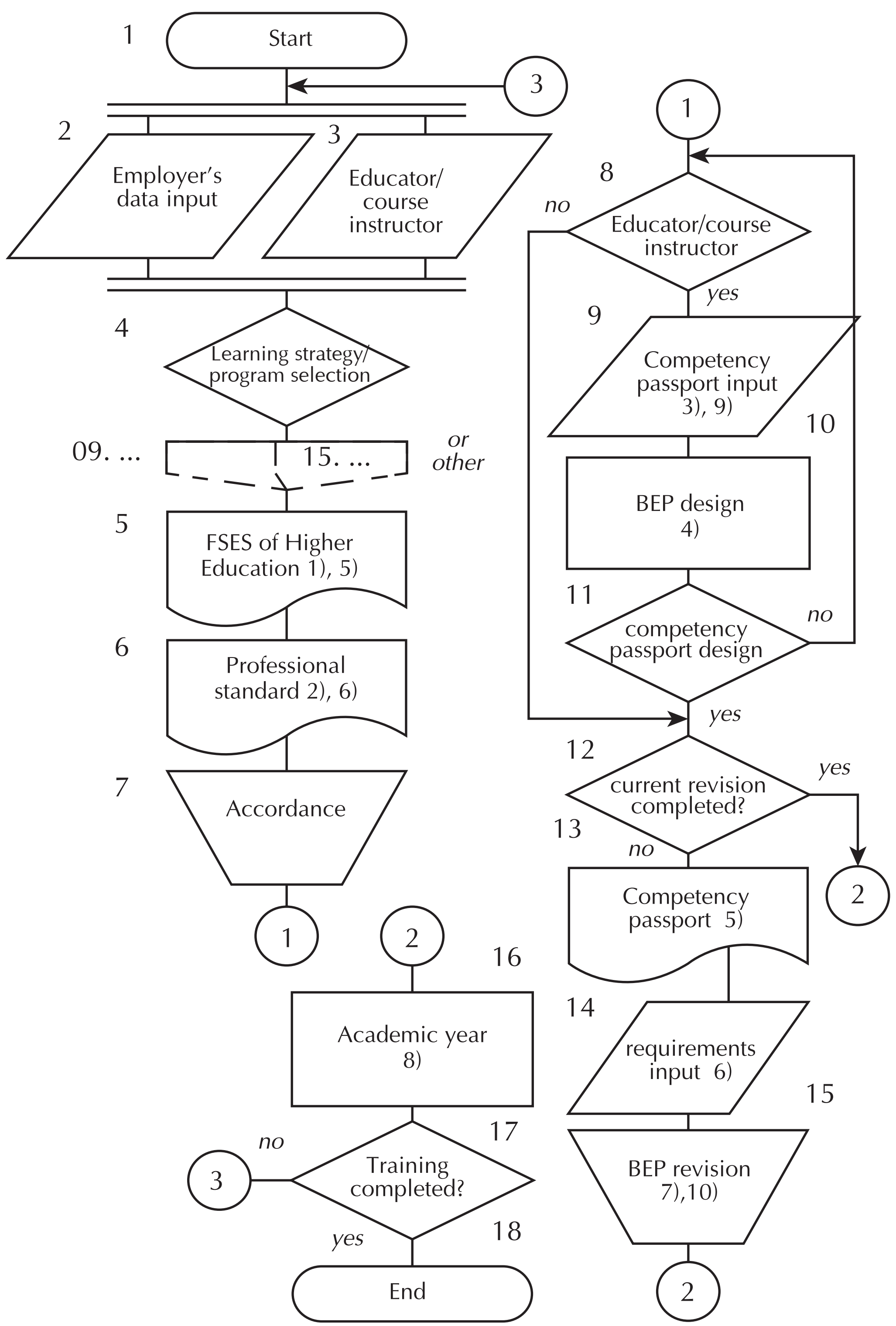


Strategy). It is followed by BEP revision, i.e. stages 7 and 10 of the Strategy). The education program should be annually revised (stage 8 of the Strategy). The stages of the algorithm should be repeated till program competition.

Due to competency passport design and determination of each competency importance, the graduate's competence within the definite BEP is developed [1, p. 31-33].

The need of an employer to influence the training process in terms of well-timed update of graduates' skills and competencies stipulates the use of information system. The information system has been developed on the basis of competence models designed at the university-employment sector level

Fig. 2. BEP design algorithm



[2, p. 52, 53].

The proposed strategy makes the foundation for designing one of the information system modules, which is directly related to BEP development [3].

Conclusion

In the context of rapidly changing work environment, there is the need to introduce new technologies in all spheres of human activities. The proposed Strategy aimed at reinforcing employer engagement in the training process would allow universities to respond effectively to ever-changing workplace requirements and labor market needs.

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Collaboration Between Coal Mining Company and Higher Education Institute for Production Process Improvement

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The paper presents the experience of collaboration in engineer training between three organizations: the surface mine office "Novoshakhtinskoye", Primorskugol, Research Institute of Mining Safety and Efficiency (NIIOGR), and Far Eastern Federal University (FEFU). Students are involved in searching for ways of production improvement through scientific and practical seminars which are held at FEFU with the participation of NIIOGR, and through work experience internship, where students are supposed to overcome particular production challenges. Engineering education, science, and production overlap at the annual scientific and practical forum "Mining School" held by Siberian Coal Energy Company (SUEK).

