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DEAR READERS!

In December 2012 the Russian Conference "Approaches to Reshaping the National Engineering Education Doctrine in Russia" was held in Tomsk. There were more than 200 delegates from different professional, academic and public spheres, including academia communities, rectors and vice-rectors of various engineering institutions, students, post-graduates, employers of enterprises and representatives of various federal/regional legislative and executive branches. Including amongst others: A.Ch. Erkenov, State Duma Deputy of the RF, Member of State Duma Committee of RF in Education; L. M. Ogorodova, State Duma Deputy of the RF, Deputy Chairwoman of State Duma Committee of the RF in Science and High-Technology; V.M. Kress, Deputy Chairman of Federation Council Committee in Science, Education, Culture and Communication Policy; and O.V. Kozlovskaya, Chairwoman of Legislative Duma, Tomsk Oblast. There were also representatives of 23 universities from 16 constituent entities of the Russian Federation. Numerous prominent international experts in engineering education also participated in this Conference: France - Rene-François Bernard, CEO of European Engineering Education Quality Assurance Network in the field of industry; Taiwan – Andrew Woo, Professor of Taipei University, and Vice-president of Global Alliance in Accreditation of Engineering Education Programs "Washington Agreement".

To provide introductory concepts on the National Engineering Education Doctrine development, its form and content, the additional issue "Engineering Education" (№10, 2012) (prior to Conference opening date), was published in for all interested delegates. This document embraced the opinions of different representatives of engineering and academia communities concerning those processes in the reshaping of the National Engineering Education Doctrine in Russia. With a view of this, the Conference discussion session was mission-focused and constructive.

The discussion issue of the day in two plenary sessions and six panel discussions embraced the problems of specialist quality training in engineering and technology and the status of engineering education both in Russia and abroad. Many delegates in their presentations highlighted the necessity of developing and implementing a "National Doctrine of engineering education in Russia", i.e. a fundamental document determining the strategy and tactics of engineering education development pertinent to the current environmental challenges. The following questions were also issued: form and content of engineering education, shaping future engineers' competency attributes throughout the learning of general engineering and professional core courses.

The priority question at the Conference was the so-called "comprehensive approach", the application of which is significant not only in shaping the National Engineering Education Doctrine in Russia, but also in designing up-dated engineering education programs. Delegates emphasized the lagging in Russian engineering education to that of today's development of engineering and technology. One of the main factors is that no engineering program course shapes the future engineer's competencies in applied systems analysis, systematology and system engineering which results in the possible decline of student independent learning skills in system analysis and synthesis. This fact was outlined in the report of one of the most recognized world experts in applied systems analysis, professor of Tomsk State University, F.P. Tarasenko, whose article is being published in this issue.

This current journal "Engineering Education" includes proceedings papers, as well as, informative abstracts, either presented or sent to the Conference. As a result "Recommendations of the Conference" are published in this issue.

Editorial Board trust that all the articles published in this issue not only embrace those ideas and suggestions that would improve the quality training of Russian specialist in engineering and technology, but also would become that impulse in furthering the research development in updating domestic engineering education.

Editor -in-Chief
President of Russian Association of Engineering Education
Professor Yu. P. Pokholkov

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Systemacity as a leverage point for Engineering Education Reformation

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F. P. Tarasenko

The author supports the idea of Russian Engineering Education reformation and underlines the importance of systemacity in engineering education management, in particular in professional paradigm of future engineers. Possible provisions of the developed Engineering Education Doctrine are suggested. These provisions are focused on systemacity in some kinds of activities in engineering university.

Key words: *engineering education, systems thinking, design thinking, systemacity of practice.*

F.P. Tarasenko

More and more figures of Russian higher education are alarmed at quality of engineering training in Russia. They evaluate it to be in a crisis state [1]: challenges of social and economic environment and inner changes in higher education system have caused problems that need to be urgently solved. The Russian Association for Engineering Education put forward an initiative to start development of "National Doctrine of Engineering Education in Russia" [1, p.p. 50-65].

Basic condition of any successful guided influence on a social system (no matter if it is some corrective actions, reform or crucial system change) is the correct correlation between the level of effect design systemacity and the level of problem complexity. If the level of management systemacity is higher than the level of problem difficulty, the aim will be achieved; if the management is not systematic enough – we'll fail. (In cybernetics this condition is known as law of requisite variety). Neither inner and outer enemies nor unskilled executors (or Mother Nature's ironies) are guilty in management fail or in unsuccessful reforms. All these and many other factors should be foreseen in the process of systems intervention design. The requirement for necessary systemacity also refers to the development of the basic engineer's competence - the ability to solve engineering problems: to design and implement technical and human-machine systems.

Thus, Y. Pokholkov's opinion that systemacity should be a necessary component of the future National doctrine is quite reasonable [2]. Not only should systemacity be implemented in the intended improvements of the engineering education but also the curricula of engineering specialities should include subjects that encourage and develop engineering systems thinking ("Applied Systems Analysis", "Systems Engineering", "Methods of Engineering Creativity"). Systemacity is one of the most powerful leverage points to influence any system [3].

A multi-purpose technology of systems problem-solving in real life, which has been developed in applied systems analysis for the last 50 years, is practically implemented in the form of interactive planning [4], or idealized design [5]. It is not a professional systems manager ("moderator", "facilitator" or "coordinator") who develops and implements a problem-solving plan: he/she doesn't have neither necessary information nor resources. The only thing he/she knows is what questions are to be asked in the process of design. The answers can be given only by all participants of the problem situation together. They will design themselves the future they want.

Engineering education doctrine is a target part of the education paradigm; it is a starting base for planning and implementing engineering education reform. The doctrine contains crucial problems of contemporary engineer training system, aims and objectives of the suggested reform and the ways to achieve them.

Completeness and accuracy of all the models constituting the Doctrine are significantly important for reform success. Mistakes in the used models cause failure of the planned reform. For example, the famous endeavors to solve such problem as alcohol addiction at the state level (in the USA – the beginning of the XX century and in the USSR – the end of the XX century) were in vain because of insystemacity of the planned interventions. These interventions were not improving ones, which is the condition of systems problem-solving. The engineering reforms can also contain mistakes in the working models. The example is a modernization program started by the ex-president and now Prime-Minister, D. Medvedev [6].

The notion of modernization according to the program is connected with planning, development and implementation of only five types of hi-tech scientific innovations. They do contribute to society progress and are necessary components of its development. Nevertheless, only these components can not ensure the desired progress, because technological modernization is not a final objective but means to achieve a target of higher level. Modernization has to be carried out in different ways for different purposes: for improving people's welfare or for improving national defense capability or for ensuring competitiveness of some national industries after WTO accession. Thus, there is a confusion of ends and means in the formulation of the modernization tasks, which can lead to failure.

However, confusion of ends and means is not the only and the worst of the possible mistakes while formulating management aims and objectives. More risks arise when not all essentially required objectives are identified. (It happens if simple solutions are suggested for complex problems.) In such cases the implementation of simple solution not only fails in solving a complex problem but also causes new problems. Quite a number of contemporary reforms don't work for that reason. The same fate is destined to the modernization reform, if the objective of technological development is not supported by other, not less important, objectives.

The key point of the program implementation became a foundation of a super powerful innovative center Skolkovo (instead of investing these considerable funds into the existing scientific, technological and production centers and their infrastructures). A famous researcher of Russian science, American professor Loren R. Graham tells about Skolkovo [7]: "I think that the Russian leaders are making the same mistake as their predecessors. They want to create new technologies and machines (equipment, techniques) in Skolkovo. But the problem is not in machines (equipment, engineering), Russian scientists and engineers are still brilliant, the problem is in society. It is the society to be reformed. This is much more important than building an isolated territory of flourishing hi-tech." Russia has always been rich in innovative creators. A lot of breakthrough ideas were born in Russia (Polzunov –steam engine, Stoletov – filament lamp, Popov – radio, Zvorykin – television, Sikorskiy – helicopter, etc.), but they were accepted in Russia only after their implementation and use in foreign countries. Nowadays, such phenomenon as "brain drain" shows the demand for Russian specialists outside Russia.

D. Medvedev's program article "Forward, Russia!" with the enumeration of prior directions of modernization ends with an invitation for "everybody who has something to tell to take part in the discussion". He offered people to e-mail him their comments on the topics mentioned in the article. In my letter I drew his attention to the fact that the program doesn't contain humanitarian component (direction) that is not less prior especially for engineering education, because hi-tech development and implementation is impossible without highly qualified personnel. Neither did I receive the answer nor noticed any changes in the program.

A lot of philosophers and educators, including L. Tolstoy, preached the idea that a humanitarian thought should be ahead of social development. French philosopher Claude Levi-Strauss expressed the same idea in the most radical way:" the XXI century will be a century of humanitarian sciences or else (otherwise) it won't be at all." Russell Ackoff [4] underlines that the highest level of human experience and understanding of reality is wisdom that determines the sense of any activity. The human history has developed criteria for conscious human behavior expressed by ethics, esthetics and morality.

Thus, an important element of engineering education Doctrine project [2] is the requirement to increase emphasis on humanitarian component in curricula of engineering training programs. Also it's worth thinking on the ways the engineering society could increase Russian managerial society's sensitivity to innovative ideas. Soviet experience of making scientists introduce their results into production turned out to be inefficient.

The Doctrine project [2] pays special attention to development of systems thinking (world perspectives) of future engineers, design thinking (perspectives of engineering activities), systemacity of practice (systems technology of engineering activity). The related disciplines should be included in the set of the required subjects of all engineering specialities curricular. (Besides, when being a Minister of higher and special education in the 80s, F. Peregudov introduced a course of systems analysis in the engineering higher schools as a required subject. But this innovation was later rejected due to the mentioned above close-mindedness of Russian practical paradigm.

However, the phenomenon of close-mindedness has not only national but also panhuman components. Not long ago three American universities conducted large scale socio-psychological experiments with managers of different levels from different enterprises [8]. The research covered more than one and a half thousand leaders of commercial, engineering, research, educational, political and public organizations. The people under test were suggested that they should give their personal evaluation of a particular situation. For example, they were asked to guess how much money is contained in a glass filled with coins of the same denomination. The suggested sum were noted, and every participant was informed about the sum suggested by other participants (and real sum in the form of subjective evaluation). Then all the participants had the opportunity to correct their evaluation taking into account other opinions. The results were also noted. The results of every experiment participant were correlated with his/her power status (characterized by the number of subordinates, degree of influence on their behavior and power hierarchy level). It turned out that self-confidence, immunity to other people's advice and errors in decision-making are related to power level by monotonically increasing dependence (it was noted that this dependence is weaker for leaders-women). No wonder, that M. Gorbachov refused R. Ackoff's offer to work on Nagorny

Karabakh problem, and later V. Chernomyrdin rejected a meeting with a group of Nobel Prize winners in economics who suggested discussing Russia's problems in transition to the new social and economic order.

One of the Doctrine's objectives should be increasing systems level of senior executives' mentality. Most of these personnel have engineering education.

While developing the Doctrine, it should be also taken into consideration that sustainable development of any system depends on its ability to adapt to inner and environmental changes. That is why the Doctrine should provide the development of an adaptation sub-system and the possibility to learn from its own experience in the frame of organizational structure of engineering education system. A principal scheme variant of such a sub-system is suggested in [4].

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Engineering Education Concept in Modern Russia (Philosophic, Scientific and Pedagogical Aspects)

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The problems of engineering education are presented in terms of modern philosophy. The importance of creative thinking in innovative activities is emphasized. The ways to develop creative skills of future engineers are discussed.

Key words: *engineering education, creativity, reformation of education.*

N.P. Kirilov

The logic of conceptual justification of innovative engineering training

The concept is regarded as true knowledge. The concept of innovative type of engineer should include three components.

The first is job description that determines specification of specialist's engineering activities.

The second – justification of content and forms of education process to train such specialists.

The third component is justification of means and kinds of scientific and practical activities of an innovative engineer in the frame of his/her job and civil relations to the society.

Innovative engineer's job description is characterized by four specifications – science, industry, business and power. Science and industry are fundamental. Business and power have applied relevance that characterizes an engineer in the frame of business and political infrastructure of his job.

We assume that the State Educational Standards formally contain a list of required sciences. But these sciences are not didactically adapted to the needs of innovative engineer professional training with respect to the job description mentioned above. We do not need sciences as they are but disciplines developed on their basis.

The discipline system of natural, technical and social character should ensure knowledge and skills necessary for an innovative engineer. It means that disciplines together should be sufficient to achieve the objectives and should be logically connected to meet didactic principles: from simple to complex, from parts to the whole, from reproductive to productive.

Thus, we need an accurate set of subjects that are systematically organized and aimed at producing innovative engineers.

The State Educational Standards have one more dimension that should be conceptually developed and filled with corresponding educational meanings and aims.

The question is that the standard comprises different levels: federal or ministry, regional or university and disciplinary. The current standard is federal. The regional or university level is still being developed. The reform ideologists supposed that it should be the regional component that clarifies abstract ambiguity of the federal level and direct practical educational process to the implementation of the reform principles and ideas.

The federal standard has only some regulations on the limits of freedom and responsibilities of universities to interpret the standard as an educational law. (Standard. Official document.)

In comparison to the Ministry, universities turned out to be less competent for such work and tend more to the traditional didactics. In the frame of Ministry's standard interpretation traditionalism is more or less episodic and secondary feature but it becomes the basic feature of the university level. As a result, the innovative determination of the educational standard federal component is demolished by traditionalism of the reform perception at the university level.

The basic mission and sense of the university component is to specify the federal component in particular meanings and objectives of a definite engineering speciality.

The managerial rights and power are given to a university, didactical and methodical rights are given to faculties and departments, and thus, the federal standard idea is transformed into a certain educational form.

The final component of the standard takes shape of a discipline curriculum. It is a discipline, including its subject and object, objectives and methods, its didactical and methodical constituents, that reaches the focus of all educational driving forces and determines the final learning outcomes. According to the logic of standard it is the educational discipline that is to implement the idea of innovative education in its certain meanings and sense. But it is this level that is the least innovative nowadays.

The problem is that this level requires pedagogical professionalism and even mastery to put together all the meanings for one result: student's knowledge and skills required for personal development in the context of innovative professional and social relations. It is the level where lack of pedagogical professionalism and culture has the most effective negative influence on the learning outcomes. Besides, it is the disciplinary level that suffers most of all from bureaucratic pressure, which makes the situation more dramatic.

When studying the logic of the standard from federal to regional and then disciplinary levels, we observe the ideals and principles evolving from abstract and theoretical to concrete and practical ones. The disciplinary level is the quality and the aim of the reform.

On the basis of the disciplinary level profile departments or faculties develop educational complex for a particular engineering speciality. All the efforts of disciplinary level fill the reform ideals and principals with qualitative content that determines if the reform is successful or not, if it became an exception from a number of ineffective Russian reforms or just one of them.

The aim of every university is to elaborate the structure and content of the standard not only downwards but also upwards. That means that all didactical and methodical ideas on subject studying should be implemented on the disciplinary level.

Summing up the speculations on the standard, we can state that the analysis of the educational standards turned out to be critical. Actually the current standard needs conceptual improving. We can even say that it is necessary not to correct but to develop new standards resulted from the previous one but being different from it. If we really want to complete the reform we have to change the standard radically.

If the standard development and improvement has such a radical character, the idea of the first, second etc. generation is quite reasonable. It is natural way of things. When the development goes from one stage to another, it needs structural and content development of a new program. Such renovation of the reform program guarantees its effective completeness. But when it has only a formal character, it is not the document development and improvement but illusion. Unfortunately, illusion is what we see when trying to understand the current changes of the standards.

What are the issues of state educational standard as a whole that are to be included in development and improvement program for this decision coordinating document? The list of issues being the subject to consider in the new generation standards contains some statements reflected in the existing generations.

1. State educational standard on this or that speciality is to include a detailed characteristic of professional specification. In the course of these specifications one should distinguish basic or fundamental and applied ones that compose social-economic and social-political infrastructure of contemporary engineer's professional activity.

2. Based on this meaningful job description it is also necessary to specify the list of the sciences study of which would condition the context of notions for engineer's professional specifications.

3. Standard must contain recommendations regarding the character, content, and forms of didactic adaptation of studied science to academic process of an engineer of innovative type.

4. Every studied discipline is to be presented as a model of studying actual science from the standpoint of a subject and an object, methods of this science as well as in terms of transformation of these characteristics into the content of discipline.

5. Didactics and methods of every discipline are to be focused on not only its content area but also content area of other disciplines specified in engineer's curriculum of the given profile. They could be accepted for the future generations.

We suggest a list of issues for development of next generation standards that, in our opinion, are of innovative nature.

1. Standard is to include recommendations concerning the process of how teaching didactics is added by learning didactics.

2. Learning process is to be simultaneous with that of self-learning, self-performance, and self-realization of student's personality.

3. Academic process is not to be based on the subject-object relation model, since a teacher and a student are two subjects or two co-subjects in academic activity.

4. Student is an initial criterion of mode, content, and forms of academic process.

5. Teacher's function is organization of academic process, i.e., expert, tutorial supervision, etc.

6. Learning process is transformed into self-learning process as a student is able to define and perform the main parameters of his/her educational activity autonomously or under teacher's supervision.

7. Learning process does not evolve into the true scientific-practical activity when a student graduates from university, but it does in the process of student's acquiring the necessary professional knowledge, skills and competencies by himself.

Hence, a standard is not only presentation of issues in academic process ontology, but also its epistemology, axiology and praxiology. Standard is, in fact, a detailed program with concrete indication of which functions and commission of the Ministry in its realization, which are University's, which are faculty's, which are those of department, which are student's. System and integrity of the functions and commissions taken vertically and horizontally are the major condition for success in engineering education.

Creativity as a system-forming problem of didactics, methodology in contemporary engineer's training

Technical issues in engineering education are, in any case, solved on the basis of rational following the concept requirements. It is enough for all representatives of academic process to interact correctly and consistently with other representatives, then the program of engineering education improvement would be successful.

In view of ideals of professional education reform we deal with not only and not so much the rationally developed program, techniques and technology of education, model of academic process, we are dealing with innovation trend in academic process, the goal of which is formation of creative personality's abilities and demands. Such a task, on such a scale has not been set before. This circumstance makes reform and the standard on which it is based innovative. Without focusing on creativity no tradition or modernization can guarantee the innovative outcomes.

One cannot state unambiguously that didactics in creative training is an absolute blind spot or terra incognita. Since the beginning of time there have been some creative jobs in the sphere of literature and arts. Creative skills can characterize proficiency in economics and politics, science and culture, etc.

This concept is used to characterize human abilities at the level of talent and genius, but what creativity is as a spiritual phenomenon and how to formalize it if at all we do not know. In fact, speaking about creativity, we, as a rule, mean not creativity itself, but craft. As for craft, it can be taught! Can one be taught to be creative? This is the question.

Obviously, we have right to, as the things stand now, consider creative learning not as a fact of didactics and methodology, but an original approach, way or tool of creativity propedeutics. At present we have at our disposal sufficient philosopho-scientific and philosopho-pedagogical bases for considering the problem of creative thinking as a problem of engineering didactics of innovative type.

We could conclude that reproductive and productive, formal and informal aspects in creative mental activity are by no means always and for everybody apprehensible, subject to interpretation, comprehension, and awareness. It is a common standpoint about the fact that creativity is a heaven-born gift. Creative thinking is somewhat mysterious, enigmatical, mythical, and incredible – that is a result of mythologizing this phenomenon, but not an adequate presentation of its idea. Moreover, for instance, the abduction method speaks straight out the fact that, at least, in scientific cognition heuristic or creative element is just connected with the process of how hypothesis come to mind of talented and genius people: intuition, talent, genius. But method of hypothesis processing that is prescribed by abduction procedures are, so to say, matter of techniques and technologies. Therefore, taking the challenge in comprehension of creativity mechanism we, in the long run, come to the situation when it is necessary to put both didactic questions concerning possibility of training in intuition, insight, anticipation, supposition etc. But even in this case, standing on accepting the fact that it is necessary to develop, improve the physical and mental abilities of different individuals given from the nature that is performed, in fact, by the system of education, training and bringing-up.

