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Editorial board

DEAR READERS

This time we would like to present you an issue of our journal «Engineering Education» dedicated to cooperation opportunities between universities and industry for developing competences of future engineers within the training process.

Level of training of today's graduates with higher education in engineering and technology depends on many factors, ranging from the quality of university entrants to interior of university classrooms. Without pretending to make completely full list of such factors, it should be noted that this list should obviously include level of ongoing research at the departments, current state of laboratory equipment for scientific and educational needs, quality of ongoing educational programs, quality of teaching materials, selected educational technologies and, of course, the level and quality of the teaching staff. All these (and other) factors influence the development of general, professional and personal competencies of graduates. In the foreword to the last issue of our journal «Engineering education» (№ 7) it was noted that the state of engineering education in Russia, according to majority of experts of the Association for Engineering Education of Russia, cannot be considered as satisfactory. At the same time, assessing the level of training of engineers in Russia, most of almost the same experts estimated this level as satisfactory. One reason for this apparent contradiction is the difference in views about the objectives, content and forms of engineering training of those who train engineers and those who use the results of their work (employers, society, state). The main goal of those who are engaged in training of students for engineering is still (in informal terms) to a greater degree just «filling of a vessel» and to a lesser degree - «kindling of a flame». In other words, they think students need to be given more knowledge by using as usual mostly passive teaching methods, and, of course, then test the level of acquired knowledge. We do this faithfully they say; therefore, the level of training of engineers can be estimated at least as satisfactory. Moreover, employers also used to acknowledge satisfactory level, despite the fact that the university graduates in the field of engineering had to be retrained for one or two years. Sometimes, and it is a well-known fact, many university graduates could hear «Forget everything you've been taught, we will teach you here how to work.» Those who today require the results of engineers work look forward to getting trained professionals, coming to industry and into real life, and able to solve real technological, operational and managerial problems. They also expect from them new engineering solutions ensuring a strong competitiveness position in global markets. And such goals could be reached only by those who were trained by «kindling of a flame» and not just «filling of a vessel». Training at such quality level is possible when a university does not focus only on developing competencies of future specialists (knowledge, skills and abilities, allowing them to apply well- known algorithms), but also provide conditions for development and at least a pilot test of competence. Competence in this case means an ability of trained professionals to apply their competencies to solve real problems and above all for creativity and innovations. Probably creation of such or similar conditions at universities could be realized by interaction between university and industry. Moreover, the term «industry» is used here in a broad sense and refers to a place of employment of future specialist including an engineering company, a plant, research institution or a small enterprise. There are different possible forms of suchcooperation: inviting an experienced expert to give a lecture or an industry representative for discussion on one of the industrial problems with students, establishing industry-based departments and arranging practical training at world's leading enterprises. One of the important aspects in this kind of partnership on is using modern industry facilities for training. It especially refers to cumbersome, expensive and unique equipment. Today, different forms of interaction are used by industry and Russian universities that train specialists in the field of engineering, which significantly expand the ways and possibilities of development necessary skills and competence.

While reading this issue of «Engineering Education» you can find out our authors' opinions on modern requirements to the level of training of engineers, the forms of interaction between universities and industry, ways to develop competencies and competence of future engineers within the training process with industry assistance. The authors of proposed articles are not only academy representatives, but industry representatives as well, who have a successful experience in cooperation between universities and industry for developing necessary competencies of future professionals, therefore, sharing good practices could be interesting and be useful for the development of engineering education in Russia.

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

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St. Petersburg State Electrotechnical University «LETI»
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The establishment and development of partner relationships between universities and enterprises is a very important task amid the developing economy of knowledge. It involves creating a net of organizations that are interested in mutually beneficial cooperation in the spheres of staff training, logistical support of educational process, production process improvement, joint research and development and etc. To make these activities the most efficient it is necessary to find the way of cooperation «university – enterprise» on the base of mutual interests and benefits. The article shows the experience of St. Petersburg State Electrotechnical University «LETI» in development and implementation of the program of strategic partnership «university – enterprise» aimed at development of engineering education.

Key words: *Engineering Education, Strategic Partnership, Industrial Enterprises, Labor Market Analysis.*

Due to the development of market economy in Russia the universities' task in staff training became wider and more complicated. Fulfilling the state order for staff training at the expense of the federal funds the universities have to take into account needs and particular qualities of regional and local labour markets, which make hard and controversial demands to the fresh specialists. Universities need to train highly qualified staff both for large federal state unitary enterprises and for small and medium enterprises of different types of ownership that consume more and more graduates. Universities should also take care about graduates' employment, their social protection and their fast adjustment to the employer's demands. Eventually it adds to the competitiveness of a university on the educational service market.

The formation of partner relationships the labour market is one of the most important tasks of universities amid the developing economy of knowledge. It involves creating a net of organizations that are interested in mutually beneficial cooperation in the spheres of staff training, logistical support of educational process, production process improvement, joint research and development and etc. To make these activities the most efficient it is necessary to find the way of cooperation «university – enterprise» based on mutual interests and benefits.

It has been said for years that universities should train specialists that are in demand for real economy. However, generally the higher education system still offers academic but not applied education. The universities trying for training applied specialists can't satisfy the growing demand of large enterprises for high professional level of staff. It should be noted that no one can blame only universities as they have mostly outdated laboratory and production equipment which makes training in modern technologies impossible. Nowadays technical base of universities, as a rule, significantly falls behind that of enterprises. Besides, though the Russian higher education is fundamental, it has a very weak link –the feedback of the consumers that is enterprises.

Strategic partnership of universities and enterprises is the demand of time. Mutual interest in higher level of graduates' training, including the quality of special training, encourages stakeholders to establish long-term partnership. Consumers of graduates are ready to invest in the system of higher education in order to have highly qualified specialists oriented towards technological features of a particular production or enterprise. Investing into the development of specialized universities, the strategic partners have the right to participate in the social governing body of a university, to assess the quality of graduates and teachers competence, to analyze the content of academic programs and curricula and to assess the level and relevance of scientific researches. Due to such partnership the education programs, which are developed and implemented by universities, can be really oriented towards the contemporary labour market.

Long-term partnership «university – enterprise» can involve different interaction models. There are some of them: target training, retraining for in-demanded specialties, and the implementation of technical, research and production tasks with participation of leading university specialists and students. It can also include joint development of standards and programs in vocational education and retraining that can meet the demand both of the contemporary economy and perspective directions of development. Nevertheless, every particular partnership agreement should be made on the basis of mutual interests creating a complex program of dipole interaction «university – enterprise» that can be changed if environment changes.

The polytechnic universities in big industrial cities that train graduates for several industrial branches should choose their partners basing on the main (prior for the university) scientific and educational directions.

This statement becomes obvious, if we admit the fact that the main university output is trained specialists. Their quality is determined by the level of scientific research conducted by the corresponding departments and faculties. The system of strategic partners gives the possibility to reconstruct the lost feedback of graduates' consumers, which is necessary for further development of vocational education to the benefits of the national economy.

The implementation of participatory form of quality management in student training in main scientific and educational directions can mean establishing of expert- analytical councils. They should be formed as independent collegial bodies under the jurisdiction of a university and should mostly consist of representatives of industry, academic and applied science who are strategic partners of the university. Such expert councils are reliable link of universities and education authorities with real economy. They can monitor particular labour and educational market segment. It provides quick and effective adjustment to changing demand by correcting special professional training part of the curriculum, which makes possible to be ahead of time in training the staff for high-tech industries.

The program «Strategic partnership», which has been implemented in St. Petersburg State Electrotechnical University «LETI» since 2005, is unique in terms of its status and tasks to solve. Its goal is to ensure high quality of professional training of specialists on basis of complex collaboration of the university and enterprises in interest – strategic partners, by joining together intellectual, material, financial and corporative resources of the partners.

The basic objects of the program «Strategic partnership» are:

- Forecast of labour market needs and employment of graduates.
- Joint development of the educational programs content and their informational, methodological and logistical support.
- Joint implementation and resource support of educational programs, technological and pre-graduation practical training.
- Qualification standards development.
- Quality assessments of educational programs and graduates.
- Activities of the expert councils in scientific spheres of «LETI».
- Encouragement of students' participation in real project and research activities. The implementation of the educational technology «study through research projects» while training practice-oriented specialists.
- Conducting research and development, new technology implementation and product release.
- Training and work experience of the university teaching staff on the basis of the partner enterprises, joint training of highly qualified staff.
- Development of strategic partnership infrastructure, establishment of joint scientific and educational centers, laboratories, basic departments and centers of collective use.
- Development and testing of effective ways of university-enterprise interaction.
- Conducting joint conferences and seminars for students, post-graduates and young scientists.
- Participation in collective management bodies of the partner enterprises. Formation of collective expert and advisory body to coordinate university-enterprise interaction.