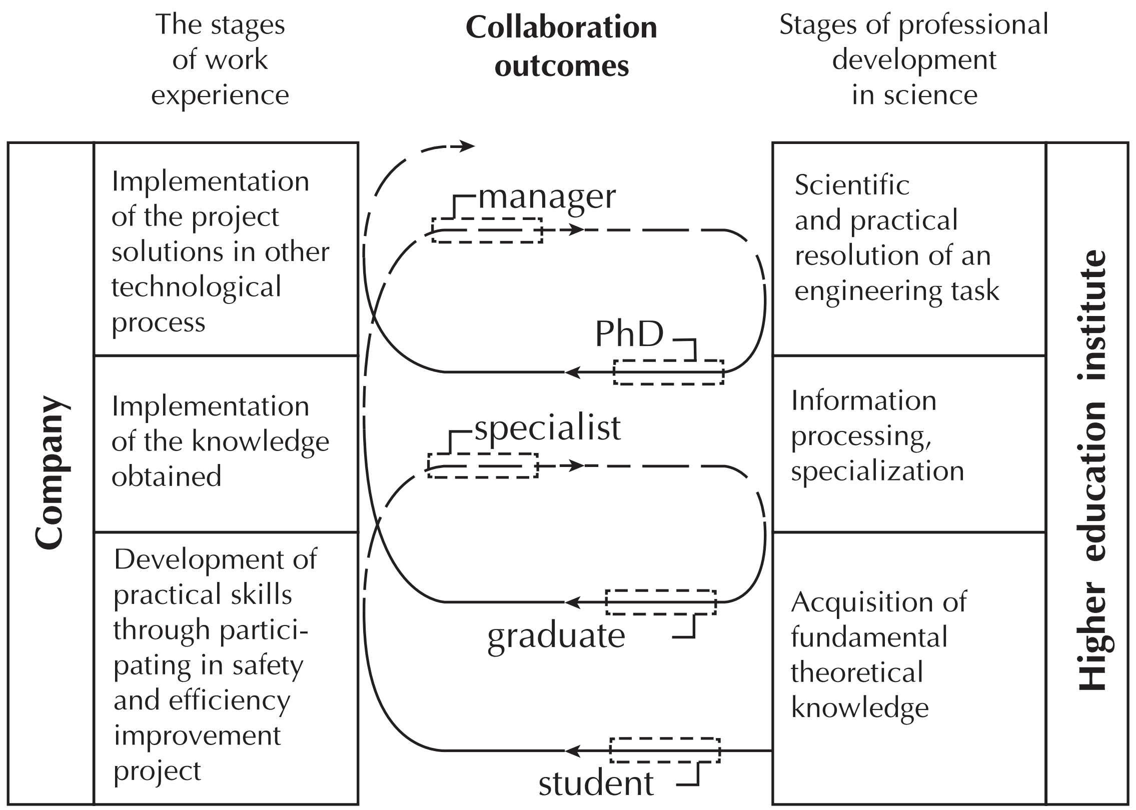
Key words: personnel policy, collaboration, personnel training, production improvement, work experience internship, seminar, scientific and industrial forum, Siberian Coal Energy Company.

Currently, the critical factor for national production improvement is graduates training since the average age of employees in the surface mine office "Novoshakhtinskoye", Primorskugol, is considerable. If measures are not taken today, the average age will rise from year to year. Having participated in a number of vacancy fairs, the company failed to receive any positive feedback, which means there should be another way to attract graduates to the company.

The students' interest in work in coal mining company arises from participation in the production safety and efficiency improvement project. This activity is carried out on the basis of the programs developed by the company's managers and professionals. This collaboration between the company and university creates a kind of network when the potential employee is involved in production improvement since his studying at the university (Fig. 1). For this purpose, since 2011, the highly qualified personnel of Primorskugol, NIIOGR, and professors and administration personnel of FEFU hold seminars for students of several specialties: mining machinery and equipment, open-pit mining, underground mining, geology and natural resources management (Fig. 2). This work with students includes the following steps: firstly, they are split into teams according to the attributed specialty or given position, then, within a team and on the basis of actual production data, they discuss various alternatives of production safety and efficiency improvement for the surface mine office "Novoshakhtinskoye".

Being involved in these activities, students identify the improvements which can be made to increase the machine and staff capacity. This allows present-day students not only to become professionals,

Fig. 1. The scheme of collaboration between the company and the higher education institute for training highly qualified personnel



but also to try themselves as managers in charge of production process improvement.

The outcomes of analytics training and modeling seminars aimed at students' clear vision of production management and encouraging production process improvement are as follows:

1. Participating in the seminars, students realize that their experience and qualification are the qualities demanded in the labor market, since the employer highly estimates the positive result, i.e. benefits of production, rather than the actual amount of work performed.

2. The majority of students are full of positive energy, eager to work and assume responsibility for their deeds. However, students cannot see the ways of how to implement efficiently their knowledge and skills in production improvement.

3. The role of employers and educators is to help students conceive the way of life they want to live, understand which part they should play and what exactly should do to make their ideas come true. This will allow concentrating on the key issues – improving one's qualification, and as a result, having better quality of life.

4. The collaboration benefits have been identified:

for administration and professors of FEFU:

- cooperation with a big developing national coal and energy company, precisely, "SUEK", and its business unit Primorskugol;
- improvement of students' and university staff's qualification resulted from practical skills obtained in production enhancement; revision of

Fig. 2. The seminar held at FEFU with the participation of NIIOGR and the critical review of experimental research carried out at the surface mine office "Novoshakhtinskoye" by the students of Department of Mining and Integrated Exploitation of Mineral Resources

educational materials and programs to make them meet the requirements of current production particularities and modern market;
- conducting scientific research on the basis of production data obtained;

for student of FEFU:

- acquisition of scientific knowledge and work experience for further development as a professional and manager;
- participation in production process improvement in Primorskugol;
- obtaining actual data from Primorskugol for further course works and the graduation thesis;

for Primorskugol:

- selecting perspective students and creating a reserve of potential young specialists;
- using students' potential to resolve engineering tasks within the project "Production Safety and Efficiency Improvement";
- establishing and developing rela-tionships in scientific world (Fig. 2).

Primorskugol organizes workplace visits for students, within which the students have an opportunity to get acquainted with the top managers, see the workplaces and have all their questions answered (Fig. 3).

At the beginning of work experience internship, there is a meeting of key managers and students devoted to the project on production safety and efficiency improvement, where each student can choose the engineering task the resolution of which he\she would like to contribute to.

The cooperative work lasts over two months. At the end of the summer work experience internship, at the special company meeting each student declares what he\she has managed to do:

- to reduce the risk of work-related injury;
- to improve equipment efficiency;
- to develop the employees' potential;
- to improve the production process and methods;
- to reduce non-productive time, etc.