We are holding a view that an engineer can and must be taught to think creatively. Those who have capabilities for this, would have the scope for their implementation. Those who are not endowed, would size-up their limits in abilities, level in creativity by themselves. If one takes into account that there are not any untalented, uncreative persons in the world, and everyone has to search for creative activity relevant for himself/herself, then it comes out that the question on creative thinking training didactics is far from being idle. The fact is that we are not ready to set all records straight today. But it does not mean that the problem cannot be effectively solved for education. Possibly, the best that can be done in the process of an engineer's formation is to help him/her in finding out the abilities, but, on the other hand, to create the conditions for eliciting his/her potential.

It means that creativity from the didactic point of view is not only ontology but also epistemology, axiology and praxiology. For the process of creativity training to be presented as a system in general terms, it is relevant to consider creativity dialectics, but before it – social-epistemological conditions of a person's creative mental activity.

Social conditions of autonomous creative personality in engineering profession

Take as a premise that a human being is a unity of generic and individual features. Within every formation society develops a personality in its own image. Personality is a set of socially significant properties and abilities of an individual at a definite stage of society development.

In definite historical view society is a unity of economics, social structure, politics and culture. Individual personality is what its position in the society.

We assume that mankind has reached the stage of its development when it can admit that such an ideal personality as creative one can become not only a far-off possibility but a real necessity. Therefore, a creative personality that also implies many-sided and well-balanced personality is one of the conditions of human progress.

For clarity, it is essential to introduce the following metaphor: personality is a contracted society, while society is an expanded personality. The processes of society contraction and personality expansion take place in the light of such phenomenon of human life as activity. Any personality including specific features, capabilities and needs is formed during each stage of his/her activity. This also holds true for the influence of personality on the society, which depends strongly on the character, content and types of personality activity. Activity is always performed together with other people and that's why it is social in itself.

Assuming that the idea of society contraction up to personality reflects basically a real mechanism, society definitely creates personality in its own image. Personality is an object with respect to society. However, society itself, in strict sense, is not a subject. Being dominant in interaction with personality, society is represented by many structures, such as government, political parties, trade unions, Church and etc. Under close examination it is not society that takes part as a subject in personality formation but state officials, party workers, churchmen and etc. Thus, society as a subject of personality formation in its own image is a conventional category. Its unity as a subject is more than problematic. However, society with all its superstructural elements, bodies and organizations and etc. has dominant influence on personality.

As for personality expansion up to society, everything depends on socioeconomic status of an individual, which he/she takes in politics, religion, culture, arts, literature and etc. In simple terms, the influence of a personality on society can take place in different way. In other words, quod licet Iovi, non lizet bovi.

From this it follows that somebody can have influence on society, while somebody cannot. Some individuals are capable of expanding their personalities in terms of social relations, ideals, values and etc., while other people, due to their reversed personalities, stand apart from these processes. In any case, the processes of society contraction and personality expansion are accompanied by various circumstances, which are beyond the needs and capabilities of a personality, but pertain to the sphere of ownership, social classes, politics and etc.

However, against this background of interconnection and interdependence of personality and society, there appeared such people who due to their intellective power, talent and genius left significant mark in history. These people, governed not only by ownership and authority but rather contrary to any governance, were able to develop themselves to the best of their capabilities and requirements. Such people were and are in literature, arts, science and industry. They are inventors, designers, pioneers, and etc. Scholars working on the phenomenon of these personalities proposed an idea that these people are not just the result of spontaneous deflection in individual and ancestorial development or the processes of contraction and expansion which were discussed above. They represent so-called autonomous personality, i.e. personality capable of converting his/her individual potential and skills, physical vigor and spiritual power to the basis of further self-development both under the conditions of social paternalism and contrary to it. At all times, autonomous personality being a phenomenon of social life was an exceptional case both with regard to statistics and the role these people played. These people existed in the past, they also exist now. These people who are gifted by nature with unique capabilities and requirements can achieve the peak of human spirits due to their genius as Mozart or due to their diligence and determination as Saliery.

However, it is a common place when a person who is born to be talented and genius is not able to reach his/her potential in virtue of social conditions. It is impossible for the society to provide such conditions which would correspond to all people peculiarities and contribute to their development. Besides, a person himself/herself is not always capable to understand the level of his aptitude, his genius and talent. There is an opinion that genius will approve itself as genius at any case. However, we know so many historical examples when such genius turned to personal tragedy.

Today, we can observe such turning points of the history when autonomous personality is becoming not just a possibility but also a necessity of society. It means that each person can and must assay his/her capabilities, genius and talent in terms of his/her autonomous existence. Society guided by not only the interests of a talented and genius person but its own motives can and must provide required conditions so that this genius person can reach his/her potential.

It is not utopia, it is a sign of present times. In general, we can make a reality of this idea, however, only if we reorganize ourselves, change our attitudes to each other and themselves, be ready to disclose ourselves and assume responsibility for these processes.

It means that not every personality is developing as creative one. Only autonomous personality characterized by his/her capabilities and requirements, nature and will, principles and views can develop as creative one. This kind of personality can recognize and assume his/her responsibility both to himself/herself and the society where this personality reaches his/her potential.

In the century of innovation, mankind possesses a wide range of various advancements: science and technology, literature and arts, education and public health service and etc. However, one of the main advancements is personal creative potential. And, if we happen to be able to reach this potential, mankind will be bound to make a quantum leap in labor efficiency which can be hardly achieved due to any other resources.

Thus, there have always been two mechanisms of individual socialization. The first one is so-called general, i.e. the processes of society contraction up to personality and personality expansion up to society. Based on nature and logic of social development, personality must correspond to the social requirements from a society's standpoint. Personality is just a small screw or pinion in a large mechanism which is called society. Personality is an object but not a subject of his/her social relations. On the other hand, the process of personality expansion up to society in the frame of the first mechanism is mainly conditioned by external factors.

The analysis of cognitive methods in the studied discipline, i.e. its cognitive toolbox as a number of cognitive procedures and technologies, is a required stage in the development towards creativity. This stage is essential for a scientist to acquire relevant knowledge, skills and competencies during learning period. The second stage of the development is concerned with the transition from standard to nonstandard way of thinking, from reproductive to productive, from reviewing-subordinate to creative forms.

The concept of engineering education can and must become a good example of such reform in Russia, which unlike other can be followed to its logical end.

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Engineering Education and Engineering in Russia: Problems and Solutions

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The article analyzes the global challenges that influence Russian engineering education and engineering in general. The information on current situation of engineering education and engineering in Russia provided by the experts of the Russian Association for Engineering Education is presented. The authors suggest measures that can contribute to positive changes in Russian engineering education and engineering.

Key words: *engineering education, engineering industry, Engineering Education Doctrine, international accreditation of educational programs, certification of engineering qualifications.*

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The Russian engineering education has a 300-year history and is rich in traditions. Since the times of Peter I who established the School of Mathematics and Navigation Sciences and to our days the traditional Russian engineering education system has been developing and has become more entrenched. These traditions were based not only on the Russian mentality (curiosity, inborn wit, determination to achieve desired results, willingness and talent "never do things by halves"), but also on the government support in questions of engineering education.

The impact of engineering education on the country's economic development, level of population engineering and technological culture and provision of its economic and process safety are crucial. The dramatic proof of which can be highlighted in the events of the past 100-150 years: development of domestic aircraft engineering, exploration and development of mineral deposits and mineral resources (especially Siberia), electro-hydraulic power development, atomic power engineering, space development and so on and so on. This would have been impossible without such talented graduates of Russian higher technical education institutions as N.E. Zhukovski, S.P. Korolev, N.A. Dolezhal, M.K. Korovin, I.V. Kurchatov, M.L. Mil, A.P. Tupolev, N.I. Kamov, V.N. Schukin, N.V. Nikitin and millions and millions of rank-and-file engineers who were involved in the design, production and operation & maintenance of that unlimited diversity of equipment, facilities and technology, and who concentrated in one's hands all the profound engineering ideas and brilliant engineering problem-solving.

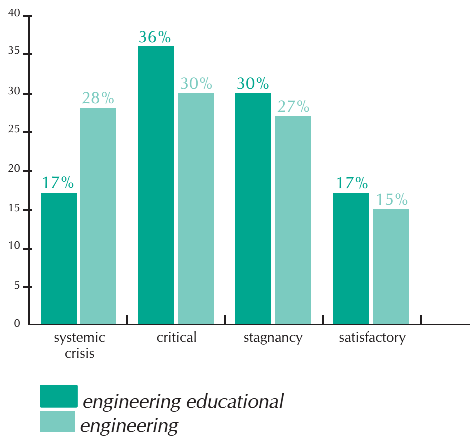
Unfortunately, it should be noted that, in the period of new Russian history, there are new tendencies indicating the breakaway of professional communities and governmental authorities from the age-old traditions of Russian engineering education. The whys of it are in the untoward response of this or that side to external environment challenges of communities and authorities. During the last few years, Russian engineering education has been stumbling over a wide range of challenges, both global and domestic, the most urgent of which are the following:

- Adoption of specialist training in accordance with the principles of the Bologna Declaration.
- WTO accession of Russia, competitiveness within the global engineering labour market; a sharp decline in the prestige of engineering professions and engineering activities.
- Lack of general qualification requirements for specialist in the engineering and technology domain, professional standards embracing the adoption of level-program training of specialists.
- Controversy between previous specialist training system and modern employer's requirements to engineer- graduates; between aging infrastructure and human resources.
- Limited number of modern-equipped enterprises providing high-quality internship of future engineers and university faculty staff.

The result pattern of engineering activities in Russia is characterized by universal and rapid replacement process of domestic engineering development to imported engineering development. The activity results of Russian engineers are in less and less demand within one's own country. During the last 10-15 years, most consumer goods, machinery, equipment and hi-technology used in Russia have been imported, including computers, mobile – satellite-conventional telephones, televisions, fridges, washing-machines, automobiles, medical equipment, high-accuracy machines, boat engines, civil planes and others. The fact is that many Russian engineers, living and working abroad, have been involved in various engineering development projects, and, this of course, "warms our soul", but it neither stabilizes the situation nor adjusts present working conditions to the revolutionary changes in engineering in Russia.

According to the data of the Association of Engineering Education in Russia and based on the results of expert seminars in 2011-1012 [1], the status of engineering in Russia is the following: systemic crisis- 28 %, critical - 30%, stagnancy - 27% and only 15% -satisfactory. Analogous situation concerns the engineering education in Russia.

Moreover, strange as it may be, the majority of experts evaluate the



training level of domestic engineers as rather satisfactory.

The experts distinguished the following factors to evaluate the status of engineering in Russia:

- fraction of high-tech and innovative engineering products in the Russian export structure;
- demand of Russian engineers in the domestic industrial sector;

- rank of Russian engineering development projects in the international top list of engineering solutions;
- fraction of Russian engineers, certified to international engineering requirements;
- fraction of engineering product import;
- scope of patent engineering solutions;
- "brain-drain";
- social position of an engineer.

Failure of relevant and prompt response to global challenges resulted in the existing critical situation of domestic engineering education. To a certain extent, this is the result of the crisis in the domestic engineering itself, i.e. those products acquired through different engineering activities- projects, technology, facilities, machinery, devices, equipment and their operation and maintenance.

Factors conforming to today's society demand in engineering activities are classified as general and specific.

The first general factor includes the lack of appropriate conducted systemic analysis of the engineering situation itself. In this case, the transition process of the country to imported techniques and technology and their mass production developed unnoticed. Consequently, this resulted in the further training of engineer-graduates (more than 200 thousand engineers annually) in accordance to previous standards and/or updated standards which do not even guarantee professional training of these engineer-graduates to existing market economy. Therefore, deprivation within the competitive market of engineering solutions and engineering products, low level of technological culture administering huge economic losses due to failure of high-cost engineering equipment, and even, tragic consequences for the people which, in its turn, could have been promoted by changes in the school education system itself and prestige decline of engineering professions within the society.

Another factor is the so-called non-systemic, inappropriate and untimely measures initiated by line agencies in response to external environment challenges and changing conditions. Thus, after signing the Bologna Declaration in 2003 and transition to level-program training in engineering and technology, no actions were conducted to regulate the activities of Bachelor, Master graduates of technical universities. If previously, enterprise employers knew how to employ engineer-graduates, now they realized that they are not ready to employ today's graduate with a Bachelor and/or Master degree. Moreover, according to the opinion of different representatives from the industrial sector and even within the university community, such Bachelor and / or Master degree graduates are considered to be "untaught engineers". This fact promoted a further prestige enhancement of engineering professions within the society. Those professional standards for Bachelor and/or Master graduate education programs are being only now developed, i.e. in 2012 [2,3]!

Transition to training Bachelor and Master Graduates for the engineering domain is connected with the possible risk of losing the Russian engineering corps. The retardation of adopting laws in engineering profession and engineering certification hinder the further provision of essential regulatory acts for engineering activities. The existing system of organizing the engineering corps through certification of professional engineers in developed countries is very simple and comprehensible. The introduction of a national register of professional engineers in every country warrants the existence, maintenance and development of the engineering corps. Base for developing the engineering corps in these countries includes the Bachelor and Master community, trained in accordance to the requirements of labour market.

Lack of effective incentives of orientated and consolidated interaction between education, research and production infrastructure and communities significantly decreases the scientific provision level of engineering activities. Engineering firms established within state corporations are weakly bond with universities and research centers of state academies (RAS, RA, MS and others). In this case, many domestic concepts and engineering projects are frequently of high-demand abroad, but in Russia.

Lack of R&D centers and R&D institutes that existed once in the Soviet period significantly reduces the engineering activity performance.

One of the specific factors - the lack of human resources for engineering activities- is the conventionalism of existing university education communities, its inflexibility to the external environment challenges, tendency to retain passive education methods, deliberation in rejecting orientated education technologies.

An excellent illustration of this could be those facts of delayed affiliation of Russian engineering universities to CDIO, implementation of practical courses and technologies to shape creative and systematic engineering mentality, entrepreneurial competencies, ethical norms, ecological outlook, etc. This, in its turn, generates fallibility of self-conception, quality evaluation and inconsistency of the level of specialist training for different engineering activities. For example, 59% AEER experts, 80% of which are representatives of research communities, acknowledged that the training level of today's engineers is satisfactory, 25%- good and 2%- excellent. It should be mentioned that 83% of the experts stated that the state of engineering in Russia is unsatisfactory. In other words, the engineers are well-qualified, but the paradox is that they work badly, irrelevant of any causes.

One should highlight the fact of weak research base in most domestic engineering universities, i.e. lack of updated research equipment, incompetent participation of instructors in the research domain, concentration of narrow topics, tenuous university collaboration (or none) with academic communities in Russia and global leading research-education centers.

In view of above-mentioned facts, the procedures in changing the situation within the engineering education system and engineering itself in Russia have been formulated as follows:

1. Develop and adopt National Engineering Education Doctrine in Russia as a strategic document, regulating the engineering resource development of Russia.

2. Design an international-recognized engineering accreditation system in Russia and institute national register of engineer-professionals.

3. Develop and implement measurement system to enhance prestige of engineering professions within the society.

4. Expand and elaborate experience of National Research Tomsk Polytechnic University in elite specialist training and professional teams of international standards within the framework of priority development areas in science, engineering and technology.

5. Initiate systemic measures to enhance engineering susceptibility and reduction of innovation antagonism of the society to provide successful engineering activities.

6. Stimulate the organization of temporary teams within universities, academic institutes, engineering firms and production companies implementing the following model "idea- product sales".

7. Develop and implement measurement system stimulating those teams producing competitive Russian trademark products for global market.

8. Take actions in reducing the bureaucratization level in education, research and engineering organizations, especially, reduction of regulation level of these institutions and

develop conditions for academic freedom.

9. Adopt law of engineering profession.

Proposals in the law development of RF "Engineering Profession" are as follows. List of sections:

1. Definition of engineering profession, engineer status in Russia, his/her rights and responsibilities, warrant of rights exercise, liability of infringement of rights and responsibilities.

2. Definition of engineering activities, types, implementation mode and provision.

3. Role of state, public-professional organizations within engineering activities in Russia; agencies for oversight and compliance monitoring.

4. Requirements to universities and curricula in engineer training; public- professional accreditation of engineering programs, its legal basis, acknowledgement of accreditation results by state agencies; preference of accredited universities and programs.

5. Engineering accreditation, accreditation agencies, requirements, procedures, documentation, status of these documents; involvement procedure of certified engineers in public-professional accreditation of engineering programs and evaluation of engineering university activities.

6. Projects, requiring the participation of certified engineers; types, implementation regulations and evaluation; involvement procedure of certified engineers, salary rate.

7. International cooperation within legislation domain and organization of engineering activities.

Potential of the Russian engineering education system is competent to enhance the quality of specialist training in engineering and technology and change the situation within the engineering domain. In December 2012 the Russian Conference "Approaches in Reshaping the National Engineering Education Doctrine in Russia" held in Tomsk confirmed this concept. Recommendations of conference representatives [4], in the event of their implementation, would promote Russian engineering universities in facilitating specialists and engineer-professional teams for those enterprises solving new targets in the country's industrialization.

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Engineering Master's Graduates as Future Managers in New Economy

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The article describes the following problems of Master's Degree training in management-development of professional management competencies, requirements for undergraduate education, responsibilities and tasks of the Master's Program instructor, business- science-education integration in improving Master's student training.

Key words: Master's Degree student training, development of professional competences, the requirements for undergraduate educational process, the responsibilities and tasks of the head master's program, business, science and education integration.

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Not with standing today's situation in the education system, many Russian scientific-education communities have acknowledged the fact of changing this system itself. Russia's integration into the Bologna convention is an important step towards the education reform. In other words, the education reform has been adopted; however, many are not satisfied with the procedure itself and the results, which could be considered as only intermediate ones. Even though the majority of reform tasks have not been accomplished, the attitude in separate university activity areas has intensified. For example, one education reform target includes the decrease of not only state but also private universities; however, statistics indicates otherwise (Table 1), while the number of full-time students has really decreased.

Despite the continuous education reform, the problems within the universities and institutes have not diminished, but have only been partially solved. Let's not elaborate on global problems existing in education institutions, but settle on those problems of Master's Degree training in management which embraces all these institutions. These problems involve both the management knowledge itself and the reluctance of instructors of different Engineering Master's Programs to implement management as a major into such programs; whereas, employers devote enormous attention to the development of knowledge, skills and abilities of future Engineering Masters in management.

Traditionally, rejecting "Management" as a subject and misunderstanding modern professional management competencies resulted in the fact that such a course as "Management" in Russia was related to economics and was considered to be an integrated part of this subject. Only recently, "Management" as a subject was assigned to the following speciality 08.00.05 "Economics and Management of National Economy". Concepts and methodological approaches of modern management has been changing, updating and being subjected to "diffusion". It is of critical importance how the future Master students and/or working managers evaluate different management phenomena in the epoch of modernism and / or post-modernism in responding promptly to the changing problems. Executives at different organization levels should know the very problem-solving remedies in modern management.