The collaboration is based on long-term agreements and complex projects that cover educational, scientific and innovative spheres, and is implemented through the following:

- Conducting joint scientific researches
- Establishing joint educational and scientific structures
- Holding joint scientific and technical conferences and seminars in prior scientific spheres.
- Organizing practice and diploma project of students in a partner-enterprise.
- Target training of specialists by order of the partner-enterprise.
- Joint formation of educational programs and curricula.
- Use of the enterprise staff in teaching process.
- Post-graduate study of the enterprise staff in university.
- Retraining and training of the enterprise staff on the basis of university.

All the stages and forms of the collaboration are determined by certain contracts and agreements.

Nowadays the University has more than 40 strategic partners that consume the graduates, educational services, and research and development products. Among them there are scientific and project organizations, high-tech enterprises and defense industry. Since 2002 «LETI» has been the base for the research and practice conference «Planning and ensuring of staff training for the industrial and economic complex of the region», which is supported by the Russian Ministry of Education and Science, Union of Industrialists and Entrepreneurs and St. Petersburg Administration. The university specialists have developed documents «Regulatory and Methodical Support of Strategic Partnership» that are recommended to be implemented in the universities of the country. They are published in scientific and methodological issue «Innovative activity» by Russian Ministry of Education and Science.

The administrative body of the program is the Center of strategic partnership and innovations which has the executive functions.

«LETI» is an active member of Association of electronic, engineering and info and telecommunication enterprises (The president is the general director of OJS «Avangard» Shubarev V.A.). On its basis in 2008 «LETI» and the partner enterprises initiated the establishment of Regional Council on interaction of universities with enterprises of electronics, engineering, means of communication and info and telecommunication in St. Petersburg. It started with the agreement between the Association with the St. Petersburg Council of rectors approved by Rosobrazovaniye and Minpromtorg of the Russian Federation. The main task of the Regional Council, which consists of the heads of 8 leading technical universities, 2 vocational education colleges and 14 enterprises of St. Petersburg, is to coordinate, plan and ensure the quality training of the staff for the industrial and economic complex of the region.

Another important result of the system interaction of universities and enterprises is the establishment of the scientific and educational consortium of higher education and intermediate vocational education institutions, high-tech enterprises and scientific and project organizations of St' Petersburg «Corporative institute of scientific research and continuing education in the sphere of electronics, engineering, communication means and info and telecommunications.»

Local analysis of labour market demands is very important for the effective employment of the graduates. Therefore, the results of the research made at the university in 2010 seem to be interesting. The aim of the research was to analyze the demand in the «LETI» graduates among the high-tech enterprises of St. Petersburg and their willingness to collaborate with the university.

52 city enterprises took part in the research. 12% of the enterprises work in the sphere of shipbuilding, 23% radio engineering, 21% electronics, 17% electrical engineering, 31% IT, 40% engineering, 12% power engineering, 4% medicine and microbiology, 17% other. It should be noted that the enterprises could position themselves in several spheres. The direct respondents were the heads of the enterprises.

The sampling of the enterprises according to the number of the staff was the following: more than 27 % of the enterprises have 1000 employees, 21% - from 500 to 1000, 31% - up to 500 people, 11% - less than 100 people, and 10% - no data.

The survey results show that high-tech enterprises of the city need the specialists trained by «LETI» and are ready to employ them for vacant positions of all the specialized directions. The qualitative characteristics of the demand in the university graduates in different scientific spheres are presented in Table 1.

Another important issue was to define the satisfaction level of the employers by the quality of the graduates. As the survey results showed, 92% of the employers have «LETI» graduates of the last 5 years in their staff. Three- quarter of all the enterprises are satisfied with the training level of the university graduates, including completely satisfied are 19%, rather satisfied are 56%, partly satisfied – 19%, rather unsatisfied or completely unsatisfied - 0% (6% of the respondent didn't answer the question).

It was natural for us to find out the weak points in the student training in the university. Thus the enterprises were asked the following question: «What don't you like about the training level of the «LETI» graduates?». The answers to the question are shown in Table 2.

Besides, 19% of the respondents showed the lack of the target training for their enterprises as the disadvantage of the university training. The conclusion is the enterprises showed as drawbacks the insufficient practical training (56%), and insufficient work experience (40%), which means the necessity to develop a practical component of the educational process in university.

The research also showed the possibilities offered to the graduates by the enterprises. These offers are the following: interesting occupational work (98%), high salary (56%), wage supplement (social package) (75%), work with modern technologies and equipment (69%), training (83%), career prospects (85%). It allows us to say that generally the enterprises are ready to make beneficial employment offers to the graduates, to supply them with interesting work, career prospects and training. However, only slightly more than half of the enterprises (56%) are ready to pay good salary.

Not less important problem of the research was the enterprises' assessment of their interaction with «LETI» in the sphere of research and development. All the enterprises make research and development in the directions which are fundamental for the university. But only 55% of them collaborate with the university. ¾ of the total number of the enterprises collaborating with the university is satisfied with such interaction. More than a half (56%) of the enterprises considers the results of the researches and developments conducted by the university to be better than that of other organizations.

It was especially interesting to research the willingness of the city enterprises to collaborate with «LETI». The survey showed the following:

- More than 80% of the enterprises are ready to take part in practice, training and graduation projects arranged on the enterprises.
- 33% of the enterprises are ready to participate in special training, but not all of them are ready to pay for such training.
- 43% of the enterprises are ready to order graduates from the university in the frame of special state-financed admission.
- 31% of the enterprises would like to have their staff been trained in the university but only half of them are ready to pay for this service.
- Almost half of the enterprises (46%) are ready to employ the students for a part-time job and 12% are ready to pay scholarship to the students who are going to work for these enterprises in future.
- A half of the enterprises are willing to make joint scientific and research work. 23% of the enterprises consider the joint monitoring of new scientific research results and expanding the scope of their application to be prospective forms of mutually beneficial collaboration of the enterprises and the university.

The program «Strategic partnership» and the experience in interacting with employers formed the basis of innovative education program of «LETI» «Specialist training for prior high-tech branches of innovative economy of the country», which was implemented in 2007-2008 in the frame of national program «Education». More than 50 scientific and educational centers and laboratories, which were established and equipped in the frame of the program, allowed the university to increase its competitiveness and appeal on the market of

Table 1. Demand of the university graduates

Scientific and Technical sphere	Demand in specialist, %	Prefer «LETI» graduates, %
Radio engineering	35	37
Telecommunication	27	27
Electronics and microelectronics	40	38
IT	35	33
Power engineering and electrical engineering	48	25
Automation and management system	23	50
Engineering and information and measurement technology	33	33

scientific and engineering products and educational service and to arrange the education process and development of scientific products in cooperation with the strategic partners.

Nowadays the main directions of LETI-enterprises integration have been formed. These are the implementation of basic and additional training programs, special training including highly qualified staff, and coordinated staff policy. The university has positive experience in involving strategic partners into training the staff of the university departments they are interested in. It is highly qualified teaching staff. Strategic partnership not always starts with the interest in graduates. There are a lot of examples of long-term joint collaboration in new technology development and production modernization. The necessity in personnel support of the upgraded technology or modernized products arises for the enterprise only at the implementation stage. It leads to the need of joint educational centers that gradually become basic departments and long- term programs of special personnel training for a particular group of enterprises are formed. Such model of personnel support of new technologies is at work in LETI for a number of enterprises.

Going back to the problem of system approach to the arrangement of university-enterprise interaction it is necessary to note that the Regional Council on the interaction between universities and enterprises of electronic industry has been working for 5 years. The council has executive management. A lot of experiments in special training including the legal aspect of graduate assignment were discussed at the Council meetings. One of the problems was how to assign a future graduate to the chosen enterprise. The following way out was suggested: enterprises hired fifth (sometimes forth-)-year students as part-time employees and sent them to the specially designed training programs in the university. These programs are additional to the standard education university program. This is the way the university work with «Concern CSRI Electropribor», JSC, Research Institute «Vector» JSC, Research and Production Enterprise «Radar MMS», «Avangard» JSC and other. A student and an enterprise sign a contract that determines the working period of the student for the enterprise after his/her graduation and 1.5 -2 –year special training course as well as penal sanctions, which have never been applied yet.