When conducting this cooperation, it is essential for the students of different years of studying to work on a team with professionals and share the mutual task, i.e. development through learning. For this purpose, every morning students have a number of tasks to plan their working day and every evening the day outcomes are analyzed for probable plan revision. As a result, the students can really contribute to the production process instead of being a burden for the employees in charge, who used to perceive internship as a waste of time

Fig. 3. The workplace visit in the surface mine office "Novoshakhtinskoye" by third-year students of the Department of Mining and Integrated Exploitation of Mineral Resources, FEFU

and efforts. The youth have an opportunity to try to work in a coal mining company, identify their role in the production process and think over possible professional and career development. It is also possible to identify those who are ready for continuing professional development and to involve motivated students into the projects on open-pit mining improvement.

Collaboration with the university students contributes to the company's intangible asserts as PhD thesis can be prepared and successfully defended (for example, in October, 2013 the PhD thesis was defended at Moscow State Mining University [1]).

Scientific and methodological support is provided with the materials developed at FEFU, where scientific seminars are held to test the scientific and practical outcomes obtained by the managers and specialists of coal mining industry in the course of production process improvement (Fig. 2).

Currently, the company professionals are conducting scientific research under the supervision of the professors of the Department of Mining and Integrated Exploitation of Mineral Resources, FEFU, on the topics as follows:

- developing competitiveness of open-pit mining on the basis of production complexes of equipment and personnel;
- developing the mine captain's professional potential;
- coal mine excavator reliability on the basis of production operation enhancement;
- improving coal mining company production on the basis of the overman's continuing professional development;
- the rationale for the use of hydraulic excavator with a backhoe bucket for open-pit mining under various geological conditions;
- improving mining excavators reliability.

FEFU professors comment upon these works and make suggestions on the structure and content, which determines the further research.

As the result of the collaboration mentioned above, it is possible to

Fig. 4. The Agreement on scientific and industril cooperation between Primorskugol, FEFU, and NIIOGR (Chelyabinsk)

conclude that one of the ways to develop the company potential is to use human resources efficiently. This can be achieved through employing highly qualified personnel, whose training the company has contributed to. Today, Primorskugol is operating a scheme of selecting the graduates for employment. The main difficulty is to assess the employee's potential and motivation for job. Hiring an intern, it is important to find out whether he\she meets the corporative requirements. The potential employees in demand are determined and hard-working students, who manage to combine the work with studies. If a student is ready for personal development, the employer will be interested in employing such a person.

One the significant outcomes of collaboration between the coal mining company and the university is the increase in the number of students on internship in the surface mine office "Novoshakhtinskoye", from seven persons (2008-2010) to 68 (2011-2013). The mutual task of the company and university is to involve students in personal fulfillment, make them resolve production tasks, without explaining the particularities of the profession, but making students comprehend this through conducting professional activities. Being the participators but not the spectators of the production process, six interns have won the competition "Gold Personnel Reserve of SUEK" [2, 3], which was held to promote creative and innovative, identify perspective ideas and projects for the development of coal mining industry, to create a human resources policy of SUEK. The next step in collaboration between FEFU and Primorskugol is the development and implementation of cooperation procedure.

The overlapping of educational process, science, and production takes place at the annual scientific and practical forum "Mining School" held by SUEK. This year the forum took place for the fourth time on the bank of Murav'inaya harbor, Artem [4, 5]. The forum was organized by the non-profit partnership "Youth Forum of Mining Leaders", the fund "Nadezhnaya smena", and SUEK with the support of the RF Ministry of Energy, Ministry of Education and Science, Ministry for Development of Russian Far East, Agency for Strategic Initiatives, and the Administration of Primorsky Kray.

The aims of the School are to support the professional development of students and young employees of the mining industry and to assess their potential for work.

The School goals are as follows:

- to develop professional and leadership skills, improve knowledge and competencies of perspective young employees;
- dissemination of principles of economical production and operational efficiency improvement;
- to encourage the implementation of young employees' technical innovation proposals, to involve young specialists in resolving scientific, engineering, and economic tasks, which are challenges for the company and the whole industry;
- to encourage sharing knowledge and experience within the company;
- to contribute to professional unity and being proud of being in the industry through development of skills and acquisition of knowledge necessary to take feasible engineering and economic solutions, to conceive and design;
- to contribute to moral, intelligence, and physical development of young employees;
- to build a strong team spirit, improve the company's image, promote mining professions and mining engineering education.

The Forum participators are young employees of SUEK, FEFU students and post-graduate students working in SUEK, winners and participators of The National Championship in Resolving Fuel and Energy Cases, student of Chegdomynsk Mining College, young employees of mining companies in Primorsky Kray, totally, 11 teams, each of 15 members.

The educational program of the School comprises professional education, acquisition of operational improvement knowledge, and personal development (i.e. development of leadership skills and management skills, efficient work principles, etc.). The program includes:

- engineering case studies,
- business games and trainings;
- master classes by the experts of mining industry;
- team building activities;
- sport and creative activities.

The key teaching teaching technology is engineering case study which stipulates team work in resolving a task on production and operational improvement for a certain company under particular economic and working conditions.

Two weeks in advance, the teams received a case developed on the basis of SUEK data.

During the School, two cases were proposed: open-pit mining and underground mining. As for the first case, Borodinsky open-pit coal mine was suggested and the engineering tasks were as follows:

1. to analyze the mining methods used in Borodinsky open-pit coal mine and assess their efficiency;

2. to analyze the mining equipment performance and assess the capacity relative to the equipment with due regard to the plan of 26 million ton production increase by 2026;

3. to suggest the most efficient mining method and develop a project on equipment performance improvement and mining operations enhancement in Borodinsky open-pit coal mine;

4. to distribute the load among excavators and coal beds, with the open-pit coal mine production of 26 million tons;

5. to develop the cost breakdown structure for innovations implementation.

As for underground mining, there were engineering tasks on the mine site "Polysaevskaya": the mine is located in the central part of Leninskiy coal region in Kuzbass and is developed by the company "Mine Site Polysaevskaya", SUEK-Kuzbass. The tasks were as follows:

1. to analyze stoping technology in the mine "Polysaevskaya", including stope capacity, and assess the efficiency of the technology;

2. to suggest a project on stoping technology improvement and coal production increase, exclusive of such a factor as air supplied to the mine;

3. to suggest a project on coal production increase and make an assessment whether it is technically and economically feasible to maximize the production;

4. to develop the cost breakdown structure for innovations implementation.

The engineering tasks suggested for the teams can be addressed by the staff of research and design institutes but the School participants managed to do it as well.