Table 1. Basic Activity Indexes o (RF) for 2006-2008 (Russia and Statistics. Rosstat, 2009)

Indexes	2006-2007	2006-2007	2008-2009
Number of universities and institutes, total	1090	1108	1134
Including: state (public)	660	658	660
Non-public (private)	430	450	474
Number of students, total (thousands)	7 310	7 461	7 513
Including: full-time students	3 251	3 241	3 153
Including: evening students	291	280	269
Including: part-time students	2 443	2 532	2 637
External studies	147	155	156
Per 100 thousand -number of university students (thousand)	514	525	529
Number of faculty staff in public universities	334	340	341,1

Up until now a manager was "labeled" not as a person coordinating processes, people and resources, but as a professional fulfilling specific functions stated in the employment position instructions of this or that enterprise and/or organization. These functions often are irrelevant to the pragmatist interpretation of the manager's tasks and goals, while the manager's performance results are considered by the achievements of his/her assigned team. He / She should be able to organize and inspire his/her employees within the essential course of high-performance teamwork, initiating management decisions and remembering that ".... the most qualified and valuable resource for any enterprise are those working here."[1]

The employers present various requirements for the future Master-graduate attributes and professional competency profiles in management. However, the major requirement for the future modern manager in engineering and technology remains the acquired knowledge and skills in high-performance of assigned management targets, which in its turn promotes the following professional management competencies:

- **Cognitive** - necessary professional knowledge (theoretical, applied and specific professional) and performance skills of basic modern economic and management knowledge, as well as, practical application of traditional and modern management methods and functions within one's engineering profession;
- **Executive** - application of acquired knowledge in professional problem-solving, which includes the ability to identify, design optimal performance sequence in achieving intended target; plan, evaluate and monitor one's activities; make decisions independently; introduce and effectively apply the resources of different groups, etc.;
- **Communicative** - negotiation skills for business communication and interaction, assuming a high level of interpersonal communication, applying knowledge and skills of information-technology communication in solving different management problems within engineering and technology domain;
- **Individual** - proficiency level of self-cognition, self-actualization and personal development methods not only in engineering areas, but also in management theory and application; endeavor to improve one's performance, commitment for career advancement, ability for self-motivation and others;
- **Reflexive** - commitment for professional reflexion (self-consciousness), understanding of cognitive

[1] *Druker P. (2002) Management Goals in XXI century. M. P 166.*

activities and coping with thinking stereotypes; knowledge of the following reflexion types:

- Retrospective - critical re-evaluation of past experience (possibilities and forwardness in embracing global manager experience);
- contextual (situational) – actual evaluation of existing situation, understanding of possible applications of modern methodological approaches in one's engineering and management activities;
- perspective - insight and vision of management results, perceptive choice of effective strategies, i.e. an algorithm in achieving target goal, consistently pursuing moral rectitude and behavior standards, etc.

This competency structure identifies those objectives in choosing fragmentary content and methods of cognitive activity in shaping definite professional skills and abilities in the management domain. Significance and applicability of this or that management competency depends on the Master-graduate management activity orientation, organization /enterprise profile where he /she will apply one's skills and abilities and, of course, extrinsic business community. Target-orientated training of Master students in this or that professional area within the framework of today's management domain, could be achieved partially throughout the Master degree course and only in that case if future place of employment is determined. Nevertheless, basic knowledge of different practical approaches in project management and applying this in various organizations/enterprises, as well as, skills in synthesizing and updating essential competencies could be taught throughout the Engineering Master-graduate degree course.

The question arises - what domains and sectors of national economy could employ Master-managers with such competencies? There are three activity domains of future Master-students: research, education and practice in different businesses. Activity domain of today's manager could embrace all existing structure-clusters within the Russian economic sector, including venture fund committees, public organizations, etc., as well as, different institutions of business infrastructures. Skills and abilities in task-oriented management of organization people and resources are always in demand.

The issue of the day in Russian education institutions – process and education mode retardation of Master's degree programs to existing changings in economy and management. Only recently more and more attention is being paid to Master degree programs in Russia. At the moment the situation is such - adopting foreign teaching methodological experience and accumulating domestic experience in this domain. The integration of foreign teaching methodological experience in the context of today's Russian education reality triggers "a rule of thumb". Nevertheless, innovation approaches in research-education training of Master-students have already been implemented into Russian universities. For example, from the first day of their studies in Tomsk Polytechnic University students already apply their knowledge and skills in competing against each other in future job searching.

The characteristic feature of organizing the research- education activities within Master's degree course (program) is the personal responsibility of the Program instructor in organizing the student training process itself. Fostering leadership skills of future Master-students, the instructor is stimulated to apply individual approach to each student. In other words, the renewed mentoring has emerged not only in universities, but also in enterprises. The Master's instructor, as a mentor (tutor), is responsible for the systematic acquisition of qualified student knowledge and skills. The professor (mentor) has to collaborate, intercommunicate and participate in the future Master-student professional activities far more than that of post-graduate. The instructor's role involves the following aspects: develop and foster interest in research activities, further self-learning and shaping one's research, engineering and management career.

Another characteristic feature – targeting and orientating training from a perspective of perception and understanding that all program courses are future research topics of Master's dissertation, the elaboration and implementation of which are important in the theoretical and practical focus of the future profession. Even this process without management fundamentals is impossible!

The development of a competitive environment is also important in the Master's training process. Such Master-students should be "inflected" by competitiveness in such aspects as learning performance, publishing papers, winning scholarships, progressing in practical experience, etc. In this case, every instructor should work out the student incentive system and maintaining competitiveness. The following incentive system version could be suggested: graduate research scholarship (including the instructor); designing database of different nominal and state scholarships and document samples package; stimulation of active Master-graduates by best industrial R&D internship placement and job vacancies; proposal of state-financed post-graduate program; financing internship abroad and so on.

Although such aspects as competitiveness among students and individual approach of the instructor to each student are very important in the training process, teamwork abilities are also vital. Another important aspect is to determine what role each Master applicant would be involved in this or that team. In this case, the psychological personal evaluation of the Master-student and his /her role in the team should be defined as well. A self-governed student team is challenge-motivated and attained to unparalleled results, importing high motivation in project-solving and maximum efficiency in incorporating personal resource of each team member.

A vital professional attribute of any future Master-graduate in management is the level of communication, i.e. to communicate effectively and make effective presentations with the engineering community and professional meetings. Nowadays, most students are unable to express themselves. Thomas Schlair (Swiss specialist in rhetoric) wrote: "the problem of phobia creeps into our head: one should switch over to another channel and trying to say at least two words in the presence of some people is luck". He suggests four rules in speech making:[2]

- major –body language (arms crossed, hooded look, grit teeth result in perplexity and suspicion of the audience and not catching its attention);
- brevity is the soul of wit (Demosthenes quotes" talk a lot but say nothing");
- the simplier - the better (don't show huffery-puffery if in a few seconds you out-talk routinely);
- don't fear to joke (something funny remembers well, presentation should be "flaring" but not clichéd).

It is important to teach students to have ready impromptu. It is well known that the best impromptu is the one that is thoroughly considered and planned.

As business and the whole world exist in the epoch of constant and persistent changes, students should understand and accept these changes within this or that organization and this is the target of the mentor- instructor. Both the Master degree program and the training process itself are in constant dynamics. In accordance to business requirements and response to time, the introduction of new and updated courses is the basic principle in developing and implementing any Master degree program in different engineering profiles. As a rule, positive changes within any organization are achieved by those managers who are leaders. Thus, another novelty-Master-student training involves the

[2] *Abashkina O. (2011) Eloquent Bellowing or Who Needs Rhetoric at Work. Guideline for Personnel Management № 9. pp. 125–127.*

alignment of personal authoritative and leadership resources to achieve target goals. Leadership as a competency of manager authority facilitates employee motivation in reconciling their personal goals and desires to the enterprise / organization targets, and then how they understand, accept and adjust themselves to those changes in the external environment and in the enterprise / organization itself.

The urgent problem of today's higher education (including Master degree programs) is the fact that many universities show no interest in collaboration with businesses. Even a high demand in human resources cannot solve those problems existing in business today: objection to professional graduate competencies; interest in developing joint projects; further Master-graduate mentoring in the workplace; integration and cooperation of attitude development of those employees working not just for results, but working for effective results.

Besides this, it is important that the Master-graduate understands the problem-solving of defining the priorities in mini-business processes, i.e. what methods and how these methods ensure the fulfillment of target-goals in such training business-processes and their re-engineering. Instructors of Master degree programs should find areas of common interest with regional and territorial businesses to involve their executives in collaboration with Master-students in feasible production- training projects.

Resource efficiency, as a critical problem, has been discussed in the scientific-academic community and working environment. The future manager should have management knowledge embracing such resource groups as human resources, physical resources, financial resources and information resources relevant to their shortage and ascending priority of efficiency resource utilization under conditions of tightening competitive environment. There is also another important resource - time. Highlighting time as a resource fostered an entirely new domain in "Management"- new methodological orientation "Time Management". The management mechanism of personal time and employee time varies and must be studied and already applied by future managers within the Master degree training program itself. People with a high experience level of personal time managementachieve higher results and pursue life-long learning, surpassing existing environment changes.

All these problems concerning future Master-graduate professional training in managers of different levels (from project to large enterprises) could be solved or mitigated only through the integration and interdependent systematic interaction of scientists and specialists of engineering profiles, specialists and scientists in economics and management. Faculty staff of different technical departments should acknowledge the integration of economic and management. There are also other issues embracing the training process of future Master-graduates which require solutions by leading economists. For example, a broad range of financial, organizational and methodological provision for this process which should and must be studied.

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Design and Evaluation of Engineering Curricula Learning Outcomes

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The authors consider the design techniques in engineering curricula (EC) based on improved ABET double-loop model. Within its framework the design and planning of complex learning outcome evaluation focused on correlation between EC and international standards in engineering education have been suggested.

Key words: *engineering education, competence-based approach, educational standard, educational program, learning outcomes, evaluation.*

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Introduction

Content of engineering education is to provide the competitiveness of the graduates in not only inner-Russian labour market but also in the international one. For this purpose the basic educational programs (BEP) of Tomsk Polytechnic University (TPU) are focused on the current international (EUR-ACE, ABET, Washington Accord, CDIO) and state (RF HPE FSES) standards in engineering education and designed in accordance with the double-loop model of ABET [1]. The model defines the sequence of design and evaluation stages in BEP quality as well as relates the inner-university quality processes in training engineers to the environment. However, methodological bases for design and evaluation of BEP complex learning outcomes (LO) presented by graduates' professional and cross-cultural competencies have been poorly studied.

In the given article the design and evaluation technique for BEP LO is suggested, the principles of their decomposition, requirements for LO and their components based on the improved BEP design double-loop model are put forward.

Design of the Basic Educational Program of Tomsk Polytechnic University

BEP TPU design technique is based on the double-loop model (Fig. 1) [2, p. 26-28].

The external (left) loop presents the processes of formation, evaluation and correction (if necessary) BEP goals. The internal (right) loop shows the way in which BEP LO are planned, achieved and evaluated in the university.

The interconnection of internal and external loops demonstrates that achievement of BEP goals is verified through LO evaluation. «Achievement» in external loop is performed slower than it is in the internal one as only on the expiry of a definite period from the moment of finishing training in curriculum (3–5 years) one can evaluate the BEP goal achievement and customers' satisfaction to the full extent, and, if necessary, correct the curriculum goals and BEP LO [2, p. 26-28].

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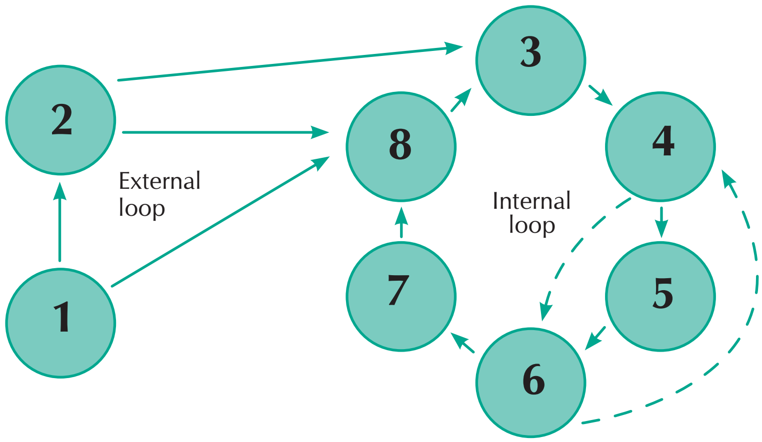
Fig. 1. Double-loop Model of BEP Designing and Performance [2, p. 27]

1 – educational program requirements; 2 – educational program goals; 3 - outcomes; 4 – ways and means of their achievements; 5 – ways and means of evaluation; 6 – evaluation indicators; 7 – academic process organization; 8 – outcome and goal achievement evaluation

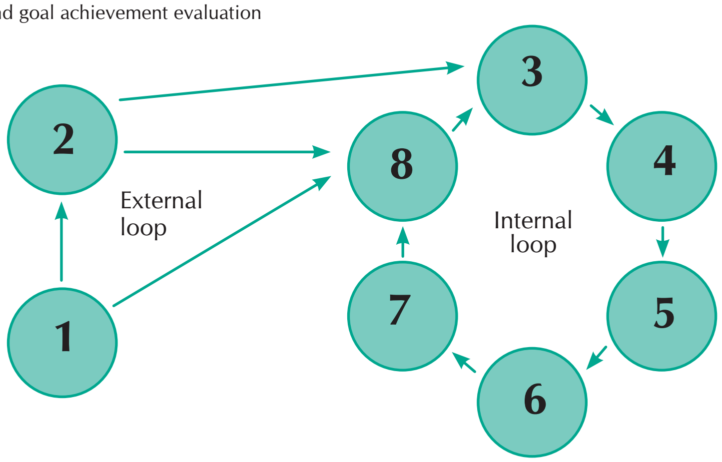


The current experience in BEP design and performance in TPU has shown that this model requires re-designing for the internal (university) loop (Fig. 2). This solution will be illustrated by the concrete example below.

In the improved model the mutual replacement of indicator design procedure and choice of evaluation means to perform procedure and training facility development is performed. The indicators, criteria, means, and methods of complex LO evaluation determined at the initial BEP design stage can be considered as LO quality standards, which curriculum, syllabus, and educational technologies should be focused on. This would allow all participants of academic process to have a common idea of LO, their intermediate representation set by evaluation indicators and distributed among the evaluation procedures of complex LO (course projects, internships, student's research, graduate qualification work). In our opinion, evaluation indicators can be referred to as intermediate qualification grades that can be proved at the evaluation procedures arranged together with potential employers. In this case they should pass through the proce-

Fig. 2. Improved Double-Loop Model of BEP Design and Performance [3, p. 33]

1 – educational program requirements; 2 – educational program goals; 3 - outcomes; 4 – ways and means of their achievement; 5 – ways and means of evaluation; 6 – evaluation indicators; 7 – academic process organization; 8 – outcome and goal achievement evaluation



dure of the preliminary agreement with employers. Then, special attention is paid to 3, 4 and 5 elements of the internal model loop.

Design and Evaluation of BEP Learning Outcomes

In the work [2, p. 13-15] learning outcomes of BEP are referred to as professional and universal (cross-cultural) competencies developed by the graduates by completing the curriculum of the definite profile and level. The necessary stage in BEP LO design, according to [2, 3], is their decomposition into components (Learning Outcome Components) – academic performance, qualifications and practical skills. Decomposed LO (local results, LR) make more specific training profile (speciality), define education content, training and evaluation methods, as well as set the level of intermediate LO performance.

At present BEP developed in TPU of two-level training system form no more than 12-18 LO by the time of graduation, including state and international standard requirements that, in their turn, are decomposed into local results in the form of academic performance, skills and qualifications acquired in academic training (Fig. 3).

Technique of LO design and evaluation, based on requirements of state and international standards, is presented in Fig. 4. Full line defines the main sequence of stages, dashed line – sequence of stages that is performed at discrepancies.

At the first Stage the initial data for planning LO BEP (FSES requirements, Criterion 5 of AEER, requirements of IEA Graduate Attributes and Professional Competencies, EUR-ACE Framework Standards, CDIO Syllabus, specific requirements of strategic partners, requirements of local, national, and international labour markets) are defined.

At the second Stage the basis for requirement classification for LO is to be chosen (professional tasks, Criterion 5 of AEER, CDIO Syllabus). At the third Stage LO are formulated. At the fourth Stage LO are analyzed with respect to doubling, accordance with requirements set up for LO. At the fifth Stage decomposition of LO into components is performed (FSES cross-cultural and professional competencies are taken as a basis for decomposition). At the sixth Stage LR are analyzed to avoid doubling and evaluation of requirement correspondence specified for LR. At the seventh Stage the repeated analysis of LO definitions is made in view of their components. At the eighth Stage for each LO from three to six evaluation indicators are developed. At the ninth Stage the list of evaluation criteria is defined for the developed evaluation indicators. At the tenth Stage the compliance matrix of LO, their indicators and evaluation methods is built.

The experience in LO design has permitted the authors to form the list of requirement for LO and their components (LR) to provide transparency and succession of training levels (Bachelor Degree, Specialist Degree, Master Degree), uniform understanding of LO by all interested participants of academic process as well as monitoring of TPU BEP LO quality.

Each LO has terse and expanded language as it is formulated in the language of competencies [4, p.19-21]. Terse language comprises (groups) the requirements for FSES learning outcomes, strategic partners, or concerned parties' demands into clusters based on definite achievement in the professional sphere.

Fig. 3. Formation and Presentation of BEP Learning Outcomes

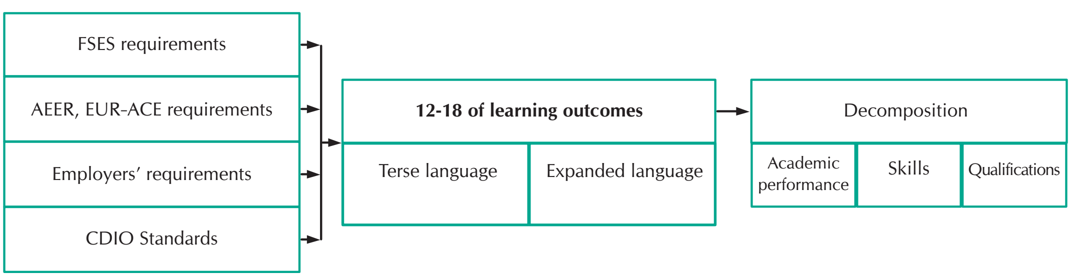


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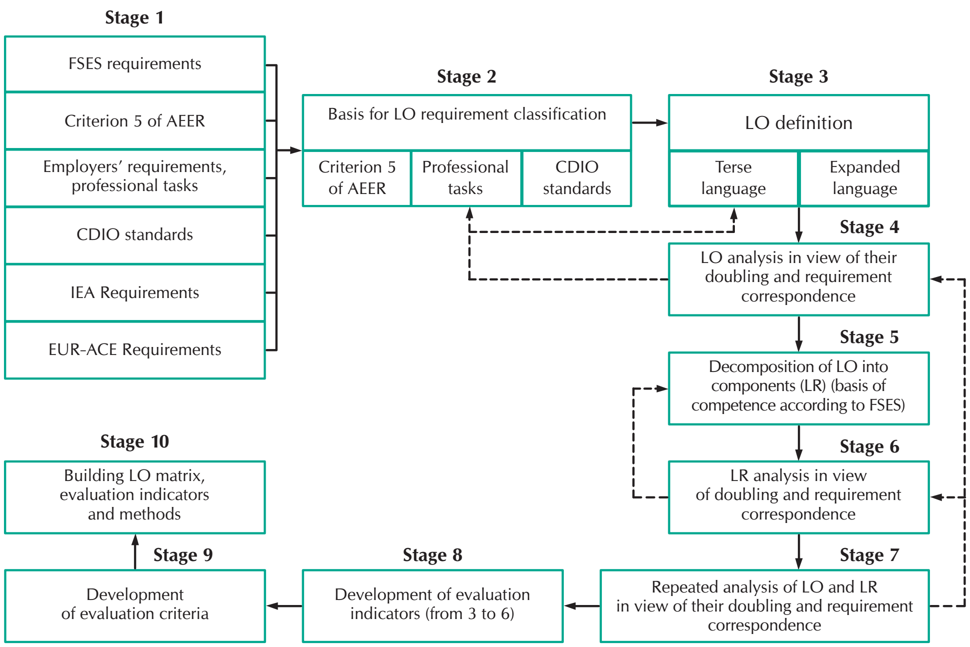
Fig. 4. Technique of Design and Decomposition of BEP LO



Expanded language has a declarative definition making concrete the activity (action) with verbs (not more than 3) that are in the spotlight at evaluation.

BEP LO develop all competencies from the list of FSES requirements, in this case, in the course of one outcome both cross-cultural and professional competencies can be formed. One FSES competence can correspond to several LO, but its components (LR) cannot double for different BEP LO.

BEP LOs are complex results and achieved in the course of mastering some didactic units – modules (disciplines) of BEP, therefore they can be objectively evaluated only by complex methods (graduate qualification paper/Master's thesis/diploma project, interdisciplinary examination, course project, research work, internship). LR evaluation with subsequent generalization of obtained results does not replace BEP LO.

LRs define definite student's activity (abilities) expressed in the language of engineering problems with the view of training profile, with characteristic of achievement quality if applicable («independently», «efficiently», «exactly» etc.).