The development of specially designed training programs of staff becomes more important in connection with new two-level education system. The second level of training will be considerably determined and financed by particular enterprises and corporations. That is why the development and implementation of possible forms and methods of personnel training with the participation of consumers is the topical issue nowadays.

Table 2. Graduate training deficiencies

The reasons for the enterprises to be unsatisfied	%
Theoretical training	21
Practical training	56
Computer skills	6
Foreign language acquisition	21
Business knowledge	6
Management skills	15
Teamwork skills	21
Communication skills	10
Insufficient work experience	40

Talking about strategic partnership one cannot forget about the university innovative infrastructure that includes innovative technological centers, business incubators, technoparks and centers for technology transferring and commercializing. All these units form the so-called university education-scientific and innovative complex (ESIC). In LETI there is a three-sphere model of ESIC. The core of the ESIC consists of educational, scientific and innovative blocks of the university. The close innovative belt involves small enterprises of the technopark and technologic innovative Center, which are closely connected with the university, being established by it. There is also a far innovative belt – the enterprises, which are strategic partners of the university. They have contractual partnership relations with the university.

Some years ago LETI initiated the establishment of expert councils on main scientific and educational directions. These councils mostly consist of the employers' representatives. Being interested in the university education quality as well as in the personnel quality, they willingly assess the quality of educational programs and students' competence. To implement it a methodical basis was created, a lot of bumps were raised in this sphere and now the university is ready to share its experience both positive and negative. On the basis of LETI there is an annual scientific and practical conference «Planning and implementation of personnel training for industrial complex of the region» established to discuss topical issues of the development of specially designed personnel training and employers' participation in assessment of graduates' quality etc.

A dipole model of university-enterprise interaction is being implemented nowadays in different forms but it is a passed stage when a separate university interacts with a separate enterprise. Today's aim is to establish a net interaction. It is necessary to create a regional communicative media with universities, colleges and technical schools on one side and the enterprises which make scientific and production complex of the region. Talking about industrial and economic cluster it is necessary to note that any competitive cluster consisting of high-tech enterprises and engineering companies can't develop without quality personnel supply and scientific support. That is why education and science sustaining industry is the basis for innovative clusters. Complex multilinked clusters such as shipbuilding, which is rapidly developing in the city, or electronics, which is catching up for the lost time, need net interaction. One university or one enterprise will never be successful in these spheres.

In 2007 the program «Strategic partnership» implemented by LETI was awarded by St. Petersburg government.

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Corporate Chair in the System of Higher Vocational Education

Don State Technical University
B.Ch. Meskhi, N.N. Shumskaya

The article examines the questions of the integration of industrial enterprises and higher education institutions to provide bachelor-engineer training in accordance with the modern tendencies in domestic and foreign education systems and employer's requirements.

Key words: *corporate department, corporate department, professional competence.*

B.Ch. Meskhi

N.N. Shumskaya

Today one of the strategic objectives of the Don State Technical University (DSTU) is the transition from traditional to modern and advanced training models. The main internal causes of poor development of innovation in higher education are the «weak links that universities have with industry, economy and social sphere of the regions, and as a consequence, the lack of information on the needs of the market» [1]. On the other hand, attempts of business to train specialists on their own by establishing their own training centers without universities assistance have not given desirable results. The area of « university – industry « partnership can be defined based on the specific features of partners:

One can conclude that: companies tend to more rapid success in the market and are willing to cooperate with universities to establish contacts with

University specific characteristics:

- production of knowledge;
- onopoly in issuing professional qualification certificate;
- training of researchers and university teachers;
- medium- and long-term foresight.

University-Industry fields of interaction:

- Professionalization of young specialists with higher education;
- Teacher training in the practical context of industry, market economy and new technologies;
- Transfer of the fundamental and applied research results;
- Continuing education of managers and professionals.

Industry specific characteristics:

- generating added value and profit through managementd of human resources, equipment and materials:
- Controlling (a complex system of management of the organization, aimed at coordinating the interaction of systems management and monitoring of their effectiveness);
- short-term foresight.

prospective employees. In addition, they are interested in obtaining specialized knowledge in a particular field of products and processes. Universities are focused on longer-term perspective, interested in innovative methods of teaching and research, but in general there is a lack entrepreneurial spirit development at universities, as it is not foreseen at their structural units.

From these considerations the following should be emphasized:

- cooperation between universities and industry is essential and mutually beneficial for both sides. Regular dialogues should become a basic form of such cooperation;
- dialogue participants often do not understand each other because of differences in their corporate culture;
- to keep competitive positions companies require quick decisions and solutions and universities are generally not ready for that.

From our point of view, today one of the most acceptable ways to solve all above mentioned problems could be establishment of corporate departments and faculties [2]. Actually this idea is not new, such term as basic (industry-based) departments already existed in the Soviet education system. Development of corporate departments allows students to form a specific set of professional competencies, to accelerate the adaptation of graduates to the corporate culture, to bring them up to a certain professional level, and moreover it allows to systemize educational processes. By joint efforts we «tighten the theoretical screw» of future professionals to the real needs of modern industry. At the same time, scientific and educational capacity of the university allows to provide retraining for the employees of enterprises, to teach them modern information technologies to solve problems together in order to increase production efficiency.

The list of key driving forces in cooperation between universities and industry includes the following:

- staffing, knowledge and technology transfer;
- joint designing of educational programs and professional training courses for the labor market needs;
- development of joint officially established platforms (technology parks, technology transfer centers, centers of lifelong learning) in order to encourage knowledge and technology transfer.

Currently, in the absence of the regulatory framework for corporate chairs in the partnership «university-industry» with no intermediates represented by scientific departments we face with a number of problems that require legislative solution. Don State Technical University as a historically (in 2010 we DSTU celebrated its 80 anniversary in 2010) leading technical university with a unique set of training courses in mechanical engineering, today continues its development based on the traditions engineering training for industry, achievements in advanced knowledge, technologies and IT in the field of engineering.

As a part of the university program «Strategic resource for mechanical engineering cluster» a special way of interaction between university and its partner-companies was introduced. It is so-called «DSTU recipe» aimed at solving all the above mentioned problems. Its main goal is the development of engineers training system in Rostov region with joint efforts of higher education, science and professional labor market. The implementation mechanism is to sign long-term strategic partnership agreement in the field of education and research including, among other things, the establishment of joint scientific and educational structures and innovative profiles. For the moment there is a corporate «Oil and gas industry faculty» at DSTU with four departments in it and five more corporate departments in other faculties. This are the departments of «Industrial Metrology», «Transportation Engineering», «Aircraft building», «Technology and equipment of processing agricultural products», «Automobile industry». The reason for establishing the last corporate departure based at media group «Yuzhnyi Region» (Sothern Region)

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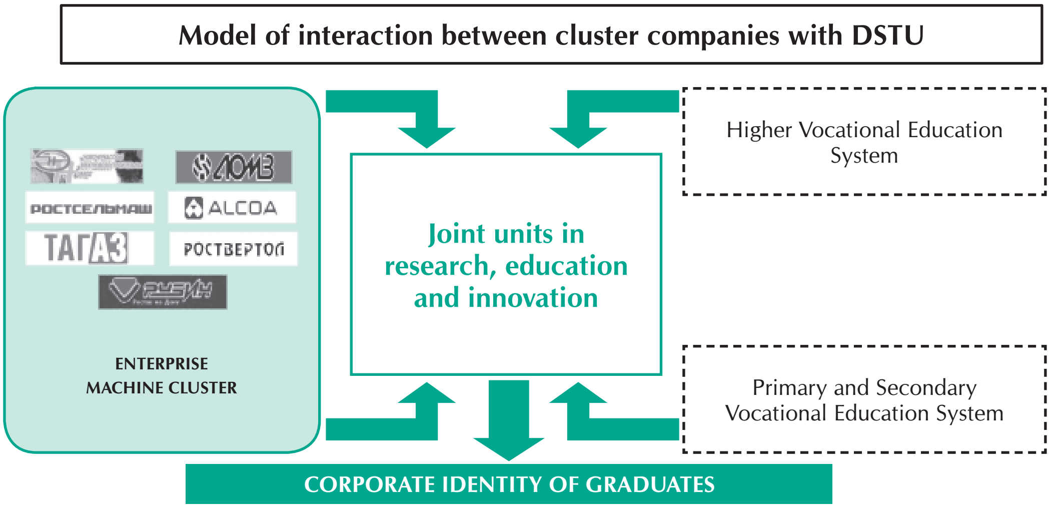
Fig. 1. Model of interaction between partner companies of the mechanical engineering cluster of Rostov region with DSTU.