On the second and third School days, the teams got supplementary tasks to resolve within two hours (Fig. 5).

Besides case studies, the participants attended lectures and seminars, met industry experts and supervisors, discussed the issues of production process improvement and personal professional development (Fig. 6). The knowledge acquired through these activities was quite helpful to resolve the above-mentioned cases.

Participating in the School activities, the

Fig. 5. Two extra hours to resolve supplementary tasks within the case study

Fig. 6. Professor of FEFU Engineering School as a lecturer at the forum "Mining School 2015"

Fig. 7. Professors of FEFU Engineering School as experts at the forum "Mining School 2015"

teams got scores, which were daily counted by the jury of 31 experts from the different parts of Russia (Fig. 7).

The winner is the team which gained more scores than the others over the School time. On the first School day, the order of teams performance was established through the draw.

The outstanding event "Mining School 2015" was held on July 6–11, 2015, and currently it is time for reflecting on the experience and preparing for the next forum in 2016. All the participants of "Mining School 2015" were fully satisfied with the event organization: from 7 a.m. till 1 a.m. there were different intelligence and sport competitions, meetings, KVN, and disco parties. There also was an exhibition of mine rescue equipment. The competition in humor "Soviet movie", where the participant made their creative performances, lasted till midnight and made everyone laugh till they cried. The excursions to Voroshilovskaya Battery and Fort № 7 were of great importance for the patriotic education of youth.

Though the forum had its winner, the team "Primorye Mineworkers", no one lost since everyone acquired new knowledge, experience in communication and team work, built personal motivation to professional development, and got unforgettable impressions.

Conclusion

The current national and global economic environment, the decrease in solid fuel production, rise in the average age of employees, and aging of equipment make coal mining companies look for new ways of production safety and efficiency improvement and attract perspective young workers and students to coal mining industry. Today, it is the time for collaboration between the coal mining company, university and NIIOGR, when the employee is involved in the production process since the time of the university studies. The overlapping of educational process, science, and production takes place at the annual scientific and practical forum "Mining School" held by Siberian Coal and Energy Company. This forum significantly contributes to professional education and personal professional development, as well as to the identification of creative and initiative youth who can become the industry leaders.

Fig. 8. Supplementary task presentation and defense by the students of FEFU Engineering School

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Information and Communications Technologies as a Factor in Railway Engineering Education Improvement and Promotion

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The article considers the role of information and communications technologies (ICT) in railway engineering education enhancement and promotion. The author has suggested a number of ways to improve the education of railway engineers.

Key words: engineering education, railway engineering education, a railway engineer, information and communications technology, ICT, education quality.

Currently, in information society, the economy of Russia needs improvements and positive investment climate. High technologies and knowledge-intensive industries, as well as a boost in the IT-sector, globally stipulate economy and intelligence development, and Russia is not an exception here. In this regard, the innovation economy greatly depends on professional staff preparation, therefore improvement and promotion of engineering education is one of the priorities of state education policy, for example, the President's program of continuing professional development for technical and engineering staff [8]. The importance of staff education improvement and continuing professional development in the information and communications technologies (ICT) sector is also contended in the Russian Federation state program "Information Society (2011–2020)" [1].

Being one of the structural sectors in Russian economy, transport industry, and railway transport, in particular, has a direct impact on the sustainable development of Russia's industrial potential. The role of higher education institutions in this process has been described before [3]. B.A. Levin has stated that the share of engineering staff in railway industry is more than in transport industry in general: future engineers make up 68.3% of all higher education students [2].

To improve and promote the railway engineering education, the international collaboration between transport engineering and technical universities is being currently strengthened. Petersburg State Transport University and its European partners have launched the project which aims to promote railway education and attract the talented youth to the transport industry. At the International scientific and practical conference "Standartization and Technical Regulation under New Conditions", held in Almaty, 2014, Rissian Railways, National Company "Kazakhstan Temir Zholy" and Belarusian Railways signed the Memorandum of engineering personnel preparation improvement for innovations and development of railway transport and mechanical engineering (October 28, 2014).

B.A. Levin in his works [2] has identified the aspects of engineering education (including engineering railway education) improvement in transport universities. The author has also determined the requirements to the quality of railway engineering education, which are stipulated by technical particularities of transportation as a system of interconnected technologies. These requirements include: [2, p. 109]:

1) continuing education, i.e. preparation of specialist able to adapt immediately to new technologies and develop these technologies through personal development;

2) development of digital and information technology competencies of future railway engineers.

The critical issue of today is the ability of the railway engineer to continue professional education and learn for life, as well as to apply ICT tools in professional activities. Modern information society needs railway engineers who possess not only profound knowledge of their profession, but also have developed ICT skills. In the 21st century ICT are one of the main elements of transport infrastructure, and railway infrastructure in particular, and is regarded as a tool of automatization and automated control of transportation.

Transport Strategy of the Russian Federation up to 2030 implies further automatization of Russian railways [9]. A new trend in railway enhancement is geoinformatics intensively developed by scientific and industrial testing center "Geoinformational and satellite-based technologies in railway transport". There are also scientific works and research considering the issue [4, 5]. The challenges and perspectives of railway automatization are discussed at the annual international science and technology conference "InfocTrans" and annual international symposium "Eltrans".

All the facts mentioned above prove the importance of ICT for railway transport and stipulate the application of ICT for enhancement and promotion of railway engineering education.

In the system of higher railway engineering education competency-based approach has been chosen and blended learning is widely used, which presumes combination of net technologies with the traditional ones.

The Federal State Educational Standards of Higher Professional Education determine the requirements which are impossible to be met through traditional teaching and learning methods. It stipulates the application of modern interactive educational technologies based on ICT, i.e. electronic learning (e-learning). Russian and international experience in this sphere (the works by A. Benedek, A. Bork, O.A. Kozlov, A.A. Kuznetsov, M.P. Lapchik, I.V. Robert, etc.) demonstrates that ICT, including e-learning, should be implemented in teaching all disciplines within the system of higher professional education.

Network educational technologies are supposed to change the educational process itself. E-learning not only ensures the high quality of education provided, but also makes lifelong learning possible, as well as increases the effectiveness of both teaching and learning. E-learning makes educational process interactive, which, in turn, ensures student's information mobility, develops individual educational path, and contributes to educational content updating [7].