For one LO not more than 6-10 LRs are defined, that are distributed in the following way, at the level: academic performance (awareness of facts, principles, theories and practices relevant to the professional and academic spheres of activity) – 3-4 LRs; skills (proved / shown), abilities in applying knowledge in professional problem solutions and tasks) – 2-3 LRs; qualifications (repeatedly proved abilities / skills in successful solution of problems in professional or other spheres) – 1-3 LRs.

LRs are to be feasible (achievable) and based on one of the evaluation methods in the course or by the time of the course completion. For LRs a single writing form is used: it is written in the form of concise declarative sentence, third person and directly concerned with student's activity (presented in one verb which evaluation is focused on). Duplication (repetition) and inclusion of LR in the course of the entire decomposition are to be excluded (the most significant components are distinguished, but doubling or parts of other components are excluded). LRs are not the results of learning only one discipline.

The next stage in BEP LO design is planning achievement indicators and LO evaluation criteria as well as choice of evaluation tools. LO achievement indicators, along with evaluation criteria are to anticipate the rate of work performance shown by student / graduate by the time of evaluation [4, p.19-21]. Achievement indicators (not more than 3-6 per one LO [4]) are formulated in the form of a short declarative sentence. Evaluation criterion can be defined for both separate indicator and the whole BEP LO achievement indicator group. Evaluation criteria characterize the quality of work performed (either minimal or rated).

Achievement criteria are conditions resulting from definition of competence. According to the definition, competence [4, p.19-21] includes three constituents: commitment, capacity and conditions. Each of the constituents, in its turn, can have a number of attributes. It is desirable to be restricted by three attributes, the most essential from the view point of learning outcomes (Fig. 5).

At evaluating conditions of definite problem solutions concerned with designing engineering projects and systems, performance of applied research, production practical activity it is important to determine the rate of novelty for the problem solved, level of students' autonomy and rate of resource loading for solution of the problem set. Students' competence evaluation would be even higher if the rate of problem novelty and the level of students' autonomy in problem solution would higher and the rate of initial resource loading would be lower, that would promote students to compensate for the deficiency by themselves. Successful solution of the problem in more difficult conditions indicates higher level of students' proficiency [5].

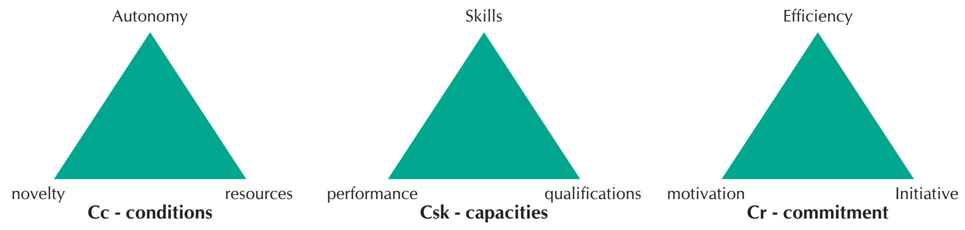
At evaluating the capacities demonstrated by the students in solution of practical problems the rate of academic performance attained, the level of skills developed and qualifications in application of academic performance and skills. Students' commitment for problem solution is evaluated in terms of their motivation that is demonstrated in the form of students' activity and interest in obtaining results, efficiency and initiative of their actions in problem solution [5].

After LO having been defined, their components (LR), evaluation indicators, criteria, and methods having been determined, in other words, having answered the questions «WHAT WAY?», «WHEN?» and «HOW?» LO will be evaluated, one can start to definition of academic content, techniques and methods. Therefore, we consider the suggested re-designing of internal cycle of BEP two loop design model to be essential and reasonable.

Conclusion

Предложена технология проектироваThe technique in designing and evaluating learning outcomes of engineering educational programs has been suggested. The technique includes several stages that allow the design team to enhance the quality of the designed BEP and provide a graduates' competitiveness. Besides, the list of requirements for the outcomes and their components has been formed. It was shown that in BEP designing, preliminarily set learning outcomes by means of evaluation indicators and criteria, have to be taken into account together with the requirements of educational and professional standards in choosing educational techniques, methods, and learning tools, content of academic aids and designed evaluation resources.

Fig. 5. Criterion Features in Terms of Competence Components



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UDC 378

Competence Approach and FSEP of the Third Generation

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The issues concerned with HPE FSES in the sphere of engineering training are considered in the article. The necessity in competencies revision and systematization, in particular, common cultural one is pointed out. It is specially noted that this process should be performed within an enlarged group of profile training. Particular attention is paid to decrease in Bachelors' training hours in the sphere of engineering and technology in physics in comparison with the standards of the second generation.

Key words: *Federal State Educational Standards of Higher Professional Education, competence-based approach, the training of engineers.*

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A specific feature of our time is the formation of global space covering nearly entire globe of educational space. Higher school is intensely integrating into transnational and global contexts. It serves as a specific retranslator of global impulses that via it act on the whole educational system focusing on its international standards and models of education. It is development of education in combination with high tech, including humanitarian that has become today a major component of innovative development [1].

At present university graduates' activity in the sphere of technology and engineering (including Bachelors) is of multifunctional nature. It includes, in particular, design of engineering processes and selection of engineering equipment, regulation of equipment operation, efficient coordination of interaction between personnel and technology, increase in its operational efficiency and etc. One more typical tendency that changes the requirement for a university graduate is merging practical and research spheres of graduates' activity: from the process of technical device operation to development of fundamentally new systems and technologies [2].

There is a paradigm shift in the Russian system of higher education mostly conditioned by the processes of its integration into international educational space. This results in the necessity of complex consideration of issues related to training graduates of engineering universities within the context of professional mobility and competitiveness as well as in the framework of a graduate's development as a social and humanistic personality.

In the framework of Bologna process it is suggested using modular-based system of education content based on competence approach. Such changes require review of curricula, mastering new teachers' competences, development of auxiliary students' supply, management, and tutorial systems, introduction of new methods and forms of academic and tutorial activity, modern concepts of learning outcome evaluation [3].

«Bachelor» Degree course involves acquisition of knowledge and skills within the chosen profile that are in demand at labour market. Besides, curricula of the first cycle, according to Lisbon Convention, are to provide access to those of the second cycle. According to Dublin (2002) descriptors – description of the things that a student is to know, understand, and/or be able to do after completing the curriculum, «Bachelor» Degree, meaning the finish of the first cycle, is awarded to the students who along with awareness of bases and history of corresponding course possess the abilities [4]:

- to present the attained competencies logically and consistently;
- to contextualize new information and give its interpretation;
- to understand the general structure of discipline;
- to use methods of critical analysis and theory development;
- to apply methods and techniques of the discipline correctly;
- to evaluate the quality of research in the given topical area;
- to comprehend the results of experimental tests of scientific theories.

It is supposed that in the course of the first training cycle there will be developed skills that are necessary for further training with higher degree of independence. In practice in the context of higher education European space introduction of «Bachelor» Degree has caused acute debates, particularly in view of eligibility to hold this or that position or career perspectives.

In the Bologna process documents Master Degree is considered as the second stage of university education. Master Degree course implies more focused and advanced specialization, a Master is often oriented at research and/or teaching profession. The degree of the second academic cycle gives an opportunity for further research to get scientific degree. According to the Dublin descriptors Master course graduates must:

- possess the latest research methods and techniques in their professional sphere;
- know latest theory and their interpretations;
- comprehend development of theory and practice critically;
- possess methods of independent research;
- be able to make contribution into discipline, for instance, within their qualification paper.

In the course of Bologna process a professional competence for labour market is regarded as the use of body of knowledge, skills, competencies, as well as personal features relevant for university graduates' successful career growth in the chosen profession and their perspective employment. Learning outcomes mean a set of competences including students' knowledge, understanding, and skills that are defined for both every curriculum module and curriculum in general [5]. Competence model of a university graduate describes a set of competences which he/she has to possess, for which functions he/she has to be ready and what should be the rate of his/her proficiency in definite professional responsibility performance.

The competence approach in engineering education is «a description of learning outcomes in the language of competences» of a future graduate. In methodical aids for development of HPE FSES projects a competence is referred to as a dynamic set of knowledge, skills, abilities, values necessary for efficient professional and social activity and personal development of graduates and which they are to master and use after finishing a part of or the whole curriculum. Competences are considered as a structural principle of contemporary higher education.

The basis of HPE FSES of the third generation is competence models of Bachelor and Master. Bachelor's competences consist of cross-cultural competencies, invariable for the professional sphere and professional competencies (specific). Invariable for the professional sphere are social-personal, general-research, general-professional, economic and managerial competences. Specific competencies are developed with regard to the sphere of activity for definite qualifications and profiles. With respect to the professional sphere «Engineering and technology» such competences as production, project, research, operational ones etc. are described. Competences of higher rate in the sphere of solving production management problems in innovative project performance are to be possessed by master managing modern approaches in staff relations, methods of innovative team building. In addition, the basis for master training is to be awareness of fundamental methods of research organization and innovation activity management at all stages of production life-cycles.

However, degree of significance of this or that competence in the standard is not defined. As a result, such a cross-cultural competence as «ability to apply methods of physical training and health promotion independently and methodically correctly, to achieve a proper level of physical education to provide full value social and professional activity» is ranged along with «ability to apply basic laws of natural sciences in professional sphere, to use methods of mathematical analysis and modeling, theoretical and experimental research. The number and content of common cultural competencies for different qualifications of Bachelor Degree course are sure to be the same (that's why they are cross-cultural). In fact, they are intended for different qualifications of Bachelor Degree and vary from 13 to 23. Besides, the same competences in FSES of different profiles are formulated in different ways. Let us give examples of competence formulation related to the knowledge of basic natural laws. «Standardization and metrology» profile: ability to apply knowledge of processes and phenomena taking place in animated and inanimated nature, awareness of possibilities for contemporary research methods of nature perception and to possess them at the level necessary for problem solution of natural scientific content and appearing in professional performance (CC-12).

«Power engineering and mechanics» profile: ability to show basic knowledge in the sphere of natural sciences and commitment to apply the basic laws in professional activity (PC-2); commitment to reveal natural essence of problems in the course of professional activity and ability to apply corresponding physic-mathematical operations for their solution (PC-3).

«Radio engineering» profile: to apply basic natural scientific laws in the professional sphere, to use methods of mathematical analysis and modelling, theoretical and experimental research (GC).

«Applied Mechanics» profile: to be able to reveal the essence of scientific-engineering problems in the course of professional activity and apply corresponding physics-mathematical operations for their solution (PC); to apply physics-mathematical operations, theoretical, calculation and experimental research methods, methods of mathematical and computer modelling in the process of professional activity (PC).

It is difficult to explain the cause for great dispersion of competences that are to be possessed by Bachelor graduates included in one large group. For example, for different Bachelor's specialities of the large profile group «140000. Power and Electrical engineering» the number of professional competences varies from 17 to 51, for the large group «150000. Metallurgy, Engineering Technology and Material Processing» – from 17 to 55, but for the large group «190000. Transport» – from 16 to 40. The graduates with the same term of apprenticeship (4 years) and degree of professional qualification (Bachelor) will possess different number of professional competences that is likely to result in the problem of competitiveness in the labour market.

At the same time, competence approach to development of educational standards results in reduction of students' fundamental training that defines graduates' breadth of vision,

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his ability to retrain and adopt quickly to new professional conditions, as it is good fundamental training that is typical feature of the Russian higher school. Using competence approach a young specialist with higher education is given a set of narrowly focused skills instead of systemic idea of the universe, that will give him/her opportunity to be guided in the current professional sphere, but deprive him/her of a chance to change this sphere [6].

Let us compare standards of the second and third generations in that part where graduates' fundamental training is defined – a cycle of mathematical and natural sciences. A number of Bachelors' profiles have this cycle in a more reduced form than it is in similar profiles in terms of the standards of the second generation. Let us give examples. There is 16% decrease of Bachelor's profile «Electronics and nanoelectronics» in comparison with that of «Industrial electronics». The Bachelor's profile «Design engineering of machine tool industry» has got 13% decrease in comparison with speciality «Machine tool engineering». At the same time there is some increase in volume of mathematical and natural sciences in some specialities. For example, in «Standardization and metrology» profile –55% increase, in «Quality management» profile – 46% increase. In the Bachelor's profile «Software engineering» physics is excluded from the basic part of the cycle. In the educational standards of the third generation in the profiles «Economics» and «Management» there are not any courses expanding the idea of modern natural scientific world view. In the previous standards of economic specialities there was some integrated course of worldview and methodological focus «Concepts of modern natural sciences», factual and methodological basis of which is experience of fundamental sciences. Participating in production organization and management supplied with high technologies, in development of social relations, regulation of financial flows, graduates of economic specialities and profiles are in need of definite background of natural sciences knowledge permitting them to influence the innovation process directly, evaluate this or that proposals for improvement of modern technologies quickly and adequately, foresee a breakthrough in scientific progress. On the contrary, absence of basic natural science knowledge can result in serious errors in professional performance. Let us compare the total time (in hours) for «Physics» for specialities in accordance with the standards of the 2-nd generation and corresponding Bachelor's profiles.

Specialities	**Hours**	**Bachelor's profiles**	**Hours**
Material science in mechanical engineering	425	Material science and material technology	396
Mechanical engineering	505	Design engineering of machine tool industry	288
Микроэлектроника и твердотельная электроника. Промышленная электроника	700	Electronics and nanoelectronics	468
Radio electronic systems	500	Radio engineering	324
Standardization and certification	425	Standardization and metrology	324
Industrial thermal engineering	550	Thermal engineering and technology	288
Gas-turbine, steam-turbine units and engines	476	Machine tool engineering	396
Software engineering	402	Information and computer science	324

One could give some other similar examples. To tell the truth, nearly half of the cycle consists of variable-based part developed by a university, but there is no guarantee that turning-out departments would intensify the natural science component in designing curricula. It is greatly to be feared that transition to the third generation of FSES could lead to aggravation of graduates' fundamental training, namely, profound fundamental training was a typical feature of Russian higher school [7].

It should be paid special attention to one of the circumstances under which the transition to HPE FSES of the third generation takes place. At the beginning of the 90's of the previous century in Russia there was the beginning of extensive growth of demand for higher education. The number of universities grew sharply as well as their students. There was particular increase in the number of fee-paying students in both non-state and state universities. In Russia the demand for higher education is explained by not only conditions at labour market and forecasts for its changes, but also social stereotypes, including prestige value of higher education, school-leavers' and their parents' ambitions. It is accompanied by a sharp decrease in demand for elementary and secondary vocational education.

Focusing on market demands universities including state ones, increase the enrollment by agreements with natural and legal persons as it contributes significantly to the budget and university material base as well as staff welfare. It should be noted that growth of fee-paying students' share was due to, first of all, a number of specialities, training in which require less financial expenses (humanitarian, economic, juridical). In fact, none of the non-state universities train students in engineering specialities.

The process of school leavers' demand growth for higher education is accompanied by decrease in the number of secondary school-leavers making up the basic group of enrollees. Most universities, especially engineering ones, have noted the level decrease in school-leavers' training. Of particular concern of engineering university teachers is training in mathematics and physics. According to the results of enrollment in 98 metropolitan universities the half of government-subsidized enrolled students in 2009, as is known, had a «weak» three in USE (Uniform state exam) of profile subjects – mathematics and physics. Similar situation was observed in regional universities. The picture has not changed in the following years. Submission of documents in several universities and for several specialities and profiles testifies the fact that school-leavers are badly professionally oriented and, perhaps, do not need it.

Focusing on low level of enrollees' training, junior course lecturers have to spend a part of academic time to close the gaps in knowledge in mathematics and physics not acquired at school, because it is impossible to continue study in engineering university without it. One has to simplify the academic process, lower the requirements that, in the long run, affect the university graduates' training quality.

In our opinion, the introduced FSES of the third generation need to be revised rapidly. It is necessary to systematize, at least within the large profile group, cross-cultural competences. Special attention should be paid to the content of mathematical and natural sciences cycle. Natural science and mathematical training for the large profile group is likely to be the same. One cannot allow the decrease in Engineering and Technology Bachelors' training hours in physics in comparison with the standards of the second generation since all new technologies are based on physical phenomena.

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Block-Modular Curriculum as a Tool of Prompt Reaction of HPE at Changes in an Employer's Requirements

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High quality training of specialists required for different branches of economy and social sphere can be performed only in terms of the curriculum that not only meets the requirements for competencies mentioned in FSES, but also exceeds sufficiently in terms of their goal-oriented development and steady updating on the part of employer. The major tool for realization of curriculum is syllabus. Due to its «integrity», the current structure and mode of syllabus do not permit for academic trajectories and, hence, for prompt reaction to changes in employer's demands in graduates' new competence development. These drawbacks are absent in block-modular structure curriculum allowing for students' educational trajectories development according to «LEGO» construction kit, without interfering with Federal Standard requirements for «obligation» of some general disciplines.

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Key words: *educational program, employer, competence model, effective response mechanism, block-modular curriculum, study pathway, educational trajectory.*

It is obvious that the basis for curriculum design is to be the development of a graduate's competence model designed in accordance with not only FSES requirements but also on the basis of professional standard. The development of graduates' competence model based only on FSES requirements and without taking into account professional standards means to create an intentionally out-of-date curriculum. The necessity to apply professional standards in profile curriculum development is to contribute to more intensive interaction of university and employers that, hereafter, is certain to affect the general conditions of economic development positively. The most sufficient result of such an interaction would be discussion and revealing the most relevant, concrete and perspective requirements for learning outcomes.

Obtaining one or another learning outcomes, the quality of which influences directly the competence development of a «professional engineer», is defined by the structure [1] and content of curriculum of corresponding profile. Therefore, the key task for academic process development in university is to design such a curriculum the disciplines (module, course) of which would intentionally develop the graduates' preset competence model, and, simultaneously, this plan would provide the possibility to react promptly to the employer's definite demands. In this case, the changes introduced into curriculum in terms of employer's requirements should not affect the basis of curriculum, i.e. introduction of changes should be in such a way that the whole curriculum should not be reconsidered every time in order to meet the changing requirements of private character.

The solution to the problem of intended formation of the required competencies and development of educational trajectories for students on employer's demands is in one plane with creation of block-modular structure. Such an approach is widely used in development and production of complex electronic and electrical devices and equipment. Let us take a modern computer as an example. The basis for it remains a base unit consisting of a case, power unit and «mother card», but for meeting the preset definite requirements different modules can be added and attached, for instance, CD or DVD disc-drive mechanism, monitor, sound or videocard, printer, loudspeakers. It is very convenient from the point of view of one or another function performed by a device and cost-effective for a customer of this device.

The same principle can be used in curriculum design, keeping FSES requirements as a basis (not to have a great disagreement in basic levels of training in all Russian universities) in each definite profile. Having developed «basic academic blocks» and taken them as a basis for curriculum for all engineering profiles (a kind of curricula unification), then the curriculum in the form of block-modular structure is formed, where every academic block is clearly aimed at development of a competence set in the graduate's model [2]. Here the target function of every academic block is set by a number of courses or modules of disciplines, each of which contributes to formation of the given competence. In this case one can form the blocks of both pre-existing disciplines of the current curriculum and entirely new, not previously studied ones, but indispensable for competence model realization. Besides, having arranged «the resource pack of academic blocks», one could form the students' training trajectories out of them in one or another direction. Moreover, this «resource pack of academic blocks» could be permanently added with other blocks according to an employer's order, without disturbing an established academic process. Only after new academic blocks having been prepared and provided with staff and supporting materials, it could be inserted in academic process. A new block will replace an old one or some unnecessary for the required learning outcome in the curriculum.

The existing form of curricula with discipline distribution in time and cycles (Humanitarian-Social-Economic, Natural Sciences, and General Professional cycles) does not permit for efficient and prompt respond to changes of market conditions in the graduates' required business competencies. Replacing one discipline for another does not virtually allow for development of the required competencies. But if to replace some disciplines in the curriculum, their inconsistence in time of teaching brings to naught the synergetic effect in formation of the given competencies [3]. To demonstrate the suggested mechanism of efficient university's respond to employer's demand visually, let us make an example of block-modular project for Bachelor's training in «Mechanical Engineering» speciality, «Engineering technique» profile (Fig. 1). It is assumed to be composed on the basis of the graduate's competence model correlated with an employer by means of distribution in time of the relevant disciplines blocks from the earlier composed resources of academic blocks (Table 3). The academic blocks themselves are provided with necessary resources and run by corresponding supervisors as well as the time for each block is defined in the experimental way in credits and hours. The content of curriculum in every academic block is responsible for development of definite competence set.