at the Faculty of Computer Science was an urgent need and demand from the regional media industry in professions – cross-disciplinary experts in journalism and engineering and technology. Thus, the positive experience of departments related to the mechanical engineering cluster has expanded mutually beneficial cooperation of the university and other regional business partners. The main goals and objectives of corporate departments activities at DSTU are: improvement of the educational process by strengthening relationships with leading companies, business community, social structures and attracting highly qualified teachers-practitioners, organization and implementation of innovative educational technologies (work-based learning) at partner companies, development of research activities, foundation of small innovative educational and research enterprises, systematic work in the field of vocational guidance for students. Heads of corporate departments are the leaders of such companies as OAO Rostvertol (OJSK) , Research and production company Novocherkassk Electrovozostoitelnyi zavod (Novocherkassk Electric Locomotive Plant) «(LLC RPC «NEVZ»), Taganrog automobile plant, Federal State Unitary Enterprise Rostov Center of Standardization, Metrology and Certification and others. Educational programs in research areas presented at departments are developed and implemented with the participation of leading experts of enterprises, who also become co-supervisors of students' graduation thesis and their field trips. Defense of a graduation project takes place at enterprises with their managers and employees and faculty of corporate departments of the university. Projects are carried out on the real data of the partner-companies of corporate departments, aimed at solving real problems and can be recommended for implementation to the business management. All graduates who have expressed their wish to continue working at the partner-companies are employed. One of the most popular and prospective ways to develop the established regional cluster could be foundation of training and retraining centers for the employees of enterprises working in the field of engineering and technology, as well as for university teachers and training centers of enterprises and their certification. The basis for the establishment of such regional center has become the South Centre of professional qualifications and engineering innovation DSTU with the status of non-profit partnership. To meet the requirements of our partner company LLC RPC NEVZ the faculty of DSTU developed and implemented training programs for engineers and technicians of the company in such fields as press - forging production, foundry engineering, technology and equipment for welding engineering. In 2011, 57 employees were successfully retrained on these programs. At the same time, university students were trained in a real factory conditions at Corporate Training Centre of LLC RPC NEVZ on the program of initial vocational education and got involved in the courses for those trades, which were in highly demand in transport engineering. In the transition to the tiered education system the existence of such centers will create not only a regional system of continuing professional education, but also personnel certification. This model of vertical and horizontal integration of providers of professional educational services at different levels and their customers is a universal adaptive model to meet the changes taking place in the region's economic policy and the labor market through a range of basic educational programs, retraining programs and skills development, providing continuity and personal focus of education, as well as the mutual interest of all participants and consistency of an overall process of continuing professional education.

In addition, in order to promote products and services of our business partners, as well as providing them with real help in the modernization of their production, introduction of new techniques and technologies university-based information portal Made-in-Rostov.ru was created. Students take an active part in developing database of the portal and communicate directly with partner companies through corporate departments. Good practice of our university in development and implementation of corporate training confirms that this kind of partnership is beneficial for both universities and industry.

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Multilevel Innovative Scientific and Educational Complex: Integration of Science, Education and Business

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The authors examine the performance of multilevel innovative scientific and educational center as a good example of professional education modernization that is based on effective interaction between educational establishments, scientific and business organizations.

Key words: *multi-level educational complex, integration of education, improvement of vocational education system.*

V.B. Moiseev

N.V. Kozlova

The strategic objective of Russia within the Concept of Long-Term Socio-Economic Development of the Russian Federation for the period up to the year 2020 is defined as follows: «to achieve economic and social sustainable development ensuring the status of Russia as a leading country in the world in XXI century, which is competitive on the global economic level, defends national interests and safeguards the exercise of constitutional rights» [1]. More precisely, the given strategy employs professional education as a key point where, however, it is necessary to solve a number of problems:

- to provide innovations in undergraduate higher education;
- to modernize educational institutions as a tool for social development;
- to develop up-to-date continuing education system including professional learning and advanced training;
- to assess quality and demand for the education in compliance with customer's requirements.

The solution of the above-mentioned problems will provide a key resource for innovative economy – human capital characterized by a unique combination of creative thinking skills and highly professional and social competencies. To achieve this goal, it is necessary to reform professional education through the integration of science, education and business.

Such integration must be beneficial to all concerned. It ensures that, for example, workers, technicians and engineers are trained in the same methodology and learning environment; enables an employer to develop quality standards for professional education; contributes to the development of research resources and knowledge base which can be applied in scientific work and experiments to increase the competitive ability of enterprises.

Besides, the cooperation with educational complex will enable enterprises to increase their operational, economic, social and research efficiency. Specifically, operational efficiency can be achieved through a target training of specialists for definite working positions ranging from a factory worker to a top manager in different professional spheres. Social outcomes can be achieved through the increase of specialist training programs to meet the high-demand of economy for essential education services. The economic impact will result from the reduction of HR costs of regional enterprises. Cooperation in scientific research will allow implementing various industrial projects, including development and promotion of new technologies, competitive science-based manufacturing, implementation of information systems in goods design and business management.

It must be noted that the necessity of integration is caused by a number of external factors [2]. First of all, keeping track of in-demand specialists at different levels is impossible without the assistance of potential employers. Secondly, technology research facilities of educational establishments must be enhanced to meet the level of present-day enterprises' equipment and machinery. Thirdly, the training of modern specialist requires a continuous adjustment and improvement of educational programs, as well as broadening the spectrum of educational activities.

Having considered all the above-mentioned factors, a multilevel educational institution combining international experience and the best national traditions in training engineers was established in Penza region.

Penza State Technological Academy (PSTA) was established as the result of merging Technological Institute, Chemical Engineering College, Industrial Technology College and Vocational school. It provides training of highly qualified, competitive and career-focused specialists who are capable of performing their work effectively and adjusting to rapidly changing professional and social environment.

Despite the change of status, PSTA, however, has preserved partnership relationship with the enterprises which have a long history of cooperation with all institutions of educational complex. Due to perfect work coordination between different educational establishments and personnel departments of these partner enterprises, it is possible to provide target training of specialists. A complex offers a broad range of educational programs designed in accordance with the local development strategy and demand for specialists in various spheres.

Above all, PSTA has launched a multi-level education enabling it to provide continuous professional training of in-demand specialists in such spheres as mechanical and instrument-making engineering, information technologies, food industry, and chemical engineering (Table 1).

The educational programs of Research and Production Association, Vocational Education Institutions and Higher Professional Establishments do not duplicate, but complement each other. Thus, the continuity of education is achieved, which in its turn contributes, on the one hand, to the reduction of specialist training period and, on the other hand, to the enhancement of young specialist qualification. The peculiarity of education the Academy provides is that PSTA has preserved the best national traditions in engineering training: combination of professional education and work practice allows PSTA to train specialists who have profound theoretical knowledge and extensive work experience. Starting with the fourth year of education (full-time tuition) and the second year of education (part-time tuition), students work in the enterprises in accordance with their specialty. It allows them to solidify their theoretical knowledge and gain required work experience [3].

Such educational pattern forms the basis for the innovative project named «Specialist-Enterprise» which makes possible to provide both succes-

Table 1. PSTA Education Levels for Mechanical and Instrument-Making Engineering, Information Technologies, Food Industry, and Chemical Engineering

Levels	Higher Professional Education	Intermediate Vocational Education	Elementary Vocational Education
150000 Metallurgy, Mechanical and Instrument-Making Engineering	151900 Design-Engineering Support of Mechanical Manufactures 151000 Production Machines and Equipment	151901 Machine-Building Technology	151902.03 Machine Operator (metalworking production) 151022.01 Commercial Refrigerating Machinery Electrician
230000 Information Science and Computing Engineering	230100 Information Science and Computing Engineering 230400 Information Systems and Technologies 230700 Applied Information Science 230111 Computer Network	230113 Computer Systems and Complexes	230103.01 Computer Operator
240000 Chemical Engineering and Biotechnology	240700 Biotechnology	240134 Oil and Gas Processing 240705 Biochemical Manufacture	240100.02 Ecologist-technician 240101.02 Pump and Compressor Operator 240705.01 Equipment Operator in Biotechnology
260000 Food and Consumer Product Technology	260800 Product Technology and Catering Arrangement 260100 Vegetable-Based Foods	260103 Baking and Alimentary Product Technology 260107 Zymurgy and wine industry 260201 Dairy Engineering 260202 Meat Product Technology	260103.01 Baker 260103.02 Bulk Storage Unit Operator 260103.03 Automatic Line Operator (macaroni production) 260103.04 Baker-master 260107.01 Brewer 260201.01 Dairy product Operator

sive and parallel professional training of specialists due to the integration of institutions of elementary and intermediate vocational education, as well as the establishments of higher professional education and post-graduate study. It also allows educational establishments to offer Bachelor's and Master's Degree Programs, as well as programs of further professional education.