E-learning is based on electronic (digital) educational resources, mostly, network ones. Currently, there are many Internet educational resources for studying informatics and ICT, as well as engineering disciplines. As a result, the task to teach the student to use Internet educational resources for studying information and technical disciplines is among the primary goals of railway engineering education. The resources to be used are as follows:

1). Electronic library network, an ordered collection of various electronic documents along with the means of search and navigation. For example, the scientific library of graphics and image processing (http://library.graphicon.ru/catalog/), the electronic archive of the journal "Quantum" (http://kvant.mccme.ru).

Besides, there are digital library systems (DLS), for example, "University library online" (http://biblioclub.ru), DLS JURAIT (www.biblio-online.ru), DLS of Lan' Publishing house (http://e.lanbook.com).

2). Massive open online courses (MOOCs), which imply different methods for online education (writing tasks, video and audio resources, Internet-conferences, assisted by tutors and regular online seminars). MOOCs are based on online courses (webinars), for example, National Open University "INTUIT" (http://www.intuit.ru).

The Ministry of the Education and Science of the Russian Federation initiated the portal for open education. The national leading universities have developed

National Platform for Open Education in Russia, which is operational since September 1, 2015. The aim of the platform is to develop national high quality open online courses available for all students and educational organizations. In 2015–2016 academic year 46 online courses will be launched (the information about the courses in represented on the website “Open Education”, https://openedu.ru/).

The website has a subdivision “Engineering, technologies and technical sciences, 23.00.00. Machines and technologies for land transport”, where one can find online courses for future railway engineers (https://openedu.ru/course/#group=40): “Mechanical Engineering”, “Construction Materials Science”, “Perspective Geometry and Engineering Drawing”, “Performance of Construction Materials”, “Fundamentals of Electronics and Electrical Engineering”.

3). Online educational editions, which contain ordered materials for a particular science from, for example, the journal “Automatization and Control Engineering” (http://magazine.stankin.ru).

4). Distance education packages, which contain educational resources to support the educational process, including e-learning technologies, for example, “Discrete Mathematics: Algorithms” (http://rain.ifmo.ru/cat/), “Electrical Machinery” (http://elmech.mpei.ac.ru/em/).

Having considered the Federal State Educational Standards of higher railway engineering education [10, 11, 12], it is possible to identify the following aspects of ICT skills development. Students start with the discipline “Informatics”, which belongs to the fundamentals of mathematics and natural sciences cycle (C.2). There is another discipline within the same cycle, namely, “Engineering Computer Graphics”, which equips students with the tools of computer modeling and simulation.

The rest of information disciplines within cycle C.2 refer to the corresponding specialties and aimed at learning ICT and/or automated management information systems in a particular sector of railway transport. As a rule, the name of the discipline sounds as “Information technologies and systems in a certain sphere of specialty”, for example, “Information technologies and test systems for electric rolling stock management” for the specialty 190300 “Rolling Stock”, the profile “Electric Rolling Stock” [10].

Also, within mathematics and natural sciences cycle (C.2) and professional cycle (C.3) students study the disciplines which deal with computer engineering and mathematical modeling in engineering. As a rule, these disciplines make students use various software packages: spreadsheets and spreadsheet tables (for instance, Microsoft Excel, OpenOffice.org Calc), software tools for mathematical and technical calculations (for example, MathCAD). The analysis of professional cycle (C.3) content shows that the disciplines comprise the elements of IT-based management in railway transport, for instance, the discipline «The Theory of Automatic Control» taught for all railway specialties and profiles [10, 11, 12].

Since ICT play an important part in a railway engineer education, as well as in the promotion of engineering railway education, it is necessary to revise the entrance examination materials used by institutions of railway higher education and include the tasks on informatics. This will stimulate the pupils to take the discipline seriously when at school, which, in turn, will help to develop ICT-competencies of school graduates who plan to work in railway engineering.

Continuing development of ICT-competencies at the railway higher education institution should last over the whole period of studies. Any course work, practical training session report, graduation thesis should meet the requirement on ICT application not only for text revision but also for calculations, testing, etc. Moreover, within the system of railway engineering education particular attention should be paid to integration of ICT into educational process, since students should acquire the skill of efficient work with ICT, including different internet resources. The institutions of railway higher education should encourage this process by providing information and methodological support.

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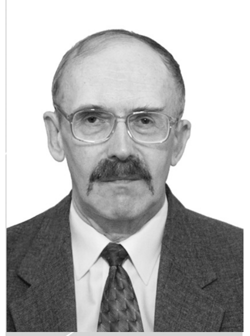

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Ways to Improve Engineering Students' Economic and Management Competencies

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The paper analyzes the requirements to present-day engineering graduates. The authors have proved that the profound knowledge in economics is necessary for engineering students. The ways to develop economic and management competencies of engineering students have been suggested.

Key words: engineering work, economic and management competencies, economic way of thinking, current labor demand, innovation in manufacturing, feasible engineering alternatives.

Today's post-industrial economy stipulates the character of engineering work and professional attributes of technical universities' graduates, who currently need well-developed economic and management competencies to meet the labor market requirements and high international standards.

However, economic and management competencies are not the priorities of engineering education at engineering higher education institutes.

The number of disciplines of economics and management is constantly decreasing, as well as the number of academic hours for these studies does. This hinders graduates' adaptation to changing market environment, restrains them from effective and timely decision making.

Therefore, modern engineering education should develop not only essential professional competencies, but also economic and management ones, which will allow the graduate to expand the sphere of professional activities.

There are many works today which consider the issue of improving technical students' economic competencies. For instance, there is a number of works which deal with the content of economics courses and their position within the curriculum of higher education institute (by V.V. Kraevskiy, N.V. Lezhneva, A.M. Novikov, S.A. Repin, V.V. Serikov, V.G. Kharcheva, V.N. Khudyakov, etc.). The importance of economic and management competencies development is described in the papers by Ye.A. Varakin, V.A. Polyakov, V.D. Simonenko, Ye.N. Khamatnurova, S.D. Churkin, etc.