Not to describe the whole content of every academic block in the article let us give the example of only two of them – one is from the part for professional competences development (Table 1), the other – for special competencies development required by an employer (Table 2).

Table 1. Academic Blocks for Development of Professional Competencies

№	Competencies	Academic block	Courses, internships, tutorials, modules, course and diploma work and papers, projects	Block supervisor
3.1.	Awareness of professional engineering methods of force field, strength, electrical, hydraulic and thermophysical calculations in the sphere of mechanical engineering.	Academic block № 3.1 Block «Professional methods» block	Cutting theory – the whole course, hydraulic gear – the whole course, thermal physics of engineering cutting processes - the whole course, mechanical engineering – Module № 1.2 Structural resistence – Module № 5,6 B. Mathematics – Module № 5.6.	Associate Professor Industrial and Environmental Safety Department Reznikov L.A.

Table 2. Academic Blocks for Development of Special Competencies

№	Competencies	Academic block	Courses, internships, tutorials, modules, course and diploma work and papers, projects	Block supervisor
4.2.	Ability to form the directions of team development, design programs, and training methods for acquiring higher qualification. Ability to manage resources, developments, trends in activity of a department or team	Academic block №4.2 «Management» block	Methods of engineering activity – Module №6 «Organization and management» Quality management system – the whole course, Personnel management – the whole course.	Associate professor of Management and organization department Shevlyakova Ye.M.

Fig. 1. Scheme of the Block-Modular Curriculum

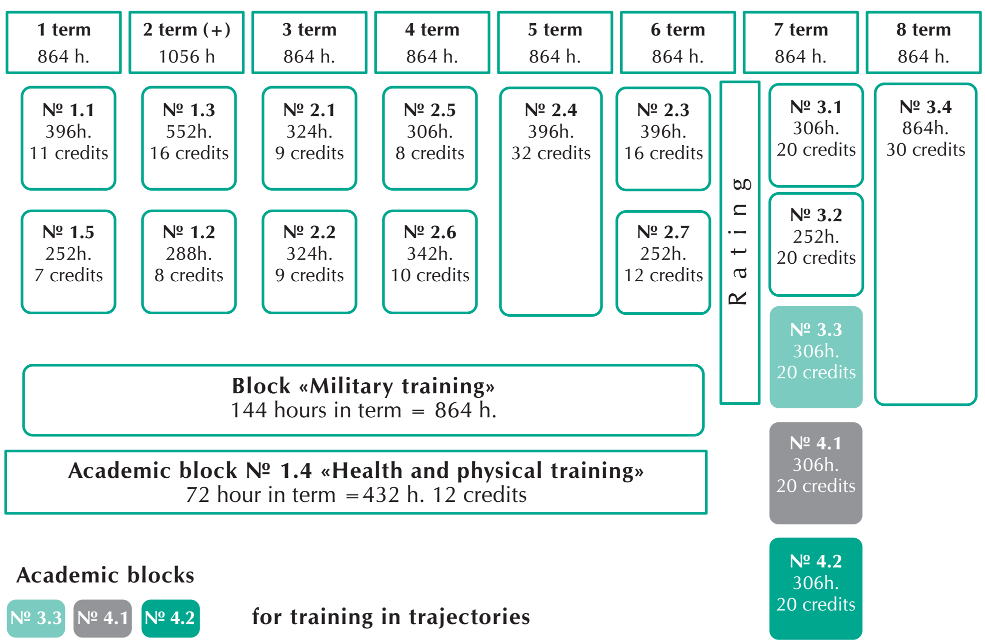

Table 3. Resource of Academic Blocks for Curriculum Design

№	Name of block	вес в кредитах	Hours	Distribution in time
1	Academic block №1.1. block «Social communication and culture»	11	396	1 term
2	Academic block №1.2 block «Adaptation to academic and labour activity»	8	288	2 term + (summer, internship)
3	Academic block №1.3 block «Professional communication and technical culture»	16	552	2 term
4	Academic block № 1.4. block «Health and physical training»	12	432	From 1 to 8 term
5	Academic block №1.5 block «Law and social-economic responsibility»	7	252	1 term
6	Academic block №2.1 block «Engineering graphics and computer modelling»	9	324	3 term
7	Academic block №2.2 block «Programming»	9	324	3 term
8	Academic block №2.3 block «Bases of engineering research»	16	396	6 term
9	Academic block №2.4 block «Mechanics, mechanisms, methods»	32	648	5 term
10	Academic block №2.5 block «Computer-aided engineering system»	8	306	4 term
11	Academic block №2.6 block «Construction materials»	10	342	4 term
12	Academic block №2.7 block «Safety and economics of production»	12	252	6 term
13	Academic block №3.1 block «Professional methods»	20	306	7 term
14	Academic block №3.2 block «Automation and mechnization»	20	252	7 term
15	Academic block №3.3 block «Modeling and evaluation»	20	306	7 term (traject.)
16	Academic block №3.4. block «Engineering solutions»	30	864	8 term
17	Academic block №4.1 block «Production operation and commercialization»	20	306	7 term (traject.)
18	Academic block №4.2 block «Management»	20	306	7 term (traject.)

The mechanism of efficient reaction to employers' demands operates in the following way. Having received an order from an employer to train Bachelors with management competencies instead of block № 3.3 block № 4,2. is introduced in the curriculum and academic process goes on in the former conditions. If managers or functionaries are in demand - blocks № 4.1 and № 4.2 are simultaneously introduced.

If an employer asks some additional characteristics of learning outcomes, one can react promptly by designing new academic block. It is possible to meet any requirements in this way.

Having prepared academic blocks, one can form practically any trajectory for students' training in required competencies. For this purpose it is necessary to remove all irrelevant blocks from block structure and introduce the required ones, as hours taken for elective blocks are the same and time for their realization is also the same. Even if it is necessary to perform global transformations, for example, to replace two or three academic blocks, it would not result in sufficient loss of resources and time and would not disturb the steady mode of academic process.

Conclusions

1. The existing form of students' training curricula in the sphere of higher professional education does not permit for efficient and prompt respond to changes of market conditions in the graduates' required business competencies.

2. Design of block-modular curriculum of students' training contributes to the development of mechanism of university prompt response to employers' demands in the sphere of graduates' training with the competence set.

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Competence-based System of Pedagogical Professionalism Development of Teachers in Engineering Universities

National Research Tomsk Polytechnic University
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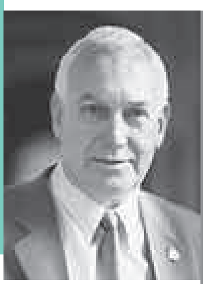
The article deals with the problem of continuing development of teachers' pedagogical professionalism in engineering universities in the context of contemporary state of higher professional education. It justifies the necessity to modernize the existing retraining system of the teaching staff. The formation of competence-oriented modular-based retraining system of the teaching personnel is discussed. It also describes the experience in implementation of modular-based component of the retraining system.

Key words: *engineering education, professional and pedagogical teacher training, the certification of teachers, training, modular-based retraining system, competence-oriented training system.*



M. Minin

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The strategic aim of engineering education in context of Russian economy transition to a new level is to train competitive in-demand engineers capable of independent goal setting and problem solving [1,2].

An important factor that determines graduates' professional training quality is high level of teachers' pedagogical professionalism. To train graduates who can meet the requirements of society, teachers should be ready to design and implement basic educational programs satisfying FES HPE (Federal Education Standards, Higher Professional Education) requirements.

Taking into account the transition to the multi-level structure of higher education and competence-based approach, a modern instructor of engineering university is imposed with high requirements in pedagogical design, efficient use of modern pedagogical technologies, monitoring of learning results, development and application of e-learning and etc. Thus, the problem of continuous development of teachers' pedagogical professionalism in engineering universities is becoming crucial.

TPU, as national research university, is to make a significant contribution into the staff potential development of Higher School, including retraining of Russian universities' teaching staff.

A complex system of continuing development of teachers' pedagogical professionalism (hereinafter referred to as System) has been developed and is being successfully implemented in TPU. It meets both Russian and international standards such as:

- State requirements to the instructor of Higher School [3].
- Engineering and pedagogical competencies of the instructor of Higher School approved

by International Monitoring Committee IGIP [4].

The System includes the following components:

- Additional education program "Instructor of Higher School".
- Professional retraining program "Pedagogic metrology organization".
- Program "Instructor of Higher Technical School" certified by Russian Monitoring Committee IGIP.
- A complex of short-term retraining courses (72 hours).

The short-term retraining courses aim at developing a number of professional teacher's competencies, such as:

- ability to develop basic education programs (BEP) to meet the FES HPE requirements;
- ability to implement effectively BEP modules of new generation to ensure students' achievement of competency-oriented learning results;
- ability to develop and apply on-line educational resources for students to learn independently by means of Internet;
- ability to implement effective project learning in the structure of integrated curriculum to develop students' problem-solving skills in professional activity;
- ability to design, implement and evaluate the quality of students' independent learning activity in student-centered environment.

Under the condition of new generation BEPs implementation it becomes necessary to enlarge the list of educational services for teachers' retraining and to improve the technologies of its implementation. According to BEP TPU Standard, "while being certified university teaching staff should prove their qualification according to the requirements of Regulations on Teaching Staff Competencies Evaluation" [5].

The Regulations distinguish a set of teacher's competences to be developed that are of prior interest for National Research Tomsk Polytechnic University. The competence requirements enumerated in "TPU teacher's passport" take into account specific character of current stage of higher professional education development. They include such teacher's ability as-creating student-centered educational environment with priority of students' independent cognitive activity, managing project and research work of students, designing educational programs and discipline modular etc.

The regulations provide that teachers' competence evaluation is conducted in the frame of their certification. Terms and type of retraining are determined on the basis of complex evaluation (including self-evaluation) of teacher's professional and pedagogical competence level.

A complex of competence-oriented training modules has been developed for practical methodical support of teachers involved in the design and implementation of new generation BEPs. This is a significant component of the system of teacher's pedagogical professionalism development.

Along with the content development, there is modernization of implementing procedures of teacher retraining system. In this context, a modular technology is considered to be promising because it is oriented on principles of productivity and experience accumulation.

The project of modular-based retraining system (MBRS) for the university teaching staff was developed in several stages.

The first stage was intended to develop the structure and content of training modules focused on professional and pedagogic competencies included in "TPU teacher's passport". This stage required well coordinated team work of teachers, psychologists and specialists in pedagogic metrology.

Special attention was paid to the modules that ensure the development of the following competencies:

- ability to manage learning process in student-centered educational setting where learning prevails over teaching (C3).
- ability to design educational programs and modules (disciplines) according to the FES HPE and TPU BEP standards, to define their targets and objectives, to plan learning outcomes and choose the most effective strategies for their achieving in collaboration with employers and the University's strategic partners (C6).
- intention to apply modern educational technologies that combine different organizational forms of learning and educational process to achieve the planned outcomes in an effective way (C9).
- ability to use modern IT means and technologies for learning/ teaching process management (C10).
- ability to apply adequate and objective assessment and control methods to evaluate student learning outcomes including graduates' professional and basic competencies (C11).

There are the following modules that are focused on the development of teachers' ability to design education programs and to manage education process in a student-centered setting:

- "Basic education program design".
- "Design and implementation of competence-based modules of basic education program".
- "Individual education program management".
- "Competence-based approach to the planning of learning outcomes control in a studied discipline".
- "Management of students' independent learning activity".
- "Pedagogic design of new generation manuals".

The following modules ensure the development of competencies 9 and10 that determine teachers' ability to create and implement possibilities of University's modern educational setting:

- "Modern media-technologies in teaching process".
- "Use of interactive demonstration equipment in teaching process".
- "Interactive teaching technologies".
- "Html-format manual development".
- "Flash-technology development and application in teaching process".
- "Teaching material development in "Moodle" environment" etc.

The ability to apply adequate and objective assessment and control methods to evaluate student learning outcomes (C11) is developed during studying the courses that are based on modern theories of pedagogical metrology (the theory of control material construction, the theory of text modeling and parameterization, the theory of adaptive testing):

- "Development of assessment tools fund"
- "Design and development of assessment tools for independent student activity".
- "Test material development".

The distinctive features of the modules are goal orientation, logical content completeness, and efficient feedback. Methodical cases of the modules include data base, lecture-presentations, questionnaires, tasks, examples, samples of the trainees' works.

The second stage of MBRS design included the development of teaching process management model based on student-centered approach, productivity and accumulation principles, that imply summing up labour intensity of the retraining modules.

According to the developed model, the teachers are offered to construct their individual long-term retraining pathways that are based on preliminary questionnaire of teachers. The questionnaire procedure implies teacher's self-assessment of the competence development level and specialist's consulting on the retraining module choice and the development of individual plan structure formation.

The retraining pathway construction includes the development of individual plan for retraining with labour intensity of 2 credits (72 hours). It consists of training modules chosen by a teacher in accordance with the character of problems that arise in the process of education program implementation (module labour intensity is 0.4-0.5 credit).

The MBRS implementation stage started in 2011, when modular program "Basic Ways of University Education Process Improvement" was launched.

The basic unit of the program includes the following modules: "Education Program Design Based on Specialist's Competence Planning", "Teaching Process Management Based on Credit and Rating System", "Competence-Based Training Module Design".

The elective unit consists of 11 modules, such as: "Pedagogical Design", "Pedagogical Tolerance in Teacher's Professional Culture", "Social and Psychological Aspects of Students training", "Creation of positive communicative education environment", "Development of Assessment Means Fund", "Individual Education Program Management", "Electronic Teaching Material – Teacher's Personal Education Environment", "Web2.0 Technologies in BEP" etc.

The university teachers were given an opportunity to form an individual pathway of the program acquisition by choosing the modules from the elective unit and setting a problem to research in the qualification project. Such model implementation experience proves that the trainees are more motivated and productive. At the same time it is necessary to pay more attention to differentiated treatment in the retraining process.

In the regulations of TPU teacher staff retraining [6] the MBRS is regarded as a possible alternative to the traditional way of university teacher retraining.

At present, the MBRS in TPU includes 30 problem-oriented educational modules for teachers' retraining. A list of the modules with their short descriptions is available online Department of Engineering Pedagogy, TPU. The modules are supported by methodical cases including data base, lecture-presentations, questionnaires and tasks.

The teaching staff of all the TPU departments is retrained in the frame of the MBRS. The modular program completion is confirmed by a standard certificate. By now, 150 certificates have been awarded.

The project result analysis shows that the MBRS is effective in terms of implementation of trainee-centered approach to individual retraining plan development, their problem orientation and practice-oriented tasks.

The ways of the MBRS improvement have been determined. It is planned to enlarge the number of educational modules and to develop their methodical support.

In the context of implementation of the President's program for engineering staff retraining a complex of special training modules is developed. It is done for teachers who teach retraining courses for engineers [7]. There are modules devoted to the problem of adult teaching ("Didactics of Adult Teaching", "Psychological Aspects of Androgogics") as well as trainings to develop the scenario of interactive training activities.

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UDC 005.584.1

Towards the Improvement of IT Education Programs

Pskov State University
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The article highlights inadequacy of IT education programs in relation to the industry requirements. Interaction patterns between Russian universities and the leading IT companies in order to revise IT education programs are suggested.

Key words: *educational program improvement, information technologies, cooperation between IT companies and Russian universities.*

S.M. Verteshev

Y.V. Bruttan

I.V. Antonov

Introduction

Information and communication technologies (ICT) sphere is one of the fastest growing sectors of the economy. In order to prepare engineers to meet the requirements of this industry, IT education programs must be constantly revised and modernized. However, this type of work is not commonly accepted by Higher Education Establishments. Therefore, to address new challenges in IT training, definite organizational changes, involving not only academic administration but also teaching personnel must be arranged.

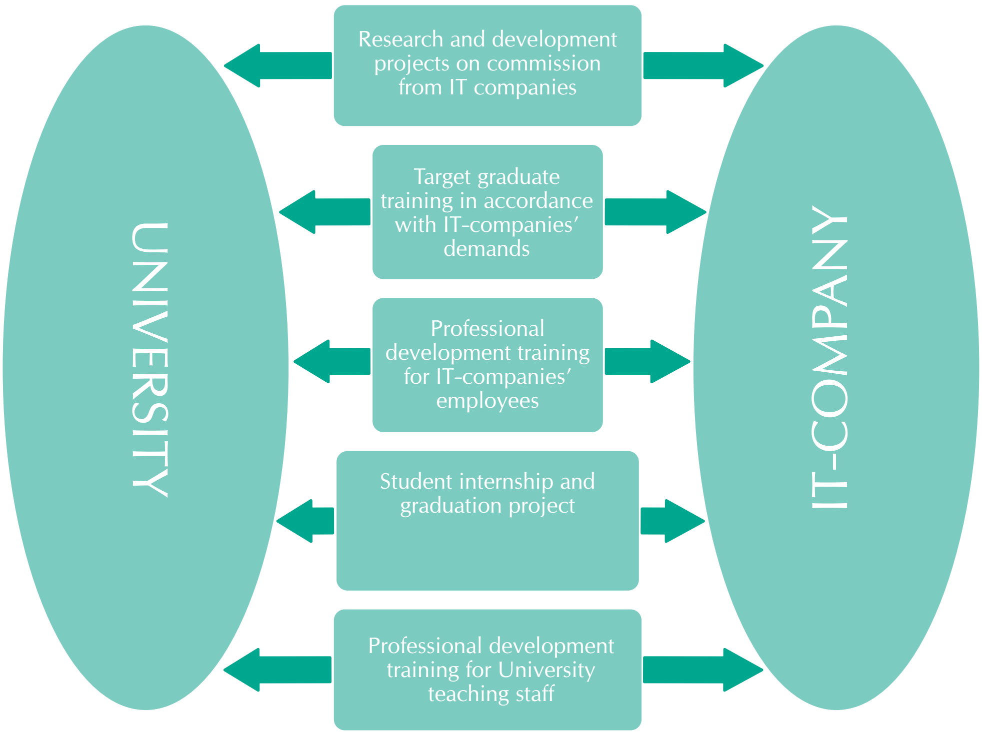
Along with the continuing professional development of teaching staff, it is very important to consider the demands and requirements of leading enterprises for the content of education programs, the level of graduate knowledge and skills acquired during an education period.

Ways the industry can influence education program content

Pskov State University has recently conducted research on the ways Russian universities and leading IT companies can interact with each other [1]. The basic interaction areas between IT companies and universities are given in fig. 1.

Specifically, survey research based on interview methods was also conducted. Survey respondents, representatives of IT companies answered the questions concerning development of IT education programs regarding the requirements and demands of the sector.

Fig.1. Basic Interaction Areas between IT Companies and Universities



According to the results obtained, the influence of IT companies on the content of education programs is currently maintained through the following ways:

- Development and implementation of joint education programs (Bachelor's degree, Master's degree programs, short-time courses and workshop sessions).
- Launching of enhanced professional development courses focused on learning the technologies which have been developed by IT companies or/and are widely applied in this economy sector.

However, the representatives of IT companies also have pointed out that most new graduates lack even the fundamental knowledge in basic subjects which are studied within the current information and communication technology programs provided by universities. The representatives of IT companies strongly recommend to revise education programs so that students can dedicate more time to studying cloud computing technology, distributed computing technology, Java programming language, Microsoft.NET Framework, and ERP systems.

IT company-university interaction

Answering survey questions, the representatives of IT companies highlighted the necessity of developing unified information resource to maintain interaction between IT companies and universities.

Such information resource will allow IT companies to post their considerations and preferences concerning the content and structure of IT education programs, announce forthcoming research and development events and activities, allocate information about job placement and student internship. The development and implementation of this resource with all above-mentioned functions is considered to be a rather important step to maintain interaction between universities and business in terms of education program revision and enhancement of IT student training.