Besides, as learning activities applied in educational process are based on the definite technological issues, a student of PSTA has a possibility to get familiar with manufacturing process during the study period. An employer in its turn can hire the applicants with the higher qualification and better professional skills. Such cooperation contributes significantly to the quality enhancement of specialist training due to the thorough consideration of enterprise technological process, i.e. applied technologies, various research and manufacturing problems.

Another important point is that it is essential to organize career orientation activities for secondary school students. The «SCHOOL-UNIVERSITY-ENTERPRISE» project of PSTA involves the organization of profession-oriented classes in state secondary schools in accordance with the in-demand professions and it aims at arousing pupils' interest in engineering and technological sciences. The project is also realized with the assistance of partner enterprises which provide schools with all the facilities necessary in preliminary career oriented training and elementary vocational education. At the present time, PSTA is successfully involved in joint programs with Penza Education Authority and such leading enterprises as OJSC «Biosintez», JSC «Tyazhpromarmtura», OJSC «Elektropribor», «Dizelmash» and etc.

To provide programs of further professional education, Advanced Training and Professional Development Faculty, Center for Pre-University Education and Center for Extended Learning «Tekhnika» have been established in PSTA.

Thus, PSTA is a unique multilevel educational platform offering affordable, flexible, continuing, and quality academic opportunities (Fig. 1).

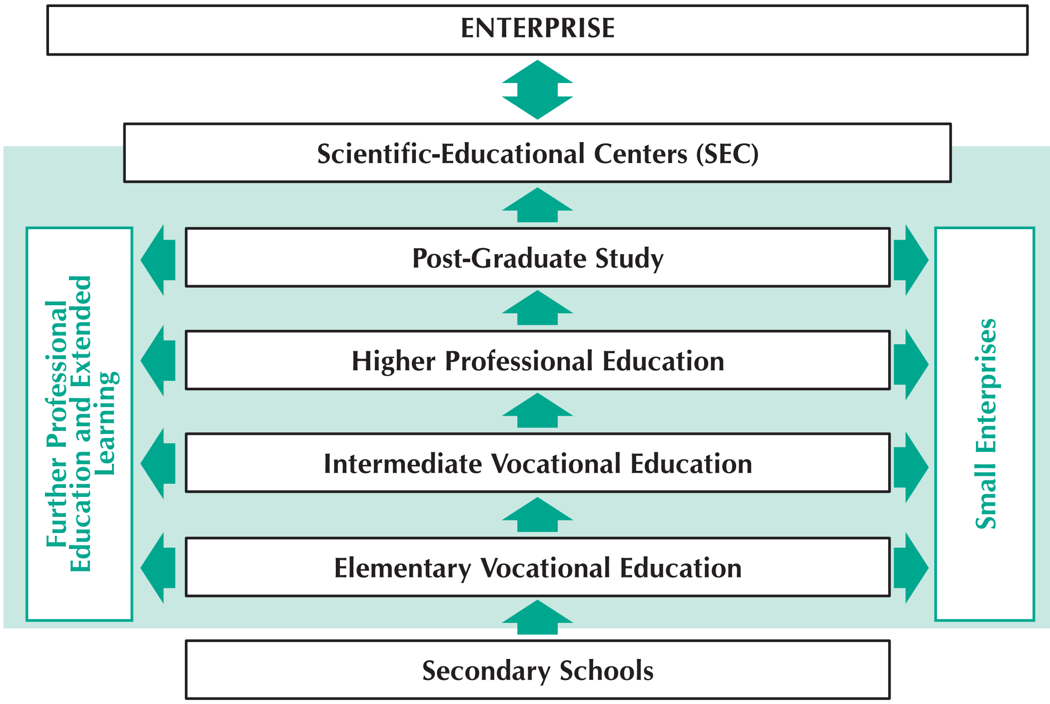
It has been proven that this three-way partnership is an effective strategy for training scientific, technological and managerial community [5]. Special educational agreement between higher educational establishment and enterprise allows students to get easily started without any adaptation period. In this case, their professional skills and knowledge are evaluated by chief engineers and supervisors of the company concerned. It is no coincidence that PSTA is a winner of All-Russian Competition «Quality Assurance Systems for Specialist Training», while its students annually become prize winners of the competition «National Asset of Russia».

Such results have been achieved because of PSTA educational system itself which combines learning process, internship with working activity. As PSTA professors who are at the same time managers of research contracts are familiar with the technological peculiarities of partner-enterprises, it makes possible to train specialists for the real economy. Thus, it can be stated that in a case of educational complex, scientific work is no less important than the learning process itself. The main objectives of the Academy are to ensure qualitative improvements and advancement in research and learning activities, to develop scientific database, to provide the Academy units with all the facilities required for scientific work, and to establish the platform for innovation and research.

Therefore, new forms of scientific management were developed. In accordance with Federal Law №217-FZ of the Russian Federation dated August 2, 2009, five new business companies and fourteen scientific-educational centers have been established for implementation of intellectual activity results.

The enterprise technological problems database which could stir knowledge-intensive manufacturing in Penza region has been developed within the framework of 10-year cooperation between the Academy and Manufacturer Business Association. Based on the

Fig.1. Multilevel Scientific and Educational Complex



data of the Assistance and Innovation Advancement Center, PSTA coordinates innovative activity in the spheres of information technologies, computer-aided design, image identification, and etc.

It is vital to note that PSTA activity is aimed at meeting the needs of such parties concerned as the Ministry of Education and Science of the Russian Federation and citizens of Penza including local authorities, Rector's Council, employment service, mass media, as well as school-leavers and their parents, directors of enterprises and authorities of secondary educational and intermediate vocational educational establishments. Quality Management System of the Academy has been developed with due regard for the results of science, education and labor market research [4]. The study of consumer's needs and satisfaction, as well as monitoring graduate employment rate, is performed by PSTA Job Placement and Target Learning Center in accordance with the following Academy standards: «Interaction with Employers. Analysis and Monitoring of Employer's Needs», «Employer Satisfaction Analysis» and etc. The Academy places a lot of emphasis on helping its graduates to find job within the framework of cooperation with enterprises and companies. According to the data concerning top ranked university centers, which were provided by the Coordination and Analysis Center of Employment Assistance for the Graduates of Professional Educational Establishments (Moscow, 2010), PSTA is ranked 8th among higher professional establishments of Russia.

The experience of Penza State Technological Academy has proven that the integration of enterprise, business and modern education establishments can contribute significantly to the assurance of quality education of specialists and assist graduates in job finding and starting their professional career. Therein lies the reason for the intensive development of the Academy which goal is to train highly-competitive specialists who will be in demand in leading service and science-based companies.

Thus, the multilevel system of professional education which has been developed in Penza State Technological Academy on the basis of science, education and business integration contributes to the successful solution of urgent problems of all the participants of continuing educational process.

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Proven Collaboration between JSC TomskNIPIneft and Tomsk Polytechnic University in Training Today's Petroleum Engineers

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The issue of the day is «What new means and programs could be considered in training today's petroleum engineers?» Analyzing the experience and enormous efforts of one R&D Institute and design office, new concepts and approaches are being discussed in the design and development of effective programs for personnel training.

Key words: *design, project conception, competencies, institute, personnel training, high educational establishment, engineering education.*

Personnel Issues in Modern PetroleumEenterprise.

During the past few decades, JSC «TomskNIPIneft» Institution like other similar Russian petroleum institutions is subjected to a shortage of highly-qualified engineering personnel. Today's engineering world embraces such growing requirements as teamwork abilities, multidisciplinary knowledge in different science branches such as field exploration and development, skills in analytical and project drafting and simulation methods (modeling), flexibility and mobility, management of sophisticated software programs. According to some experts in its entirety technology and information significantly speeds up the process of «knowledge ageing.» Science and technology progress at such a rate that existing engineering resources date rapidly up to 20% annually [1]. Sophisticated production technology, new requirements in reservoir engineering promotes the problem of training and re-training personnel. Today's professionals should be self-oriented in their constant training and re-training.