The works mentioned above analyse and compare various aspects of the issue, nonetheless, there are still some interesting and relevant problems to be addressed. In recent years, the question of engineers' economic and management competencies improvement has been gaining importance as these competencies allow the person to adapt to social and economic changes, serves as a basis for personality development and human capital formation [1]. The necessity to improve economic and management competencies of engineers is also caused by the social need in technical specialists able to think in terms of economics and management.

As a result, the present-day engineer should be able to make economic calculations at any stage of a product lifecycle. Besides standard professional competencies, the graduates of technical institutes should develop management skills, be able to choose feasible engineering alternatives and assume responsibility for their implementation.

The knowledge in economics and management obtained at the higher education institute makes it possible for the engineer:

- to manage effectively the industrial process;
- to ensure economic feasibility of the important technical decisions;
- to make efficient management decisions and be responsible for their implementation.

A present-day engineer is responsible for manufacturing process and competitive products output and also should be able to manage people, work in a team and have potential to occupational mobility. The specialists need profound scientific and technical knowledge in engineering, be focused on professional development, use critical thinking to identify the optimal decision [2].

In foreign countries, engineer's economic and management competencies are of great importance as they connect manufacturing with the market. Knowledge in economics and management is among core competencies of elite engineers in Sweden, Japan, the USA, Germany, and China.

European technical education standards imply that economic and management competencies account for up to 30% of all competencies essential for a technical institute graduate.

In the innovative economy, the employer is interested in employees who can overcome economic and management challenges, and optimal decision making directly depends on how well the relevant competencies have been developed at the higher education institute.

The profound knowledge in economics is quite important for engineers as it helps to understand the laws of economic behavior and unveils the laws and modern trends in public production.

The well-developed economic and management competencies will allow a graduate [3]:

- to take timely the role of manager;
- to adapt to changing enterprise environment, both inner and outer one, as well as to the changes and shifts in manufacturing process;
- to influence staff in different situations;
- to generate ideas and to implement them in different spheres of work.

When at work, an engineer with improved economic thinking skills will be able:

- to form concepts and take a definite stance towards current economic challenges in Russia;
- to think over the process of national social and economic development;
- to lay foundation for stepping up creative efforts in professional activities;
- to adapt timely to the current market conditions.

The necessity to change the content and structure of engineering education is caused by moving into post-industrial society with a new type of economic system, diversification of business activities, innovations and high technologies in manufacturing. With the market conditions constantly changing, the national society is badly in need of engineering staff with well-developed economic competencies and the potential to occupational mobility [4].

As a result, the graduates' poor knowledge in economics might be considered a significant drawback of national higher education system. Therefore, the development of economic and management competencies should become one of the priorities in higher technical education improvement [5].

The Russian and foreign scientists suggest several ways to implement these improvements:

1) to determine the content and structure of academic disciplines of economics within the basic sciences and professional cycles to improve graduates' economic and management competencies (works by E.M. Korotkov, A.G. Porshnev, V.S. Semashko, Yu.G. Tatur, and others);

2) to provide didactic support for economic courses taught for engineers in compliance with the requirements of the Federal State Educational Standards of Higher Professional Education (works by A.A. Belyaev, I.A. Blank, V.R. Vesnin, B.A. Rayzberg, K.A. Raitskiy, and others);

3) to improve professional education under new economic condition and develop personal qualities necessary to carry out professional activities efficiently (V.A. Belikov, A.N. Sergeev, E.F. Romanov, A.Ya. Nayn, O.V. Lesher, N.M. Yakovleva, and others)

4) to equip leaders with management skills (L.I. Evenko, A.P. Egorshin, A.V. Molodchik, and others);

5) to enhance specialists' education management (I.I. Lyakhova, V.M. Raspopov, Z.M. Umetbaev, and others).

The foundation of engineers' economic and management competencies improvement should rest on the scientific papers dealing with such methodological challenges as:

1) competency-based approach in higher education (M. Amstrong, S. Uiddet, Dzh. Raven, A.V. Khutorskiy, Yu.V. Koynov, and others);

2) development of economic competence and economic thinking (A.V. Dorofeev, F.M. Rusinov, S.A. Shenderova, E.A. Fadeeva, and others);

3) interaction of economic and manufacturing activities (G.Ya. Gorfinkel', N.N. Kostina, T.A. Petrova, A.V. Koren'kov, O.N. Sinitsyna, and others);

4) professional and personality development (E.M. Borisova, E.A. Klimova, S.L. Rubinshteyn, T.V. Kudryavtseva, V.A.Petrovskiy, L.L. Zelinskaya, and others).

A particular challenge is to create a model of engineers' economic and management competencies improvement and implement this model into the national higher education system. The model implementation will contribute to high quality engineers training, and the graduates will be equipped with the competencies necessary to fully realize one's professional potential.

To overcome this challenge, it is essential to do the following steps:

1) to analyze economic and management competencies with regard to their development in the course of engineers training at higher education institutes in compliance with the Federal State Educational Standards of Higher Professional Education and the Federal State Educational Standards of Higher Education;

2) to identify in the curricular of engineering students the disciplines of economics which allow developing economic and management competencies specified in Federal State Educational Standards of Higher Professional Education and Federal State Educational Standards of Higher Education;

3) to create a model of engineering students' economic and management competencies improvement with due regard to the current market conditions;

4) to equip engineering students with essential knowledge in economics, including:

- basic economic concepts (challenges of economic development, economic policy, manufacturing capabilities, agents of production, demand, supply, mathematical modeling in economics, etc.);

- fundamentals of economics for professional activities (the laws and rules of an enterprise's economic operation, process engineering methods, economic planning, work measurement, the principles of staff management, etc.);

5) to summarize and solidify the acquired knowledge in economics when preparing graduation thesis, which is an essential stage for the graduate to become an engineer with a wide range of competencies required for modern manufacturing production.

The result of this work is a package of developed methodological materials which can be used by the academic staff in the educational process.

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Summary

ELITE ENGINEERS FOR ECONOMY. WHO IS THE HIGHLY DEMANDED SPECIALIST OF TODAY AND TOMMOROW?