The basic modules of the proposed information system which is planned to handle above-mentioned tasks are given in fig. 2.

Access to information will be possible through regional domains in correspondence with university locations or without any regional restrictions. With the help of this information resource, universities can post their current IT education programs, while IT companies will be able to comment and make a persuasive argument about the content of current education programs, which will be considered by universities in further enhancement of IT students training.

Conclusion

The proposed interaction pattern and information resource will allow universities to adjust education programs to rapidly changing requirements of information and communication technology sector, which in its turn will contribute to training highly-qualified engineers equipped with necessary professional skills which correspond to the requirements of modern IT sector employers (fig.3).

Fig. 2. Basic Modules of the Proposed Information System for IT Company-University Interaction

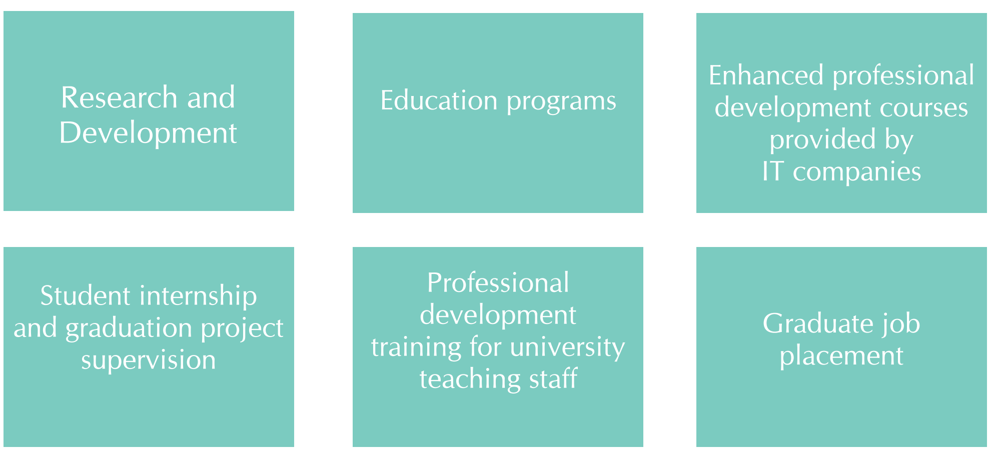
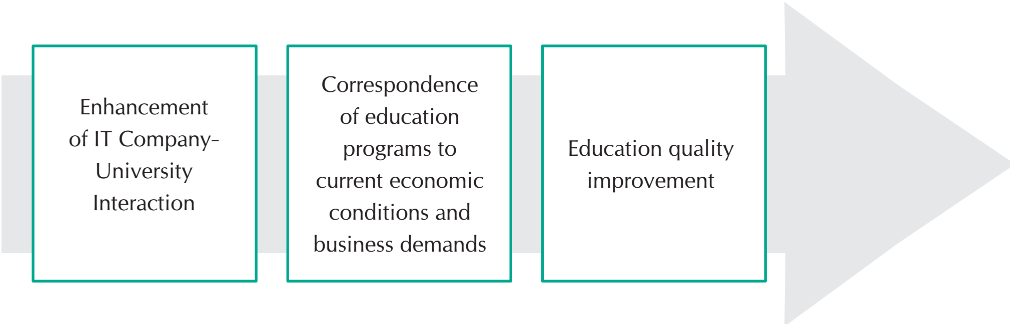


Fig. 3. Expected Outcomes of the Proposed Network Information System



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UDC 338.2

Innovative Business Safety Specialists Training According to Newly Developed Doctrine of Engineering Education in Russia

Irkutsk State Technical University
A.P. Sterkhov

The article deals with the problems of safety insurance of innovative business in compliance with the new Doctrine of Engineering Education in Russia. The necessity of systematic knowledge in technical science, economy and law is underlined. Master's degree program in "Safety Management in Innovative Business" is considered to be the most preferable. The article highlights the basic problems and objectives in training the Master's degree students in "Safety Management in Innovative Business".

Key words: *integrated safety, innovative business, safety specialist, problems, main objectives.*

A.P. Sterkhov

The processes which our country confronted at the turn of the XXIst century, i.e. the change of ownership structure and economic system, have resulted in severe shortage of qualified business safety specialists. It basically concerns innovative business.

The shortage of qualified safety specialists is primarily explained by scientific and methodological inadequacy of business safety and security, including a great number of problems in legal, economic, informational and engineering training of safety specialists.

The analysis of the current situation has revealed that the present state-legal mechanisms and traditional safety methods of innovative business are rather inefficient and even unacceptable within the business activity framework.

Inadequate legislative and regulatory framework for business security, absence of required legislation amendments, ineffective mechanisms for coordinating the interests of State and entrepreneurs, inefficient business risk insurance policy and evident shortage of qualified legal consultants are among the reasons for insufficient business security. As a rule, rather low level of knowledge of safety specialists, shortage of highly-qualified personnel capable to guarantee company security, absence of experience background and required literature focused on safety specialist training also lead to ineffective company security policy.

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Based on the relevant publications, it may be inferred that complex business security policy is still being developed [1]. In most cases, the authors consider only definite aspects of business security policy in terms of legal framework or technical, informational, economic and environmental issues.

Besides, a qualified safety specialist must have broad knowledge and skills in economics, legal science and engineering [3]. He/she must demonstrate knowledge not only in production management but also in peculiarities of human relations, be familiar with private law issues as well as with information-analytical work including the aspects of social engineering.

As a safety specialist must possess skills and attributes of an engineer, manager, economist and lawyer, it is possible to pursue one of the above-mentioned degree programs. However, engineering education is considered to be more preferable in a case of innovative business security. In this respect, Master's degree program "Security Management of Innovative Business" designed for engineering manager training is more appropriate. It is proved by the fact that rapidly changing safety technologies require more qualified managers equipped with deep knowledge of science and engineering. On the other hand, security insurance of business and economic system in general is primarily defined by the implementation of innovation processes in companies and enterprises. The share of goods and equipment produced by implementing innovative technologies and solutions ranges from 70 to 85 % of gross domestic product growth in the developed countries [2].

Another alternative for safety specialist training is Master's degree program "Business Security Management". It can be explained by the fact that almost all decisions concerning legal, informational, economic, environmental, technical and engineering aspects of security insurance can be estimated in terms of money.

The most crucial problems in training safety specialist for innovative business are as follows:

- absence of state educational standards in safety specialist training approved by the Ministry of Science and Education;
- absence of job position and job description for innovative business safety specialists in the Russian National Classification of Occupations of Employees, Positions of Civil Servants and Wage Category which is recommended to be referred to in a case of different ownership patterns. This Russian National Classification of Occupations of Employees, Positions of Civil Servants and Wage Category is an integral part of the Unified System of Information Classification and Codification of the Russian Federation and it has been developed within the State program for the transition of the Russian Federation to the international system of accounting and statistics in accordance with the requirements for the development of the market economy;
- absence of scientifically grounded recommendations and reasons for adding business safety specialist position into the company structure;
- methodological inadequacy of innovative business safety and security;
- problems in regulatory support of innovative business security.

To solve the above-mentioned problems, first of all, it is required to fulfill the following tasks:

- to develop methodology for complex security insurance of innovative business;
- to develop the concept of business security insurance;

- to establish appropriate policy of business complex security insurance;
- to add position of safety specialist for innovative business to the Safety Specialists and Workforce Qualification Reference Book;
- to develop and certify Bachelor's and Master's Degree requirements in innovative business security;
- to incorporate appropriate degree programs into the State Educational Standard;
- to develop teaching materials in order to provide high-quality training of safety specialists for innovative business.

The draft of federal entrepreneurship protection law as a basic nominative legal act would solve a great number of relevant problems and contribute to security insurance of innovative business. It is essential to formulate principles of business security insurance, develop basic methods for entrepreneurship protection and business security within the law. In addition, business security must be based not on the state law enforcement, but on economic mechanisms.

In order to handle the problems in business security, it is required to establish a complex system of security control based on the joint efforts of the government and its regulatory agencies as well as business entities themselves. To coordinate this kind of work and cooperation, business security councils of different levels can be arranged: business security council of the Government of the Russian Federation, regional business security council and etc.

A well-structured services marketing must be established within the business security framework. It should be noted that security methods which are widely applied by entrepreneurs are certainly very important but they can hardly be used alone. Therefore, safety and security "market" must also embrace a wide range of guaranties which are concerned with relation stability and support of entrepreneurship development. Each of these guaranties requires further elaboration [3]. The application of the discussed methods will help to define the scope of business contribution to its effective management.

From the above reasoning it is obvious that it would be more preferable to train safety specialists for innovative business at National Research Technical Universities. On the one hand, Russian Research Universities are proved to be the centers of fundamental science. On the other hand, these universities produce highly skilled personnel appropriate for innovative development.

In this case, the quality of safety specialist training will have direct influence not only on the future of business security but also on the possibility of creating favorable environment for innovative development of the entire entrepreneurship in our country.

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Specialist Training and Retraining in Building Reconstruction

Tomsk State University of Architecture and Building
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The article deals with the main problems of modern construction quality as well as the quality of restoration and reinforcement of buildings and constructions. It underlines the urgency to train and retrain engineers for building reconstruction. The study materials developed by the Department of Ferroconcrete and Stone Constructions of TSUAB are presented. They provide a methodical basis for training highly qualified civil engineers.

Key words: *specialist training and retraining, reconstruction, construction, restoration and strengthening, manual.*

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I.V. Baldin

D.G. Utkin

The problem of quality increase in design, construction and operation of ferroconcrete buildings is still at issue and of great economic importance.

As the issues concerning design, reconstruction and reinforcement of ferroconcrete and stone constructions are getting more important, there appears an urgent need for training and retraining highly-qualified bachelor's and master's degree professionals, post-graduates and doctoral students within the discussed subject area. Tomsk State University of Architecture and Building (TSUAB) is working towards handling this growing demand.

TSUAB provides civil engineering training programs in Building Reconstruction, Operation and Property Management, as well as a number of retraining courses for civil engineers on the basis of the Institute of Continuing Education. Department of Ferroconcrete and Stone Constructions is actively involved in this kind of work.

Transition to the two-level system of higher education urges universities to address the needs in developing more advanced Master's training programs by constant enhancement of teaching technologies and procedures. Besides, a number of new disciplines focused on leaning unconventional reconstruction technologies, new methods for structural inspection, reconstruction and reinforcement of structures and buildings have been introduced.

The topic of fifth-year student papers, who are pursuing degree in Industrial and Civil Construction, are concerned with Restoration of Buildings and Constructions and aimed at developing new methods for reinforcement of ferroconcrete ceiling panels, continuous flooring joists and built-up column of multistory industrial buildings. This work is a sequel to the previous course papers on "Ferroconcrete and Stone Constructions of Multistory Industrial Buildings". The initial data applied in these student works are always different. For example, it is required to estimate bearing capacity of the construction and propose the variants of its reinforcement against temporary increase in load which is a common place in building reconstruction leading to the change of its intended purpose. Such initial parameters as concrete strength degradation during building operation and reduction in reinforcement steel diameter due to corrosion are always changed.

The use of practical examples concerning the inspection of real buildings and constructions characterized by the same defects and damages can help students to reinforce theory in the classroom. By giving a demonstration, illustrations and photos of damaged building bearing constructions which have been already reinforced, students can connect engineering theory with practical applications in order to carry out their assignments successfully.

Besides, internships give students the opportunity to gain valuable applied experience in structural inspection of real buildings and constructions working independently or as a member of an engineering team. Participating in real structural inspection, students can propose construction solution, detect and lag defects and damages, determine strength characteristics of construction materials, estimate bearing capacity of building bearing constructions. Then, based on the existing manuals and teaching materials students are to propose the variants to reinforce and reconstruct these damaged constructions and defend their internship report.

While perusing Master's degree in "Reconstruction of Buildings and Constructions" students acquire advanced knowledge in application of various building reconstruction methods and technologies. During a study period, a master student has all possibilities to gain valuable experience in structural inspection and development of reinforcement and reconstruction schemes which can be applied in different constructions and buildings. Above all, while working on final qualification project, a master's student is not limited by the existing theories and technologies but rather encouraged to develop new methods for construction reinforcement and restoration with further possibility to patent his/her invention. Particularly, a new manual devoted to the aspects of structural inspection, reconstruction and reinforcement of ferroconcrete and stone buildings and constructions has been recently developed by the research team which includes two Master's students.

Complex analysis of the scientific works focused on developing appropriate calculation methods and technologies for ferroconcrete and stone buildings and constructions is carried out in TSUAB.

Theoretical and experimental research regarding ferroconcrete and stone buildings and constructions has been conducted; valuable practical experience in creating and developing real-life design-and-engineering solutions which can be applied for reconstruction of buildings and constructions has been acquired; a number of monographs and textbooks have been developed [1...5], inventor's certificates and patents have been obtained. The textbooks are designed so as to demonstrate students and engineers how to conduct structural inspection, calculations concerning reconstruction and reinforcement of ferroconcrete building constructions. Besides, the work is carried out towards standardization of calculation methods, technologies of reconstruction and reinforcement of ferroconcrete, concrete, stone and reinforced masonry structures and constructions.

The inventions made by the Department of Ferroconcrete and Stone Constructions of TSUAB were given favorable considerations by the specialists of design and development companies, building contractors and leading universities of CIS countries. Five textbooks are recommended by the Ministry of Science and Education of the Russian Federation and Education and the Methodics Association of Russian Universities as textbooks for students of higher educational institutions pursuing degree in speciality 270100 “Building and Construction”.

Based on the gained experience in structural inspection and obtained data in theoretical and experimental research, a number of computer software programs which allow specialists to carry out calculations and structural inspection, design and select appropriate method for reconstruction and reinforcement of ferroconcrete and stone buildings and constructions have been developed. Due to these software programs, it is possible to display possible defects and damages of ferroconcrete and stone constructions, select a relevant method for reinforcement and reconstruction. Software programs provide users with access to more than thousands of variants of reconstruction and reinforcement of ferroconcrete and stone buildings and constructions.

The usage of software programs while designing ferroconcrete and stone constructions significantly reduces time expenditure and labor intensity.

Thus, it can be stated that the problem of training and retraining specialists, Bachelor’s and Master’s students in Reconstruction and Reinforcement of Ferroconcrete and Stone Constructions is still at issue. Therefore, TSUAB is working towards building a culture of continuous improvement in undergraduate teaching within the discussed subject area, including both theoretical knowledge and practical experience.

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UDC 378

Third Generation Federal State Educational Standards Requirements to Student Research Work

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According to the State educational standards of the third generation student's research work management should be focused on the development of both cross-cultural and professional competences. However, student research skills are developed at the final stage of training, particularly, while preparing a final qualification project.

Key words: *student research work, competences, Federal State Educational Standard.*

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The third generation of State Education Programs (SEP) has slightly changed the requirements to the implementation conditions of the bachelor basic education program (BEP), in particular the requirements to research work. SEPs require encouraging the development of student research societies and using widely active and interactive training forms in teaching process, which should attract students to research activities. Such classes should constitute not less than 20% of the whole amount of classroom training.

In 2009 St. Petersburg State Electrotechnical University (ETU) developed the third generation of Bachelor SEP for speciality 210400 "Radio Technology" [1]. Duration of training is 4 years and workload is 240 credit units (c.u.). A credit unit is equal to 36 academic hours. (a.h.) if compared to second generation SEP.

According to basic and special training of bachelors in speciality 210400 "Radio Technology" they can fulfill six kinds of activities one of which is research. Thus the student's research workload can be estimated as 40 c.u. It includes:

1. Scientific and technical information analysis, analysis of domestic and foreign experience in the research topics (8 c.u.);
2. Object and process modeling including modeling by means of standard application programs (8 c.u.);
3. Participation in planning and conducting experiments according to a given procedure, data interpretation using modern IT and technical tools (8 c.u.);
4. Making reviews and reports on conducted research (8 c.u.);
5. Ensuring protection of intellectual property and research results and developments (8 c.u.).

Research is regulated by State Standard Specification 15.101-80 and is defined as a complex of theoretical or (and) practical experimental research conducted to obtain benchmark data or to find principles and ways of product development or modernization [2].

Research activities can be divided into fundamental, applied and exploratory, whereas fundamental and exploratory ensure generation of ideas that can be transformed into science, research, experimental and engineering projects (R&D).

It is obvious that most of graduates will be involved in innovative activities, applied research or accompanied activities even if they don't work in scientific establishments.

New bachelor BEP requirements have new notion – competences that are defined as the ability to apply knowledge, skills and personal qualities for successful problem-solving in a certain domain. The competencies are divided into cross-cultural (CC) and professional (PC) ones.

Six out of 19 CCs (32%), necessary for bachelors in speciality 210400 "Radio technology", ensure successful research activity:

- to have thinking culture, to be able to compile, analyze and perceive information, to set a goal and to find the ways of its achievement (CC-1);
- to express logically and structurally correctly his\her ideas both orally and in written form (CC-2);
- to be ready to collaborative and team work (CC-3);
- to use basic natural laws in professional problem-solving activities , to apply methods of mathematical analysis and modeling, theoretical and experimental research (CC-10);
- to apply basic means and methods of data collecting and interpreting, to use computing technologies for data management (CC-12);
- to be able to use Internet as a means of information obtaining (CC-13).

Seven (22%) PC out of 32 can be referred to student's ability to research work:

- to be able to collect, analyze, interpret and organize scientific data in the domain of his/her research, to use achievements of domestic and foreign techniques and technology (PC-6);
- to be able to collect, analyze scientific and technical information, to compile domestic and foreign experience in radiotechnics, to analyze patent literature (PC-18);
- to apply object and process mathematical modeling according to typical methods, including modeling by means of standard application programs (PC-19);
- to be able to implement experimental research programs including the choice of correct technical means, and data interpreting (PC-20);
- to be ready to take part in making analytical reviews and scientific and technical reports on fulfilled work, to prepare edition of research results in forms of presentations, articles and repots (PC-21);
- to be able to implement and develop research results and to ensure protection of intellectual property and research results and developments (PC-22);
- to be able to work as a leader of small teams (PC-23).

Thus, 13 (26%) out of 51 competencies are necessary for successful graduate's research activities.

Bachelor basic education program (BEP) provides 6 subject modules that form the following competences relevant to research activities:

- M1 - Humanitarian, social and economics subjects: CC-1...CC-3, total 3;
- M2 – Mathematics and natural sciences: CC-10, total 1;
- M3 – Professional subjects: CC-13, PC-6, PC-18...PC-21, PC-23, total 7;
- M4 – Physical culture: none;
- M5 – Internships: CC-3, CC-13, PC-20, PC-23, total 4;
- M6 – Final state certification: CC-1 ...CC-3, CC-10, CC-12, CC-13, PC-6, PC-18... PC-22, total 12.

Tables 1 and 2 describe comparative importance of cross-cultural and professional competencies in student's training for research work. It shows that according to FSES HPE, the leading role in the formation of student's research abilities is played by final state certification (12 competencies), professional module (7 competencies), internships (4 competencies) and the module of humanitarian, social and economic subjects (3 competencies).

Strange as it may seem, but mathematics and natural sciences shouldn't influence the research competency formation.

50% of the subjects are instituted by University State Education Standards. Internships can be research work. Final state certification summarizes the studied subjects in the final qualification project that contains a massive proportion of research work.

Research program (for internships) should ensure for students the following opportunities:

- to study professional literature and other scientific and technical information, foreign and domestic achievements of scientific and technical knowledge;
- to conduct research and perform engineering tasks;
- to collect, interpret, analyze and classify necessary scientific and technical information;
- to make reports at conferences etc.

Bachelor BEP implementation of research activities are performed by teaching staff with PhD or Doctor's degrees who are constantly engaged in research activities. Every student should be supplied with Internet, library and other data base access.

To ensure quality of learning/teaching process there is a list of requirements to minimal facilities. It includes laboratories equipped with modern measuring equipment, IT tools, industrial samples of devices and systems and special research equipment.