Major Engineering Competence Development Trends within JSC TomskNIPIneft.

To maintain recruitment needs, including the development of the Institute in furthering the enhancement of oil production in perspective Russian regions, one should invest not in short-term training courses, but in the implementation of the target education background for one's personnel in close collaboration with different universities and institutes.

JSC TomskNIPIneft is the easternmost institution in western Siberia implementing the following integrated cycle: research project→ institution → petroleum enterprise. Present work targets only embrace such aspects as reserve calculations, reservoir engineering design documentation, reconnaissance and project engineering in infrastructure sites, including environmental protection and efficient nature management.

In the 90s of the last century JSC TomskNIPIneft directed all its facilities and resources into the eastern regions of Russia – Kamchatsk oblast. Profitable natural gas supply facilities were designed here, including the pilot production of two gas-condensate fields (Kshuksk and Kvakchinsk) and more than 400 km-pipeline throughout Kamchatsk oblast.

Operating in these eastern regions involved challenging problems furthering new experience and associated competencies. For example, the construction of Kamchatk gas pipeline in seismic hazard zone (up to 10 on Richter scale) required the application of special engineering structures for buildings and facilities. This project included new engineering construction design and specific technical requirements in accordance to State legislative documents. Since 2007 the Institution has been implementing significant engineering construction design of production facilities for Urybcheno-Tokhomsk, Vankorsk and Verkhnechonsk fields.

Operating in eastern regions, the institute developed contemporary engineering competencies, especially conceptual engineering and technology in Facilities Design Construction (FDC). During the past few years, the Institution has completed 19 feasibility studies, the most significant of which are: «Integrated concept-program in gas utilization and gas transport-system development within Krasnoyarsk territory and Irkutsk oblast» and «Strategies in further development of helium industry within helium-rich fields of Eastern Siberia».

Engineering design of production facilities in Urybcheno-Tokhomsk field and pipeline construction from the above-mentioned field to Taishet highlighted the relevant development of engineering competencies of production facilities design in complicated conditions. For example, such factors as FDC in permafrost zones, significant elevation differences along the northern pipeline section, limited underwater pipeline lying through Angara and Birusa Rivers.

Rapid performance activities resulted in the implementation of principles and engineering competencies in project management. To implement the project management principles an organization framework was developed within the institution, named as project engineering office. These offices embraced various functions in project management, i.e. the management and control of such project aspects as the project itself, basic technical requirements, optimal project life, quality performance, project cost, human and material resources and risk management. The after-effect of such reorganization was the further retraining and advanced training of in-house specialists. During the past few years, the above-mentioned development of engineering competencies affected only some competency aspects of this institution. These issues could not have been solved without personnel planning management and the close collaboration with NR Tomsk Polytechnic University.

Collaboration Model Outline between Enterprises and Universities.

There are different collaboration models between petroleum enterprises and universities, such as internships, recruitment activities, financial support, i.e. equipment procurement, grants, scholarships, etc. However, the dimension and influence of such collaboration on the academic activities of this or that university is insignificant, especially the possible up-dating of present curriculum programs in training and retraining of future specialists. JSC TomkNIPIneft is developing not only the traditional training methods, but also implementing different integrated curriculum projects.

A striking partnership project example is the Petroleum Learning Centre (PLC), Heriot-Watt University and Tomsk Polytechnic University, existing for more than 10 years within the Common Education Space. This Center implemented the modern education approach- integrated academic activities in the professional training of petroleum enterprise personnel through international education projects. Such a project reflected the growing demand in professionals for Russian petroleum enterprises, furthering their interest in relevant education level and readiness to financial support. JSC TomkNIPIneft actively participated in the early establishment stages of this Centre: transfer of personnel to Tomsk Polytechnic University and design of study manuals for the 3rd and 4th program- terms. The academic project course includes 4 terms, the first 2 of which involve basic training courses in geology, petrophysics, exploration, development and production, drilling, field infrastructure development and economics [2]. Learning activities in above-mentioned disciplines are performed in computer classes through sophisticated software programs. In the third term (April-June) students perform individual research projects related to case studies in field exploration and development. During the 4th term (July- September) the students work are in multi-disciplinary teams to perform case-study projects in actual oil field development. Such case-study projects promote the ability to design geological and hydrodynamic models of an oil field, estimate various field development models, evaluate the development impact on environment and apply modern economic analysis in selecting the optimal development model for this or that oil field. These study manuals for experimental academic sessions were designed by a group of active department personnel of JSC TomskNIPIneft, who are still cooperating with this Center today.

Human Resource Issues.

JSC TomskNIPIneft has up-dated its strategies in selecting and training new professionals in view of the policy of many governmental and organizational frames. This policy includes the promoting and furthering of bilateral relations with different Tomsk universities, especially NR TPU, the graduates of which comprise more than 50% of the institution's engineering personnel (Table 1).

As mentioned above high non-standard requirements are being imposed on the specialist of JSC TomskNIPIneft. The following fact highlights this aspect- «green» junior engineer personnel by no means always stand the «ideal employee» which the employer would like to see and have. According to the latest management questionnaire (2011), more than 50 questioned manager-supervisors characterized yesterday's graduate and today's junior engineer as having average knowledge and skills (Fig.1). According to the 5- grade scale an average university graduate cannot even achieve «four» in the key requirements of the employers, if not to mention other specific requirements.

The following fact should also be mentioned- the institution in-cooperated a rather rigid individual selection of young skilled personnel among graduates of university-partners.

Nevertheless, the professional qualification of graduates in many cases depends on this or that specialty, department, and university and student participation in different research projects. Within the framework of the above-mentioned questionnaire, the graduates of PLC showed significant performance skills. However, this highlights the fact that there exists a stable tendency in today's universities - graduates study only within the frame of standard curriculum, without considering the realities of modern production. Such curriculum includes only one specialty with a set of integrated disciplines, excluding a distinct correlation to in-situ conditions. Existing curriculum programs are theoretically over-elaborated and oriented on «stale» academic standards.

Table 1. Number (percentage) of graduates included in JSC TomskNIPIneft personnel

University (Institute)	Number of personnel	доля, %
National Research Tomsk Polytechnic University (NR TPU)	354	51
National Research Tomsk State University	125	18
Tomsk State Architecture-Building University	112	16
Tomsk Control System and Radio-Electronics University	21	3
Tomsk State Pedagogical University	7	1
Others	76	11

The above –mentioned factors have serious consequences:

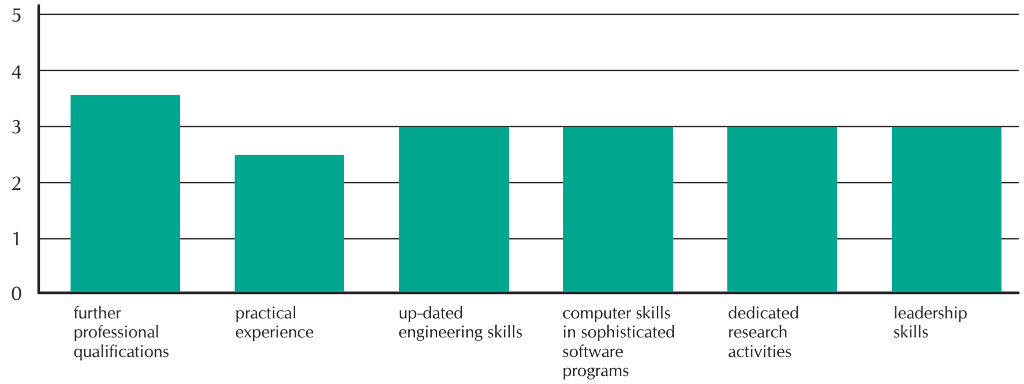
- a graduate-specialist needs to adapt himself\herself to the current job requirements and this takes time;
- lack of time and efforts results in an unsystematic assimilation of up-dated knowledge, i.e. «on-the-go» knowledge («a little bit here and a little bit there»);
- newcomer-specialist has neither time nor possibilities to enhance his\her knowledge and skills in production-technology and standardized and even inflexible thinking is oriented only on specific task-solutions (sector, group or department).

Such consequences involve negative tendencies and risks within different production sectors as the isolation of various departments furthering the development of optimal solutions only within this department. Such «optimal» solutions could not only negate the stated task in general but also the production target of the enterprise itself.

Decision System Development in Human Resources between NR TPU and JSC «Tomsk NIPIneft».