V.V. Novoselov, V.M. Spasibov
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The staff shortage and also insufficient qualification of university graduates became a limiting factor of economy today. The Russian science and education lagged behind world development for a period of 15-20 years, got stuck at the level of the fifth technological way while abroad, in the developed countries, the sixth one is already actively formed. Attempt to come up is of little promise. Breakthrough steps aresteps is needed. Today, to break forward, Russia has to master convergent technologies, interdisciplinary approach in development of science and education. In article problems of the higher school, tasks of training of specialists of a new type are analyzed.

USING A PROCESS APPROACH TO PRODUCTION AND EDUCATIONAL ACTIVITIES

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The article focuses on the use of the process approach , declared the ISO series 9000 any professional activity .The article notes the importance of assessing the characteristics of the process: the efficiency, effectiveness and adaptability. It presents the feasibility of the process approach in educational activities for the preparation of competent engineers to make this principle the basis of their professional activities.

TRENDS IN ENGINEERING EDUCATION DEVELOPMENT FOR INNOVATION – DRIVEN ECONOMY

I.L. Gonik, E.V. Stegachev,
O.V. Yurova, A.V. Tekin
Volgograd State Technical University

The article proves the urgency of engineering education development for innovation-driven market economy, both at regional and national levels. It also describes the actions that should be taken to develop complex engineering education environment based on the experience of Volgograd State Technical University.

THE LEVEL STRUCTURE OF CREATIVE CLASS

A.V. Kozlov, O.V. Sidorkina,
T.V. Pogrebnaya
Siberian Federal University, School № 82 of Krasnoyarsk, School № 10 of Krasnoyarsk named after academician Yu.A. Ovchinnikov

The article deals with the description of essential characteristics of creative class developed within technological creativity based on the modern engineering creativity methods – applied dialectics, or the theory of invention problem solution (TIPS). Evaluation criteria of creativity levels are suggested. The ways of increasing students' creativity level in the engineering education are studied.

ON NESSESSITY OF BALANCE BETWEEN PROFESSIONAL DEVELOPMENT AND RANK PROMOTION OF UNIVERSITY FACULTY MEMBERS

I.N. Kim
Far Eastern State Technical Fishery University

To ensure successful professional development, a faculty member should plan his/her de-velopment trajectory that would be perfectly coupled with the career growth. Promotion of a faculty member is an effective way to encourage his/her professional activity, which, in its turn, would speed up the competence acquisition and allow a faculty member to pass through "the zone of incompetence". The career growth of a faculty member should be slow but steady in its progression.

DEVELOPMENT OF ENGINEERING GRADUATES' COMPETENCES

V.P. Solov'ev, T.A. Pereskokova,
Yu.A. Krupin
National Research Technological University «MISIS»

The article proposes the use of competence-based approach in Higher Engineering Education. The proposed graduate's competence model developed in accordance with the Federal State Educational Standards, and employers' requirements makes it possible to unite all participants of education process in order to achieve a primary goal, i.e. high quality of engineering education. This would certainly raise the prestige of engineering education.

MEASURES CONTRIBUTING TO PUBLISHING ACTIVITY OF FACULTY MEMBERS

I.N. Kim
Far Eastern State Technical Fishery University

Today, publishing activity is one of the priority indicators in department faculty activity. In all international ratings the significant share of the integral indicator (from 30 to 50 %) ranking universities in their positions accounts for the evaluation of research activity performance. It is worth noting that most of department members of Russian universities face a number of challenges in developing their publication career due to insufficient level of foreign language and information technologies knowledge. The article presents the actions that should be taken in order to stimulate publishing activity of faculty members and increase their citation index.

INTRODUCTION OF MODERN TEACHING TECHNOLOGIES INTO "METROLOGY, STANDARDIZATION, AND CERTIFICATION" CURRICULUM

A.A. Gluhanov
Northern (Arctic) Federal University named after M.V. Lomonosov

The main trend of Higher Engineering Education is the use of interactive teaching technologies. Precisely, introduction of such educational games as business games, case-studies, etc. into the curriculum of "Metrology, Standardization, and Certification" which is basically regarded as practice-oriented course allows educators to make teaching more interactive. The article examines the ways to use various interactive teaching technologies within the above course, the examples being provided.

ON-LINE QUALITY ASSURANCE OF STUDY PROGRAMMES: EQUASP APPROACH

A. Squarzoni
University of Genoa
J.J. Perez
Universitat Politecnica de Catalunya
V.E. Mager
Peter the Great St. Petersburg Polytechnic University

The description of the EQUASP model for quality assurance of study programmes, developed in framework of a TEMPUS project, is introduced.
The introduction section contains brief information on the concept of quality and quality assurance of study programmes along with the Tuning approach to the design of study programmes and the standards and guidelines for quality assurance in the European Higher Education Area.
The fourth section describes the EQUASP approach to quality assurance and pinpoints the necessary documentation for the quality assurance of study programmes. More specifically, the EQUASP standards for the quality assurance of study programmes are defined,

followed with the identification of the fundamental processes for a quality management of study programmes together with the associated quality requirements and expected activities for their accomplishment.
The information and data which study programmes need to document in order to provide evidence of the quality of the educational service offered and therefore, to assure their quality, are established.
The standards and guidelines constitute the 'EQUASP Model' for the quality assurance of study programmes.
The fifth section introduces the EQUASP approach for monitoring of quality of study programmes perceived by interested parties (students, graduates, employed graduates and employers).
Finally, the sixth section summarizes the objectives already achieved and introduces the activities in progress for the completion of the project according to the established work plan, while the conclusions summarize the benefits of the EQUASP system.

ON MODELLING MANAGEMENT PROCESS IN ENGINEERING SCHOOLS

Ju. V. Podpovetnaya
South Ural State University,
Financial University under the Government of the Russian Federation (Chelyabinsk branch)
N.A. Kalmakova
Financial University under the Government of the Russian Federation

The article considers an education process in an engineering school. Economic and mathematical approaches to education management modeling are suggested to build a new architecture of education process. The authors describe the application of Production Function Model to education process in a technical university. Special attention is paid to research management model and quality model for graduate training.

YAKUTSK STATE ACADEMIC OLYMPIAD IN TECHNICAL DRAWING – 50 YEARS

R.R. Kopirin
North-Eastern Federal University

The article is devoted to the current teaching problems in technical drawing in the schools of Sakha Republic (Yakutia), involving the 50-year background experience in organizing and conducting olympiads in technical drawing. The pedagogical achievements of the technical drawing teachers and olympiad winners have been described.