The Internet access hours for student's independent research work from University computers should

Table 1. Comparative Importance of Cross-Cultural Competencies in Student's Research Training

	CC-1	CC-2	CC-3	CC-11	CC-12	CC-13	Total:
M1	x	x	x				3
M2				x			1
M3						x	1
M5			x			x	2
M6	x	x	x	x	x	x	6
Total:	2	2	3	3	1	2	13

Table 2. Comparative Importance of Professional Competencies in Student's Research Training

	PC-6	PC-18	PC-19	PC-20	PC-21	PC-22	PC-23	Total:
M1								0
M2								0
M3	x	x	x	x	x		x	6
M5				x			x	2
M6	x	x	x	x	x	x		6
Total:	2	2	2	3	2	1	2	14

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be not less than 2 hours a week per student.

The University should be supplied with necessary licensed software.

Thus, the current State Education Standards of Higher Professional Education of the third generation contain more cognitive components, and professional competencies hardly reach 50%.

Meanwhile, there is no difference between competencies of Bachelor, Specialist and Master Degrees. Competencies of all Degrees are often identical.

To perform Bachelor research activity (to manage internships, human resource, methodical, information and facility support of teaching process) it is necessary to make great changes in internship system and staff choice. Methodical, information and facility support of teaching process should be constantly updated to meet the changing conditions of labor market, new technologies and research fields.

It is also necessary to solve legal problems, in particular the correlation of scientific Degrees.

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UDC 378

Role and Place of the Course "Theoretical Mechanics" in Training of a Contemporary Mechanical Engineer

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The article deals with organizational-methodical problems concerned with teaching the course of Theoretical Mechanics for engineering students in modern conditions. Attention is paid to fundamental significance of this course. The methods and forms of lectures and practical classes are discussed.

Key words: *National Doctrine of engineering education, theoretical mechanics, teaching methods, educational testing, web-technology.*

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One of the principles of the National Doctrine in Engineering Education [1], developed by the Association of Engineering Education in Russia, is transition to the new educational methods in engineering training. In the broad sense this principle implies: "...search for and development of original engineering, social, and pedagogical solutions, application of ideas and crucially new "high", providing multiple increase in efficient teaching and academic labour techniques, creation of mass "talent production" methods, using distant learning" [1].

The present article deals with organizational-methodical problems concerned with teaching the course "Theoretical Mechanics" for engineering students in modern conditions.

In addition to "Theoretical Mechanics" course "Engineering Mechanics" curricula include a number of engineering disciplines: "Strength of Material", "Theory of Mechanisms and Machines", "Details of Units and Devices". In the context of transition to credit training system there appeared a tendency to unite these disciplines under some common names: "Engineering Mechanics", "Applied Mechanics" etc. What are the drawbacks of such an approach? The matter is that "Theoretical Mechanics", in contrast to all applied courses, is a fundamental discipline. It means that it develops not only knowledge, skills and competences, but also scientific outlook of a future engineer. It is this important component that is usually «washed away» when uniting the disciplines of engineering profile, as the major attention is paid to learning some particular methods of equilibrium or object motion calculations.

On the pages of "Engineering Education" journal different aspects of engineering education modernization under the condition of transition to the two-stage higher education system are discussed. In V.I. Livshitz's article [2] it is fairly pointed out to the gap between university education and conditions of real production, it is emphatically offered "to replace the concept of fundamentalization to professionalization in engineering education". However, such an extreme opinion appears to be dangerous. From our point of view one should support a balanced approach of S.A. Podlesniy [3] who stands for optimal combination of fundamental and professional training. Complete "replacement of education fundamentalization into professionalization" could result in training of specialists who only possess competencies in a focused professional sphere, but do not have any scientific outlook orientation. The gaps in fundamental training can lead to serious errors in the development of definite engineering projects.

Students' materialist conception is developed at studying fundamental laws of nature and its properties. In this case it is impossible to avoid historical aspects of development of basic scientific ideas: "long-range" and "short-range" potential, "discontinuous" and "continuous" concepts. Without them it is impossible to understand the essence of mechanics – mechanical motion and material bodies' interaction. It is just these concepts about motion and bodies' interaction that make possible to understand material properties and material world arrangement.

Special attention should be paid to awareness of mechanical laws. Usually, students keep in mind only the second Newton's law out of all dynamics laws that is expressed in a simple formula applied in problem solutions. In this case no attention is paid to methodological significance of the first mechanics law – law of inertia. As a result, the conditions of dynamics basic law application are ignored and there appear the problems in comprehension of essence of inertia forces. Methodological significance of the third Newton's law also often remains "outside the parentheses".

Let us pay attention to the inextricable and integral connection of theoretical mechanics and mathematics. It is mechanical parameters that allow for gaining deeper insight into the essence of differential quantities. Theoretical mechanics is, perhaps, the only course of engineering curriculum that uses the theory of differential equations to the full extent as the most important tool for dynamic systems analysis. Unfortunately, at present in engineering practice there is often the situation when a specialist cannot take the first step in research of a definite mechanism – perform mathematical modeling and compose differential motion equations. In this case the second stage of engineering analysis becomes impossible, i.e. determination of motion characteristics. In this situation there is no sense in possession of modern calculation means and software as the mechanical problem itself has not been formulated.

Usually mechanics teachers justify such a result by complete lack of classroom hours. However, application of modern educational techniques allows for making "Theoretical mechanics" course limited in time, but of rich content. First of all, what it involves is multimedia resources. A modern lecture is unconceivable without application of software, for example, slides of Power Point. In this case one should use a definite technique. Training material should not be presented in poster form. Every slide should be filled in gradually. For this purpose it is relevant to use pop-ups, staged construction of complex views, motion simulation by means of animation etc. Students should have at their disposal soft copies of slide lectures developed by the lecturer. It is even better if there is a possibility to develop and offer students soft multimedia lectures with sound. Such a set of lectures developed by the author in each of the basic parts of theoretical mechanics: "Statics", "Kinematics", "Dynamics" [4]. This resource is used by the students in independent work. It does not replace traditional textbooks, but helps students to be easily oriented in learning material. In particular, by means of it one can compensate the information from the classes missed. Besides, modern web-techniques allow lecturer to apply efficiently the potential of university educational portal, posting on a personal website all necessary training materials.

As additional sources in "Theoretical mechanics" course it is recommended to use, for example, a very instructive methodical aid by A.M. Pavlov [5]. It describes the history of emergence and development of the basic concepts in mechanics: "velocity", "mass", "force", "impulse" and others. How the idea of inertia and momentum conservation was developed; what debates took place regarding the first and second Newton's laws; how the science came to the concepts of motion and rest relativity – the principle of relativity; how gradually mechanics was arriving to the law of universal gravitation; whether the gravitation constant is constant; what we know about the nature of gravitation; argument about measurement of motion; how gradually scientists found the meaning of concepts of work and energy, the law of energy conservation; how the ideas of force moment and impulse moment emerged; connection of the conservation laws and properties of space and time properties – all these are closely interrelated with academic material treatment and accompanied by the examples.

The following aspect is concerned with the arrangement of practical classes. The method at which a student is solving a problem at the board (often at teacher's dictation), the others are just coping the solution, under current conditions is absolutely unacceptable. One needs to apply the active forms of practical classes' arrangement.

Credit training technique requires shifting the gravity center to students' independent work. It is possible only at the individual approach. But having practical classes with the group of 20 students and more it is not an easy task. Nevertheless, there is a way out, it is well known – every student is to make individual task including definite set of problems on every theme. For this purpose it is convenient to use, for example, "The book of short problems" edited by O.E. Kepe [6]. A key element of such a technique is a credit test of students' solved problems. A lecturer has to briefly discuss with every student checking his/her understanding the essence of the problem and method of its solution. By the way, such an approach enables the development of oral expressions of students' ideas.

Another necessary form of control in the current conditions is testing. Its primary advantage is high technology permitting for checking many students' knowledge simultaneously and defining the outcome quickly. However, testing involves the professional approach: one should know and meet a great deal of methodical requirements and organization conditions. In leading universities lecturers have the opportunity to attend training seminars on methods of test design, there is a system of expertise and certification of testing resources, the necessary adequate software is developed permitting for organization of computer testing for groups of students. At such an approach one can evaluate students' competencies without lecturer's participation. If there is a system of independent testing in a university and all necessary organizational requirements are met, the results obtained in examination period can be used for objective evaluation of quality performance of every lecturer [7]. In this case the basic demand for IOS quality standard is complied [8] – objective measurement of service quality in the process of its performance (internal quality monitoring).

Particular attention should be paid to students' research work organization in the course of theoretical mechanics. It is students' participation in research and methodical work that contribute to the development of creative approach and formation of impendent skills in scientific search. Theoretical mechanics provides a wide choice for students' research topics. Of particular interest for students are those concerned with controversial issues, paradox phenomena, or historical casus. For example, in the Internet there are a lot of video-films presenting self-moving mechanisms – eternal engine. Attempts to explain the operation principle in each case are sure to promote deep understanding the nature of different physical interactions and mechanical laws.

In recent time the development of distant educational techniques takes place at a quick rate. It implies application of specific teaching methods and specific training materials for different sections of mechanics. In our opinion it is multimedia training materials with sound that could replace a lecturer in the students' independent work to the full extent using distant techniques. In this connection the problem becomes to teach lecturers to develop relevant training materials. The technical support of this work should be performed by workers of special multimedia laboratory. Only professional approach to this task provides development of multimedia materials.

In conclusion one should say that in two-level system of higher education it is very important to differentiate fundamental and applied disciplines. Of particular significance is fundamental training for Bachelor's Degree. Without fundamental knowledge of mathematics, physics, and mechanics it is impossible to train engineer capable of keeping up with the times, comprehending, and developing innovations in engineering and technology. A university course of "Theoretical mechanics" plays a special role in formation of scientific outlook of modern mechanical engineer and implies great opportunities in training creative specialist. Without deep and sound knowledge in the sphere of mechanics bases it is impossible to lay the foundation for learning all subsequent disciplines of mechanical engineering. To solve this problem it is necessary to raise the level of current requirements for teaching methods and develop the adequate resources.

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WAYS TO IMPROVE THE QUALITY OF ENGINEERING EDUCATION

WAYS TO IMPROVE THE QUALITY OF RUSSIAN ENGINEERING EDUCATION IN NEW INDUSTRIALISATION

S.A. Podlesniy, A.V. Kozlov
Siberian Federal University

The article discusses ways to improve the quality of engineering education in Russia in the era of post-industrial information society, analyzes the factors affecting the preparation of world-class specialists in the field of engineering and technology.

CURRENT TRENDS IN ENGINEERING EDUCATION OF RUSSIA

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Moscow State Automobile and Road Technical University MADI

The article deals with the current trends in engineering education of Russia: engineering education quality assurance and introduction of the system for certification of engineering qualifications in order to get impartial assessment of the level of training at higher education institutions.

FUNDAMENTAL APPROACH - BASIC PRINCIPLE OF ENGINEERING EDUCATION

V.A. Prokhorov
North-Eastern Federal University named after M.K. Ammosov

According to the author today the system of higher education should be based on fundamental knowledge, be flexible and universal, focus on the formation of general and professional culture. The article proposes a new model of training at technical university that is based on revision of balance between fundamental and technical components, forming a multi-level integration of technical and fundamental knowledge.

PUBLIC ACCREDITATION OF BELSU ENGINEERING EDUCATIONAL PROGRAMS

A.V. Mamatov, I.S. Konstantinov, A.N. Nemtsev, L.A. Kadutskaya
Belgorod State National Research University

The article deals with public and professional accreditation of engineering educational programs as a tool for solving problems of improving the quality of training of future specialists in the field of engineering and technology. The authors present the experience of the Belgorod State National Research University in completing the procedure of professional accreditation of educational programs.

COMPETENCE APPROACH IN ENGINEERING EDUCATION

O.A. Gorlenko, V.I. Popkov
Bryansk State Technical University

The article discusses the main features of competency models graduates from engineering universities in accordance with the requirements of state educational standards (third generation). The spread of the number of common cultural and professional competencies for different areas of the integrated training of engineers indicates the need for urgent revision and improvement of the given educational standards.

CONCEPT OF ENGINEERS TRAINING IN CHEMICAL ENGINEERING

V.V. Kondratyev
Kazan National Research Technological University

On the basis of KNRTU analysis of recommendations and outcomes of various conferences, parliamentary hearings, forums, academic schools and methodological seminars the problems of engineering education have been summarized. The concept of training engineers in the field of chemical engineering has been formulated.

THE THEORY OF SEMI-FINISHED PRODUCTS IN THE APPLICATION TO HIGHER VOCATIONAL EDUCATION

V.G. Martynov, V.N. Koshelev, V.S. Sheynbaum
Gubkin Russian State University of Oil and Gas

The article shows the direct connection between the increasing diversity of educational trajectories of engineering skills and the general laws of post-industrial society of development. The authors make an attempt to review the process of training engineers in comparison with the production of goods and services related to the category of semi-finished products.

ANALYSIS OF FACTORS AFFECTING THE REQUIREMENTS OF PROFESSIONAL COMPETENCE OF MODERN ENGINEER

O.L. Servetnik I.P. Khvostova
North-Caucasian Federal University

The social and economic factors affecting the requirements for the professional competence of the modern engineer are considered in the paper.

INCREASING TRANSPARENCY OF THE EDUCATIONAL SYSTEM BY IMPLEMENTING STATE EDUCATIONAL STANDARDS

A.N. Danilov, V.Y. Stolbov
Perm National Research Polytechnic University

The paper focuses on the entropy approach to the management of the training process in the transition to new state higher educational standards which involves different extent of transparency of students training systems at different levels of their training. The higher the degree of openness, the more ready for self-organization is the system . This will ensure the development of new way to organize the training process in accordance with the educational objectives set out in the transition to the new state higher educational standards.

WHY RUSSIAN UNIVERSITIES DO NOT APPEAR IN THE TOP 100 WORLD UNIVERSITIES?

E.A. Gladkov
Tomsk Polytechnic University

The paper analyzes the main reasons for the lack of Russian universities in the top 100 world universities.

THE ROLE OF BUSINESS AND GOVERNMENT IN THE FORMATION OF STAFF REQUIREMENTS FOR INNOVATION-BASED ECONOMY

S.A. Vasilyeva, I.V. Filimonenko
Siberian Federal University

The paper deals with the interaction tools between government and business on the staffing model for innovative development of the national economy.

MODERNIZATION OF ENGINEERING EDUCATION

MODERNIZATION OF ENGINEERING EDUCATION AT THE REGIONAL LEVEL

E.A. Arkhangelskaya
North-Eastern Federal University named after M.K. Ammosov

Among the many challenges facing higher education, the author identifies as particularly important the direct participation of the University in the development of innovative technologies and social infrastructure of the region. The paper describes the main ways to overcome the crisis of engineering education, the priorities of its development and modernization. Implementation of the conceptual modernization program for engineering education is considered by the author as a crucial measure to address the current problems in this area.

KEY APPROACHES TO MODIFICATION OF EDUCATIONAL STANDARDS FOR TRAINING IN THE FIELD OF INFORMATION TECHNOLOGY

M.V. Trofimova
North-Caucasian Federal University

The Russian and foreign experience of educational standards for training in the field of information technology is considered. The paper analyzes the approach to determine the content of training on the basis of requirements for professional competence of specialist in the field of information technology.

INFORMATION AND COMMUNICATION TECHNOLOGIES AS AN INNOVATIVE EDUCATIONAL ENVIRONMENT AT TECHNICAL UNIVERSITY

N. Y. Bratchenko, T.A. Mikhailichenko
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Current state educational standards for students of technical universities address formation of information and communication competencies. It is shown that the of up-to-date laboratory complexes in the training process contributes to the development of fundamental knowledge, skills and abilities of future engineers. The paper presents the most relevant examples of implementing information and communication technologies within the training process.

PROBLEMS IN ORGANIZING INDEPENDENT STUDY OF STUDENTS IN NATURAL SCIENCE COURSES AT TECHNICAL UNIVERSITY

D.V. Terin, Y.V. Klinaev, O.A. Monakhova
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Saratov State Technical University named after Yuri Gagarin

The article deals with ways of organizing independent work of students within such disciplines as "Physics", "Modelling of Physical Systems", "Digital Signal Processing", "Computer processing of the experimental data" introduced by the department "Technical Physics and Information Technology".

FEDERAL STATE EDUCATIONAL STANDARD FOR TRAINING ENGINEERS SPECIALIZED IN "DESIGN OF BUILDINGS"

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Moscow State University of Civil Engineering

The paper is devoted to the development of the federal state educational standards of higher professional education in "Design of buildings" at Bachelor and Master training levels.

METHODS AND TOOLS FOR TRAINING SPECIALISTS IN THE FIELD OF ENGINEERING AND TECHNOLOGY

RESEARCH AND DEVELOPMENT ACTIVITIES AS THE BASIS OF TRAINING MODERN ENGINEERS

V.G. Zaharevich, B.M. Vladimirskiy
Southern Federal University

The paper reviews some of the current problems of training engineers' that should meet up-to-date requirements. The authors give grounds for the necessity of initiating and executing of large multidisciplinary projects to improve the quality of education and level of graduates from engineering universities.

RESEARCH WORK OF STUDENTS AS A METHOD TO STIMULATE CREATIVITY

E.N. Kartavtseva
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The paper describes the main trends in the development of vocational education, including learning and research activities of students in the course "Mapping". The objectives of students' research work of the faculty of secondary vocational education are considered in the article. The main forms of research activities for cartography students of the first, second and third years, and the main directions of their creative work development are presented.

INDIVIDUAL EDUCATIONAL TRAJECTORIES AND COMPETENCE-BASED APPROACH IMPLEMENTING CLIPARTS AND VIRTUAL EDUCATIONAL INFORMATION SYSTEMS

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[2] Engels Technological Institute (branch) Saratov State Technical University named after Yuri Gagarin

The article deals with the methodological aspects of the formation of individual educational trajectories. The models and methods of competence-based approach implementing both clipart and virtual educational information systems are discussed.

NETWORK COOPERATION OF UNIVERSITIES AND ACADEMIC INSTITUTES IN PREPARATION OF THE ENGINEERING STAFF IN PRIORITY AREAS OF SCIENTIFIC AND TECHNOLOGICAL COMPLEX OF RUSSIA

A.N. Danilov, V.Y. Stolbov, A.A. Yuzhakov
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Three models of networking cooperation of universities and academic institutes in the implementation of educational programs for master's degrees in priority areas of scientific and technological complex of Russia are presented. Advantages and disadvantages of each model are discussed. The examples of these models are shown in the article.

TRAINING PRODUCTION ENGINEERS FOR THE OIL AND GAS INDUSTRY

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It is shown that the main principles of training engineers for oil and gas industry are based on close cooperation with leading Russian industrial companies. The interaction of technical universities with industry provides effective training at all levels of studying Bachelor - Master - PhD student - PhD - Doctor of Science. In this case, the system of training is based on the results of the industrial experiment method of mathematical modeling and systems analysis strategy. Specialists have opportunity to implement the results of their research in oil and gas processing factories within the studying process. This facilitates their advanced career development at enterprises in the oil and gas industry.

TEACHING THE COURSE "REINFORCED CONCRETE AND STONE STRUCTURES" USING MULTIMEDIA TECHNOLOGIES

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The paper describes the content of a textbook on the discipline "Concrete and stone structures" where all illustrative material is presented with the help of multimedia technologies. The processes of structural performance under load at different stress-strain states are accompanied by cracks in concrete or masonry forming a network of micro-cracks and the formation of the main crack are shown together with the change of stresses in the section design. All these factors accompanying the process of resistance design are reflected in the movement, in a dynamic form.

CORRELATION OF EDUCATIONAL MATERIAL ON THEORETICAL AND STRUCTURAL MECHANICS AND FORMATION OF THE NATIONAL DOCTRINE OF ENGINEERING EDUCATION

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The problems and their solutions in the teaching of such courses as "Structural Mechanics" (StrM) and "Theoretical Mechanics" (TM) are considered in the article. It is assumed that the teacher of TM department shouls take into account issues and requirements of StrM course when preparing teaching material. At the next training stages the new knowledge acquired by students is associated with the previously obtained. Students become more motivated to study those subjects that they had found unnecessary before.

CONTINUITY AND QUALITY OF ENGINEERING EDUCATION

E.P. Aprosimova
North-Eastern Federal University named after M.K. Ammosov

The paper deals with the need to include topics on specifics of engineering training in the natural science courses, as well as providing opportunities for individual training trajectory for talented students in secondary schools.