Based on a detailed analysis of the above-mentioned factors, the following target goal was established to improve the performance efficiency of the institu-

Fig. 1. Performance quality assessment of employed graduates (2009-2011)



tion project departments- significantly update multidisciplinary engineering knowledge level and develop integrated teamwork. This includes the organization of engineer-teams within each department to develop not only optimal, but also integrated project decision results, evolving the limitation and possibilities of these departments.

Implementation tools involved the project target development strategies in personnel training for the Department of Infrastructure Development. The mission of «INFRASTRUCTURE DEVELOPMENT PROJECT» (herein referred to a «Project») includes the following: «Training specialists having such qualities and traits as deep knowledge and experience, teamwork skills, integrated competencies in surface infrastructure development of oil & gas fields to significantly improve the project quality and performance rate, increase labor productivity and upgrading gain, as well as, to minimize possible risks in project management'.

The Project was implemented within the learning module framework of NR TPU. Not only experts from JSC «Tomsk NIPIneft», but also professionals from such institutions as PLC Center, National Research TPU, Tomsk Control System and Radio-Electronics University, Ufa State Petroleum Engineering University, and other consulting companies have been involved in this project-program development and implementation (Fig. 2).

This Project includes such technological modules that develop not only management skills, but also computer skills, i.e. application of sophisticated software programs in different activity areas. Such a wide scope of knowledge and skills furthers the understanding of those production possibilities and limitation within related departments.

The Project includes 12 technological and 10 management module courses, all of which are based on such learning tools as lectures, problem-solving discussion in groups, panel discussion, teamwork activities, contingency models, stimulation games and autonomous learning. The Project module structure involves two types: (1) short-term out-of-job training from 6 to 10 days (i.e. 48-72 hours) and (2) intensive self-education on-the-job training. The content and pattern information of autonomous learning within the framework of this Project is depicted in Table 2.

Control measurements within each module include two or three types, such as exam, mini-project, term paper or supervision of professionals from different enterprises. These control measurements involve either written format or paper presentation with a representative Institution Examination Board.

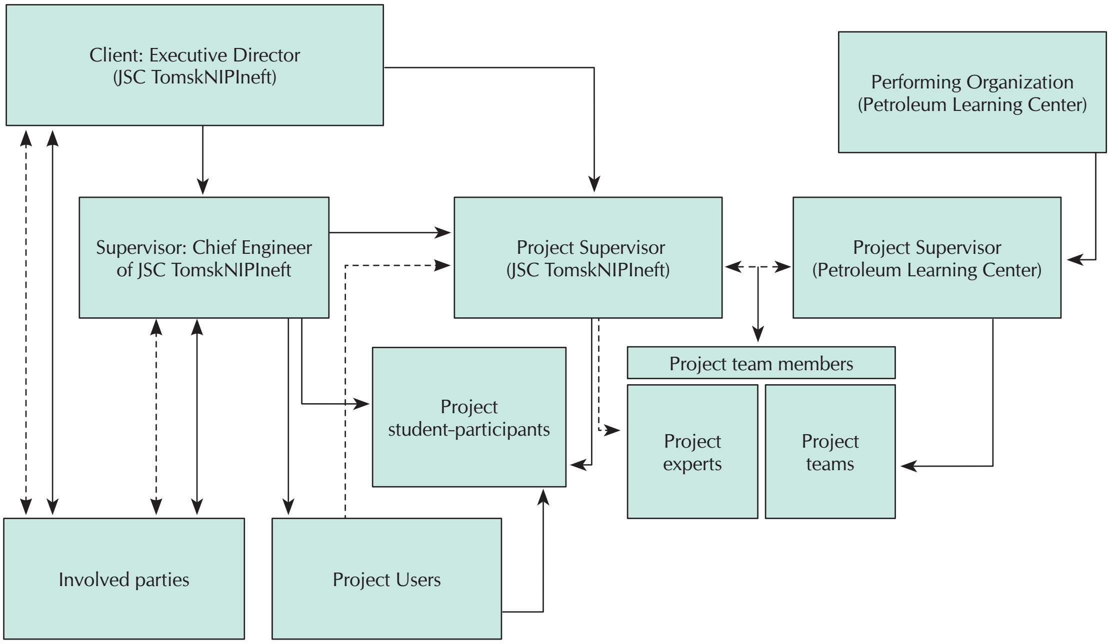
To evaluate the employee's integrated knowledge and skills in design & construction of production facilities, an innovative learning tool was proposed- project teamwork. The project teamwork involved a problem-solving situation- new undeveloped oilfield. The project task is to develop design & construction of production facilities of an oilfield, including its further perspective development. Within the framework of this project the team fulfills the following task items:

- Engineering design concept of production facilities construction and process development work (PDW) protection;
- Design study and survey procedure;
- Engineering design of basic project exposure draft (ED);
- Engineering design of project plan progress.

During the project design the team members work out the following problem solutions:

- site location and dimension of production units;
- well production pipeline transportation;
- crude product export;
- hydrocarbon process system;
- reservoir pressure maintenance system;
- application of associated gas (LNG);
- related solutions in power supply, water facilities, drainage system,

Fig. 2. Project-program development and implementation diagram



automatization, communications and others;

- economic assessment of suggested production facilities construction;
- risk evaluation;
- project stage activities schedule.

The Project is based on actual data and information of one specific existing oil- field. After fundamental training such an approach reveals the following possibilities as (1) on-site training and (2) teamwork result evaluation in comparison to existing and implemented production decisions.

In 2011 the first employee-team group in TomskNIPIneft successfully completed their training course within the framework of this Project, and today the second team group is preparing their graduation papers. The second newly edited version of this Project was proposed in December, 2011. This new-version Project is termed as «Engineering Manager for EAD (Engineering & Design)».

Based on the Project result analysis the following diagram was plotted vividly showing the dynamic professional career growth of the first team-group. During 2008-2011 12 employees

Table 2. Autonomous learning within the framework of the Project

AUTONOMOUS LEARNING		
Price Model in EAD (Engineering &Design)	36	credit
HSE (Health, Safety and Environment)	36	credit
Principles of Design Documentation	36	credit
AutoCAD 2011 in E-learning format	36	credit
MS-Project in E-learning format	36	credit
Introduction in Management	36	credit
Innovations in Petroleum Industry Sectors	72	credit

showed significant career growth in comparison to the ordinary development engineer (Fig. 3).

Due to the positive and effective results of the above-described project, this Development Engineering Training Project could be introduced into different petroleum companies as a key approach in training highly-qualified design engineers and development engineers for the oil and gas sectors

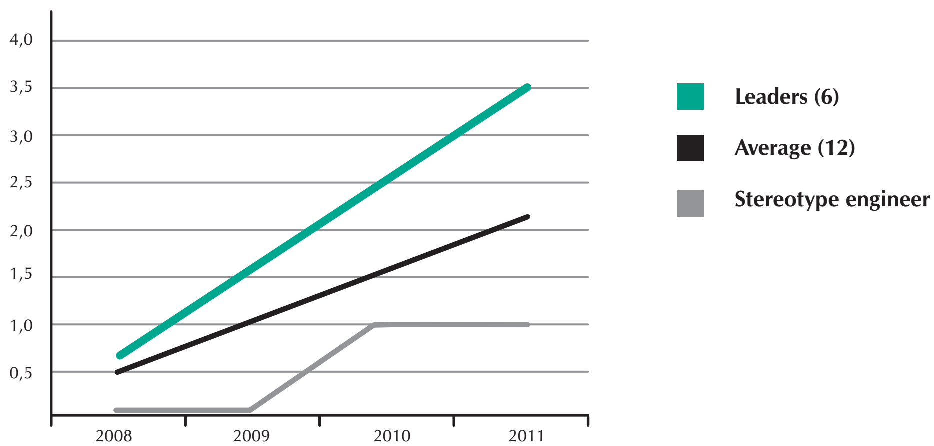
Conclusion.

The development of an effective embracing engineering education system is one of the most vital problem-solving issues in many modern fuel and energy enterprise sectors of Russia.

Based on their experience in project strategy of engineering personnel training, the authors consider that highly-qualified engineering education should provide not only theoretical knowledge, but also those practical skills and abilities that are essential for any graduate i.e. future engineer. The solution is in the integrated collaboration between enterprises and different universities and institutions. The foregoing tasks should include the implementation of integrated projects in personnel training and further the development of expert training teams in enterprises which would use own resources in future engineering training. Such a mid-term systematic approach being implemented in different enterprises would allow not only to train highly-qualified engineers, but also enable them to work in complicated conditions of uncertainty, elaborate various branches of knowledge furthering one's skills and abilities in practice, as well as, improve one's skills in sophisticated IT and advance one's knowledge in challenging petroleum business technology.