ENGINEERING STAFF TRAINING – ISSUE OF NATIONAL CONCERN

E.P. Aprosimova, N.I. Andeev
North-Eastern Federal University

The article examines the quality of engineering education. It underlines the urgency of:
- implementing system policies regarding engineering education;
- introducing preferential treatment and incentives to the enterprises which are planning to contribute to engineering staff training through the cooperation with universities.

DEVELOPMENT TRENDS OF MILITARY – INDUSTRIAL COMPLEX AND ITS INTERACTION WITH EDUCATION AND SCIENCE

D.Yu. Muromtsev, T.Yu. Dorohova
Tambov State Technical University

The article describes the major issues, such as shortage of qualified personnel, integration of educational and innovative processes, renovation and development of domestic military – industrial enterprises, as well as the development trends in the military – industrial complex itself.

STRATEGY TO REINFORCE EMPLOYER ENGAGEMENT IN ENGINEERING EDUCATION

L.V. Motaylenko
Pskov State University

The article discusses the basic issues facing higher education, unveils the forms employer engagement can take, examines the stages of competence development within Basic Engineering Program. It proposes the algorithm of Basic Education Program design on the basis of the developed strategy to reinforce employer engagement into the engineering training process.

COLLABORATION BETWEEN COAL MINING COMPANY AND HIGHER EDUCATION INSTITUTE FOR PRODUCTION PROCESS IMPROVEMENT

Yu.S. Doroshev
Far Eastern Federal University
A.V. D'yakonov, E.E. Soboleva
JSC "Primorskugol"
V.A. Khazhiev
Ltd. "Research Institute of Mining Safety and Efficiency"

The paper presents the experience of collaboration in engineers training between three organizations: the surface mine office "Novoshakhtinskoye", Primorskugol, Research Institute of Mining Safety and Efficiency (NIIOGR), and Far Eastern Federal University (FEFU). Students are involved in searching for ways of production improvement through scientific and practical seminars which are held at FEFU with the participation of NIIOGR, and through work experience internship, where students are supposed to overcome particular production challenges. Engineering education, science, and production overlap at the annual scientific and practical forum "Mining School" held by Siberian Coal Energy Company (SUEK).

INFORMATION AND COMMUNICATIONS TECHNOLOGIES AS A FACTOR IN RAILWAY ENGINEERING EDUCATION IMPROVEMENT AND PROMOTION

N. A. Nastashchuk
Omsk State Transport University

The article considers the role of information and communications technologies (ICT) in railway engineering education enhancement and promotion. The author has suggested a number of ways to improve the education of railway engineers.

WAYS TO IMPROVE ENGINEERING STUDENTS' ECONOMIC AND MANAGEMENT COMPETENCIES

I.V. Krasnopevtseva,
A.Yu. Krasnopevtsev
Togliatti State University

The paper analyzes the requirements to present-day engineering graduates. The authors have proved that the profound knowledge in economics is necessary for engineering students. The ways to develop economic and management competencies of engineering students have been suggested.

Public-Professional Accreditation of Curricula (Results)

Russian Association of Engineering Education (AEER) has been involved in the development and progression of public-professional accreditation system of engineering and technology programs within Russia during the last 10 years. The following issues were embraced: the study of international experience history and the development of assessment criteria and requirements for engineering and technology programs, pursuant to existing international requirements. Further, Russia, represented by AEER, was admitted to the international Alliance ENA EE (European Network for Accreditation of Engineering Education). AEER was entitled to assigning the international certification label (EUR -AC E label) for accredited programs. In view of this fact, the existing quality assessment system of education programs in Russia has been acknowledged in 14 EU countries, such as Germany, France, Great Britain, Ireland, Portugal, Turkey and others.

At the same time AEER had been taking insistent measures in entering the International Engineering Alliance Washington Accord and in 2007 AEER was included in the Alliance as associated member with Provisional signatory (website WA).

In 2012 (June 14) the International Engineering Alliance Meeting (Interim Meeting 2012, Sidney, Australia) was held, where Russia, represented by AEER, was admitted to Washington Accord (Washington Agreement) as authorized Signatory member (website WA).

Russia became the 15th Signatory-country of the Washington Agreement. This implies that all engineering education programs accredited by AEER are acknowledged by other Signatories as equivalent analogue accredited programs, including such countries as USA , Canada, Great Britain, Japan, Korea, Singapore, Ireland, Australia, South Africa and other countries.

Thus, the quality assessment system for engineering education programs developed by AEER has been acknowledged by the majority of developed countries. It can be stated that a well-developed national public-professional accreditation system for engineering education programs has been established in Russia and AEER accreditation has been internationally accepted.

Based on the results (31.12.2015) 201 EUR-ACE® labels were awarded to 375 accredited education programs from 55 Russian universities; while in Kazakhstan, 34 education programs from 7 universities were awarded EUR-ACE® Label due to international AEER accreditation.

The following Register shows the successfully accredited education programs by AEER.

List of Accredited Programs, Russian Federation (as of 31.12.2015)

	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
	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
	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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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
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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	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
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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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
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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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
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

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
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
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

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
	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
	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

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
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
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

	Program Code	Qualifi-cation	Program Name	Certificate	Accreditation Period
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
	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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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
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
	Southwest State University				
1.	28.04.01	SCD	Nanotechnology	AEER EUR-ACE®	2015-2020

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	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
	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
	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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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
	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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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 31.12.2015)

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
	D. Serikbayev East Kazakhstan State Technical University (Ust-Kamenogorsk, Republic of Kazakhstan)				
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 (Astana, Republic of Kazakhstan)				
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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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 (Pavlodar, Republic of Kazakhstan)				
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 (Almaty, Republic of Kazakhstan)				
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 (Karaganda, Republic of Kazakhstan)				
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
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 (Kostanay, Republic of Kazakhstan)				
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 (Semey, Republic of Kazakhstan)				
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 31.12.2015)

	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 31.12.2015)

	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 31.12.2015)

	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 31.12.2015)

	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 Espaca – www.iies.es)
13. **FINLAND** – FINEEC – Korkeakoulujen arviointineuvosto KKA – http://karvi.fi/en/


ENAEE
European Network for Accreditation of Engineering Education

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
18'2015

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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