ENGINEERING EDUCATION
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RECOMMENDATIONS
All-Russian Scientific and Practical Conference "Approaches to Development of the National Doctrine of Engineering Education of Russia in the New Industrialization" (4 - 6 December 2012, Tomsk)

The conference is organized by the Association for Engineering Education of Russia, the Association of Technical Universities of Russia, the Association of Innovative Regions of Russia, the National Research Tomsk Polytechnic University, the National Research Moscow State Technical University named after Bauman, Administration of Tomsk Oblast, Administration of Novosibirsk Oblast, the Foundation for Assistance to Small Innovative Enterprises in Science and Technology with the support of the Chamber of Commerce of the Russian Federation, the State Duma Committee on Education, the State Duma Committee for Science and High Technology, the Federation Council Committee on Science, Education, Culture and Information Policy, the Plenipotentiary Representative of the RF President in the Siberian Federal District V.A. Tolokonskiy.

The conference attracted over 200 participants representing universities, engineering firms, industrial companies, state and federal agencies of the legislative and executive authorities.

Upon hearing reports and considering discussions and participants in the conference note that:

Transition of the economy from the lowest to the highest technological modes is determined by the level of technological culture of the society, the quality of engineering education and the state of engineering in the country.

The economic system of Russia is characterized as a mixed economy. Thus, according to academician Evgeny Kablov the share of the second technological wave in Russia remains at 10%, the third - about 30%, the fourth - 50% (mainly in the military-industrial complex and the aerospace industry), the fifth - about 10%. At the same time, the third technological wave in the U.S. economic system is - 15%, the fourth - 20% and the fifth - 60%. And the sixth technological wave already has about 5%.

Based on the results of the research conducted by the Association for Engineering Education of Russia (AEER) the current state of engineering could not be assessed as satisfactory: 28% of experts believe that engineering in Russia is in a systemic crisis, 30% - in critical condition and 27% - in a state of stagnation. These results are confirmed by the real data as well. Thus, the share of machinery, equipment and technology in the structure of Russian export, according to various estimates, ranges from 2.9% to 5% (U.S.A. - 37%, Japan - 42%).

According to the AEER experts the state of engineering is closely linked to the state of engineering education and the level of training of engineers. However, the level of training of engineers (learning outcomes) in Russia is recognized by the same experts as satisfactory or good (85% of the experts). And this is in sharp contrast with the assessment of the state of engineering in Russia (only 15% of experts believe the current state of engineering in Russia is satisfactory or good). The explanation for this contradiction lies in the principles of non-compliance, the content and form of modern training of specialists in the field of engineering and technology (bachelors, masters, engineers) with the industry requirements, created and developed according to the laws of the market economy.

Regarding Russia's accession to the WTO the optimal way for engineering and industrial development, allowing Russia find the rightful place in the global division of labor, is the development and implementation of thenew industrializationprogram. The importance and need in such a program was mentioned in the keynote speech of V.V. Putin at the Forum of "Business Russia" on December 21,2011.

Since 2009 programs of industrialization have been developed and implemented in many countries of the world in accordance with their development potential. For example, in Kazakhstan – the State Program of Forced Industrial-Innovative Development, in Latvia – Program of National Industrial Policy, which main provisions will be considered at the meeting of the Latvian government at the beginning of 2013, but its goals and specific measures are incorporated into the National Development Plan for 2014-2020, etc.

New Industrialization in Russia involves the creation or upgrading of 25 million jobs for highly skilled workers by 2020 according to the presidential decree № 596 of May 7, 2012 outlining the government's long-term economic policy objectives. The decree envisages the investments in Russia will grow to 25% of the gross domestic product (GDP) by 2015 and to 27 % by 2018, increase of share of high-tech and knowledge-intensive industries in the GDP by 2018 to 1.3 times in comparison with the level of 2011, an increase in labor productivity by 2018 to 1.5 times to the level of 2011. Also, Russia should take the 50th place in the World Bank "Doing Business" rating by 2015 and 20th place by 2018, the bill says. To achieve the stated ambitious goals it is required to elaborate Complex Program of New Industrialization, including staffing issues.

In recent years Russian engineering education has faced a number of global and national challenges. Necessity of adequate and timely measures to meet these challenges requires the adoption of systemic, political and economic decisions, covering the entire education system, as well as changes in the regulatory framework.

In case the efficient steps are taken the Russian system of engineering education could meet the staffing needs of the New industrialization Program. However, the post-industrial information society requires the shift of engineering education paradigm. Its basic principles should be included in the National Doctrine for Engineering Education of Russia, which formation approaches were the subject of the conference.

Given the above, participants in the conference recommend:

1. Legislative and executive authorities of the federal and regional levels:

- To develop together with the expert community the New Industrialization Complex Program of Russia based on the Strategy for Innovative Development of the Russian Federation 2020. The Program should include main goals, system indicators, means of achieving the goals, organizational structure management, resources (financial, human structural, and others). The Program should contain development of human resources in the fields of science, education, technology and innovation. Give the program the Federal Law status. Elaboration and implementation of such a document will allow to develop the National Doctrine of engineering education in new industrialization aimed at advanced training of professional engineers and mass training, skills upgrading and retraining of specialists in the field of engineering and technology.

- To develop Regional Road Maps of new industrialization, adopt and implement a set of measures to enhance the interest of all industrialization participants. Embody the principles of the Regional Road Maps in the regional laws. The Regional Road Maps should meet possible scientific and staff requirements.
- To encourage the participation of business community (engineering firms, industrial companies) in establishing endowment - funds of universities, training specialist in the field of engineering and technology, highly qualified engineers, generation of entrepreneurs in the field of high technology business and a society with a high level of technological culture.

2. Federal Assembly of the Russian Federation:

- To develop and adopt after revision the "Law on the engineering profession in Russia," which regulates the rights and duties of engineers, system of quality assurance of training in the field of engineering and technology, including state institutional accreditation of technical, universities, professional accreditation of engineering education programs and certification of engineering qualifications.

3. Ministry of Education and Science of the Russian Federation:

- (With participation of relevant ministries, academic community, the business community, industry representatives) work out and expedite drafting of the "National Doctrine of engineering education of Russia in new industrialization", defining the goal, advanced nature, methods and tools for the development and improvement of the national engineering education in the new industrialization. Introduce draft document for broad discussion by expert community and the public, for adoption to the Government of the Russian Federation and, as a bill to the State Duma of the Russian Federation.
- To make a list of directions and specialties for students in the field of engineering and technology to meet the needs of new industrialization.
- To build up an integral system for accreditation of higher education institutions, international professional accreditation of engineering educational programs and international certification of engineering qualifications, maintaining a national register of accrediting organizations and the national register of professional engineers.
- To continue efforts and significantly improve the quality of pre-school, secondary, vocational and higher education. Promote interaction and cooperation between education, business, science and government.
- To consider the introduction of a 12-year secondary education.
- To form a set of measures to stimulate the work of groups of higher education institutions to improve the quality of engineering education.
- To develop and implement a tool to stimulate targeted training for staffing the Regional Road Maps of New Industrialization.
- To develop a legal status and legal form, allowing secure association (alliance) of universities and research organizations without each agency to lose its entity.

4. Academic community, representatives of professional engineering societies:

- To take an active part in research and creative work on the formation of the of the "National Doctrine of engineering education of Russia in new industrialization" National Doctrine for Engineering Education of Russia.
- To be involved in promotion activities among the youth for to improve the image of an engineer and enhance the prestige of the engineering profession.
- To participate in the formation of a society with a high level of technological culture innovations awareness.

5. Representatives of scientific organizations, business community, engineering firms, industrial companies:

- To take part in the discussion on the formation and maintenance of the principles of the "National Doctrine of engineering education of Russia in new industrialization".
- To contribute to developing the training requirements of modern specialists in the field of engineering and technology, engineering qualifications, professional standards.
- To support activities in forming pool of experts to participate in the procedure of professional accreditation of engineering educational programs and certification of engineering qualifications.
- To work actively together with universities to prepare up-to-date professionals in the field of engineering and technology. Provide opportunities for the training of teachers, practical training for students, taking advantage of modern facilities, founding educational laboratories at universities, creating required conditions to establish basic departments within enterprises.
- To promote the development of practice-oriented educational technology by establishing staff centers on the basis of large industrial enterprises.
- To cooperate with universities by encouraging most qualified specialists and experts to participate in the learning process.
- To create decent working conditions for engineers: the availability of modern equipment and technology, the demand and the prospect of career growth, high salary for successful graduates from engineering educational programs.

6. The heads of higher education institutions training engineers and specialists in the field of engineering and technology:

- To support participation of faculty from different universities I development and discussion the content and principles of the "National Doctrine of engineering education of Russia in new industrialization".
- To continue efforts towards improvement the quality of engineering education and qualification level of universities' management staff, with the use of Russian and international best practices.
- To review curriculum and educational standards within the universities in order to develop creative skills, general competence, including competence in the field of engineering entrepreneurship with the involvement of potential employers and partners from academia and engineering companies.

- To increase emphasis on the humanitarian components in the curriculum of engineering training as the basis to develop system thinking abilities of future engineers.
- To provide in due course resources to implement Student-Centered Educational Environment corresponding the needs of postindustrial information society.
- To develop elite engineering, creating the conditions for the formation of engineering elite, who are able to make technological breakthrough and ensure efficient implementation of the Russian new industrialization program.
- To take active part in development of global open information environment, which allows to increase implementation of e-learning technologies in education in Russia and to close the gap with the international academic community in this area in a short time.

7. Mass media:

- To use efficient tools to influence public opinion to form a positive image of an engineer and engineering profession.
- To promote the leading role of engineers in the implementation of the new industrialization program of Russia.

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Summary

SYSTEMATICITY AS A POINT OF FORCE OF ENGINEERING EDUCATION

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The author focuses on reform of Russian Engineering Education and underlines the importance of systematicity in engineering education management, in particular in professional paradigm of future engineers. Possible provisions of the Engineering Education Doctrine which is being developed are suggested. These provisions are focused on systematicity in some aspects of engineering university's activities.

ENGINEERING EDUCATION CONCEPT IN MODERN RUSSIA (PHILOSOPHIC, SCIENTIFIC AND PEDAGOGICAL ASPECTS)

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The problems of engineering education are presented in terms of modern philosophy. The importance of creative thinking in innovative activities is emphasized. The ways to develop creative skills of future engineers are discussed.

ENGINEERING EDUCATION AND ENGINEERING ACTIVITY IN RUSSIA: PROBLEMS AND SOLUTIONS

L.M. Ogorodova, the deputy of State Duma of the Federal Assembly of Russian Federation
V.M. Kress, the member of the Federal Council
Yu.P. Pokholkov, National Research
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The article analyzes the global challenges that influence Russian engineering education and industry. The information on current situation of engineering education and industry in Russia provided by the experts of the Russian Association for Engineering Education is presented. The authors suggest measures that can contribute to positive changes in Russian engineering education and industry.

ENGINEERING MASTER'S GRADUATES AS FUTURE MANAGERS IN NEW ECONOMY

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The article deals with the problems of engineering Master's Degree student training. It describes Masters' student managerial competencies, requirements for Master's student training, tasks and objectives of Master's Degree programs. The need of business and education interaction to improve engineering Master's student training is emphasized.

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DESIGN AND EVALUATION OF ENGINEERING EDUCATIONAL PROGRAM LEARNING OUTCOMES

A.I. Chuchalin, Ye.A. Muratova,
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The authors consider the design technology of engineering education programs (EEP) based on the upgraded ABET dual-level models. In its framework the proposals for the design and assessment of learning outcomes in compliance with international standards are made.

COMPETENCE-BASED APPROACH AND THIRD GENERATION FEDERAL STATE EDUCATIONAL STANDARDS

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The questions related to the introduction of Federal State Educational Standards of Higher Professional Education to the sphere of engineering training are considered in the article. The authors note the necessity of their improvement and, in particular, systematization of cultural competencies within the basic learning modules. Attention is drawn to the fact that in comparison with the second generation standards training hours in engineering Bachelor's programs have decreased.

BLOCK/MODULAR CURRICULUM – EFFECTIVE RESPONSE MECHANISM TO EMPLOYER'S CHANGING DEMANDS IN HIGHER ENGINEERING EDUCATION

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Effective training of specialists in different spheres of economics and social services can be provided by the implementation of such an education program which is focused not only on developing the competencies enlisted in the Federal State Educational Standard but also on constant revision of the content to match it with employer's changing demands. The basis of any education program is its curriculum. Traditional curricula can hardly provide students with possibility of following their own pathways which in its turn prevents them to meet the employer's changing needs. Unlike traditional one, block/modular curriculum allows students to build their study pathways like in "LEGO" constructor and at the same time to achieve the learning outcomes stated in the Federal State Educational Standard.

COMPETENCE-ORIENTED TEACHER TRAINING SYSTEM IN ENGINEERING UNIVERSITIES

M.G. Minin, E.N. Belomestnova,
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The article focuses on continuous development of teacher's pedagogical competencies within the current state of higher engineering education. The necessity to reform the existing teacher retraining system is stated. Competency-oriented and modular-based system is discussed. The experience in implementation of modular-based teacher retraining system is described.

TOWARDS THE IMPROVEMENT OF IT EDUCATIONAL PROGRAMS

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The article highlights inadequacy of IT educational programs with the industry requirements. Interaction patterns between Russian universities and the leading IT companies in order to revise IT educational programs are suggested.

SPECIALISTS TRAINING IN INNOVATIVE BUSINESS SAFETY ACCORDING TO NEWLY DEVELOPED DOCTRINE OF ENGINEERING EDUCATION IN RUSSIA

A.P. Sterkhov
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The article deals with the problems of safety insurance of innovative business in compliance with the new Doctrine of Engineering Education in Russia. The necessity of systematic knowledge in technical science, economy and law is underlined. Master's degree program in "Safety Management in Innovative Business" is considered to be the most preferable. The article highlights the basic problems and objectives in training the Master's degree students in "Safety Management in Innovative Business".

SPECIALIST TRAINING AND RETRAINING IN BUILDING RECONSTRUCTION

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The article deals with the main problems of modern construction quality as well as the quality of restoration and strengthening of buildings and constructions. It underlines the urgency to train and retrain engineers for building reconstruction. The study materials developed by the Department of Ferroconcrete and Stone Designs of TSUAB are presented. They provide a methodical basis for training highly qualified specialists for civil engineering.

REQUIREMENTS FOR STUDENT RESEARCH ACTIVITY IN ACCORDANCE WITH THE STATE EDUCATIONAL STANDARDS OF THE THIRD GENERATION

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in Yakutsk

According to the State educational standards of the third generation student's research work management should be focused on the development of both general and professional competences. However, student research skills are developed at the final stage of training, particularly, while preparing graduating paper.

THE ROLE AND PLACE OF THEORETICAL MECHANICS COURSE IN MODERN MECHANICAL ENGINEERING TRAINING

A.K. Tomilin
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The paper deals with organizational and methodological issues related to the current teaching of theoretical mechanics course. Attention is paid to the fundamental importance of this course. Learning methods and techniques are discussed.

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 embraces: 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 (30.06.2012) 78 EUR -AC E labels were awarded to 159 accredited education programs from 30 Russian universities; while in Kazakhastan, 34 education programs from 7 universities were awarded EUR - AC E label due to international AEER accreditation.

The following Register shows the successfully accredited education programs by AEER.

List of Accredited Programmes, Russian Federation (as of 31.12.2012)

	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
	Ivanovo State Power University				
1.	140404	INT	Nuclear Power Plants and Installations	AEER EUR-ACE®	2009-2014
2.	210106	INT	Industrial Electronics	AEER EUR-ACE®	2009-2014
	Irkutsk State 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
	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
	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
	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 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®	2010-2015
	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 Institute of Radio Engineering, Electronics and Automation (Technical University)				
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 EUR-ACE®	2005-2015 *
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®	2008-2013
9.	210104	INT	Microelectronics and Solid State Electronics	AEER EUR-ACE®	2005-2015 *
10.	200200	FCD	Optical Engineering	AEER EUR-ACE®	2010-2015
11.	210300	FCD	Radio Engineering	AEER EUR-ACE®	2010-2015
	Moscow Institute of Electronic Technology (Technical University)				
1.	210100	FCD	Electronics and Microelectronics	AEER	2003-2008
2.	230100	FCD	Computer Science	AEER	2003-2008
	National Research University of Electronic Technology (MIET)				
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®	2007-2012
4.	140609	INT	Electrical Equipment for Aircraft	AEER EUR-ACE®	2007-2012
5.	140611	INT	Insulators, Cables and Capacitors	AEER EUR-ACE®	2007-2012
6.	140403	INT	Technical Physics of Thermonuclear Reactors and Plasma Installations	AEER EUR-ACE®	2010-2015
	"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
	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®	2007-2012
20.	200203	INT	Opto-Electronic Equipment and Systems	AEER EUR-ACE®	2007-2012
21.	240304	INT	Chemical Engineering of Refractory Non-Metal and Silicate Materials	AEER EUR-ACE®	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®	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
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®	2012-2017
38.	240501	INT	Chemical Technology of Modern Power Engineering Materials	AEER EUR-ACE®	2012-2017

39.	140404	INT	Nuclear Power Plants and Installations	AEER EUR-ACE®	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	Equipment 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
	National Research University «Belgorod State University»				
1.	210400	FCD	Telecommunications	AEER EUR-ACE®	2012-2017
2.	210406	INT	Communication Networks and Switching Systems	AEER EUR-ACE®	2012-2017
3.	210602	INT	Nanomaterials	AEER EUR-ACE®	2012-2017
	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
	Novosibirsk State Technical University				
1.	150501	INT	Materials Science in Mechanical Engineering	AEER EUR-ACE®	2012-2017
	Samara State Aerospace University				
1.	160301	INT	Aircraft Engines and Power Plants	АИОР EUR-ACE®	2008-2013
2.	160802	INT	Spasecraft and Rocket Boosters	АИОР EUR-ACE®	2008-2013
	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
	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
	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
	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®	2009-2014

2.	150202	INT	Industrial Welding Technology and Equipment	AEER EUR-ACE®	2009-2014
3.	151002	INT	Mechanical engineering technology	AEER EUR-ACE®	2009-2014
	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	2007-2012
5.	190603	INT	Transport and technological machinery and equipment service (oil and gas production)	AEER	2007-2012
6.	190701	INT	Transportation organization and transport management (automobile transport)	AEER	2007-2012
7.	130602	INT	Oil and Gas Fields Machinery and Equipment	AEER EUR-ACE®	2008-2013
8.	150202	INT	Industrial Welding Technology and Equipment	AEER EUR-ACE®	2008-2011
9.	190205	INT	Lifting, Transportation Means and Road Machines	AEER EUR-ACE®	2008-2013
10.	240401	INT	Chemical Technology of Organic Substances	AEER EUR-ACE®	2009-2014
11.	240403	INT	Chemical Engineering of Natural Power Supplies and Carbon-base Materials	AEER EUR-ACE®	2009-2014
12.	240801	INT	Machines and Apparatus of Chemical Production	AEER EUR-ACE®	2009-2014
13.	280201	INT	Environmental control and rational use of natural resources	AEER EUR-ACE®	2010-2015
14.	280102	INT	Safety of technological processes and productions	AEER EUR-ACE®	2010-2015
15.	120302	INT	Land cadastre	AEER EUR-ACE®	2010-2015
	Ural State Forest Engineering University				
1.	270205	INT	Automobile Roads and Aerodromes	AEER	2006-2011
	Ural State Technical University				
1.	240302	INT	Technology of Electrochemical Productions	AEER EUR-ACE®	2008-2013
	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®	2007-2012
2.	130603	INT	Oil and Gas Processing Equipment	AEER EUR-ACE®	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®	2008-2013
6.	130602	INT	Oil and Gas Fields Machinery and Equipment	AEER EUR-ACE®	2008-2013
7.	130501	INT	Design, Construction and Operation of Gas and Oil Pipelines and Storage Facilities	AEER EUR-ACE®	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
	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

List of Accredited Programs, Republic of Kazakhstan
(as of 31.12.2012)

	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
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

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