The implementation of contemporary project management strategies into enterprises as a «new philosophy» in training today's petroleum engineers could be that «lever» which would retain and enforce their competitive position in the petroleum engineering market.

Fig. 3. Dynamic career growth curve of Project participants



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Education-Research-Production Complex as Engineering Training Model System for Human Resources in High-Technology Industries

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Considering present-day conditions the training of human resources for hi-technology industries integrates the following related organizations- university, enterprise–employer, primary and secondary vocational institutions. Due to existing economic and organizational factors many technical universities are unable to provide and modernize their laboratories with expensive or even sophisticated equipment. In view of increasing requirements for modern engineering competencies and corresponding professional abilities and skills, consistent development and improvement, as well as, competence assessment, it is appropriate to coordinate the merging of university- students- graduates-employers into an education-research- production complex. The following article depicts the model system in engineering training in accordance to today's requirements.

Key words: *training research and production complex, graduates' competence, engineering qualification certification, quality management system, independent professional accreditation, standard methodical ware.*

BThe economic and socio-political conditions of today indicate the following effective path development of hi-technology industrial sectors - innovation and production activities to competitive products. Besides procurement, one of the most important factors in effective innovative and everyday production activities is the human resources and qualifications of all-level specialists, i.e. those engineers possessing innovative creativity, skills in research & development (R&D) of new engineering proposals; in other words, this organization can be described in the following cycle: knowledge → idea → engineering design and process engineering → high-qualified product [1-3]. Thus, the target education task is the organization and development of lifelong learning to engage effectively human potential which would involve integrated education, research and production activities. Human resource training and professional development is one of the prevailing conditions in ensuring successful enterprise performance within the existing hi-technology industry sectors. Engineering training enforcing creativity and practical experience embraces not only the collaboration between enterprise and university (institute), but also an integrated academic-research-training process to develop those competencies of a graduate that would meet current needs and demands of all partners and parties (enterprise-university) involved in this process. The development and shaping of future engineer-graduates should be accomplished throughout his\her studies and education, as well as, professional activities, including pre-university training and instructional support during his\her professional life at this or that enterprise.

The success criteria in this academic-research-training process are the following: graduate compliance to employer's requirements, their demand and competitive performance in the global job market, education satisfaction, university prestige promotion, all of which enhance education quality that is essential for all involved parties- state, graduate and employer.

It is the university, being capable of promptly and appropriately responding to emerging issues and accommodating educational services in accordance to employer and learner demands, could provide both competitive performance of all participants within this system under conditions of mutual beneficial co-operation and training specialists for enterprise-employer, as well as, one's university.

The most effective tool, according to success criteria (academic-research-training process and competitive performance in the global job market) is to establish an integrated system merging technical university, enterprise-partners and institutions of primary (primary VEI), professional (professional VEI) and secondary vocational education (SVEI) into education-research-innovation corporation, i.e. education-research-production complex (ERPC) [4-5].

The organization structure of such a multi-oriented professional training complex–ERPC is depicted in Fig. 1. The major functional targets of ERPC are the following: collaboration in enterprise HR development, including development of professional competence requirements, design of curricula and academic and their mutual implementation, recruitment and oriented training of future enterprise specialists under contract and employment of graduates to contract.

Each participant within the framework of this complex (ERPC) program in developing professional competencies has his\her assigned role. The education institution embraces the development of socio-personal competencies within pre-university training and orientation programs upon coordinating programs. It is the technical university that trains human resources (HR) for hi-tech enterprises and develops those professional and cultural competencies in accordance to Federal State Education Standards (FSES) and employer's requirements. Besides professional competencies, such skills and personal qualities are shaped, developed and maintained throughout the graduate's professional life as socio-personal responsibility, creativity, corporate culture commitment, moral and ethic principles, teamwork and leadership skills, motivation and ambition endeavors.

The organizational structure of ERPC activities involves the collaboration of the following institutions: university promoter → technical university → Russian Ministry of Education, the latter of which frames applications and furthers the academic process (i.e. programs, curricula) in prevailing professional areas through financing and accepted FSES (Fig. 2).

Agency, Ministry, professional institutions, and enterprise associations, in accordance to the demands of this or that enterprise, frame its own specialist application and are involved in the finance and resources provision of the education-research process, which, in its turn, is mutually organized both by the technical university and enterprise-partner, as well as, organizing further training and education.

In its turn, the technical university frames graduate application, postgraduate feed-back, further training, refresher training, and professional engineering development

Fig. 1. ERPC organizational structure

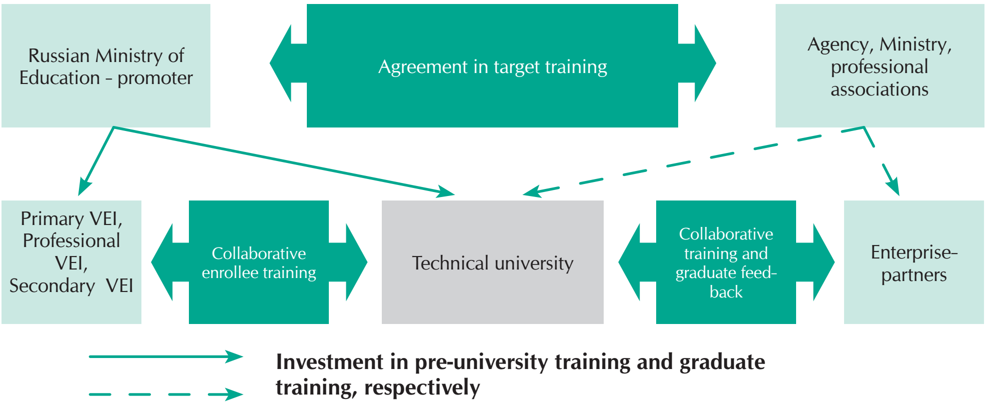
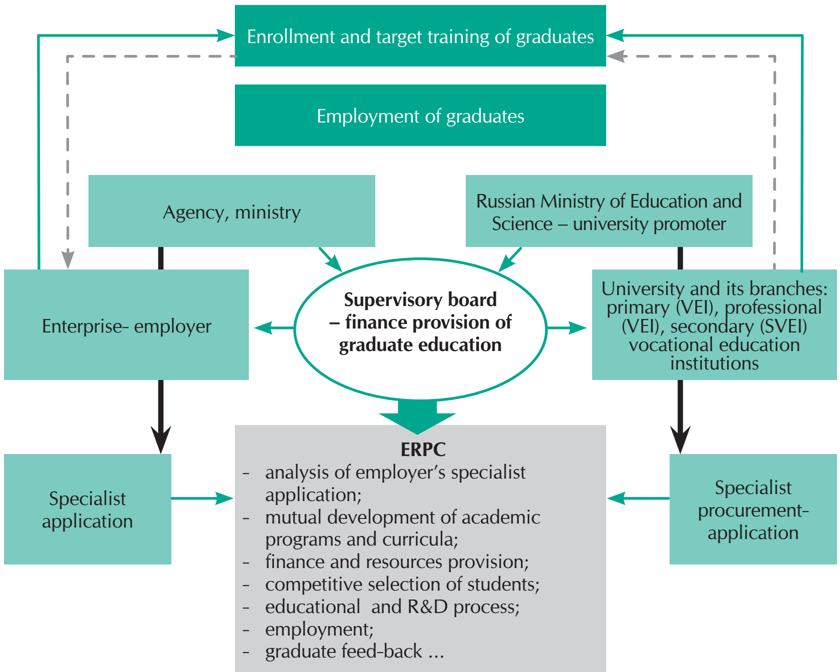


Fig. 2. Integrated communication diagram within education-research -production complex



certification in collaboration with primary (VEI), professional (VEI), secondary (SVEI) vocational education institutions and enterprise-partners.

The enterprise, based on its needs and demands in HR and development prospects of the enterprise itself, plans its strategic and HR policy, frames its specialist application in collaboration with the Agency, Ministry, professional institutions annually, as well as, the finance provision. In this case, the functions of the enterprise include internship (on-the-job training), involvement in R&D, management, and project activities, and development of its own HR.

The University, i.e. technical university, in collaboration with primary (VEI), professional (VEI), secondary (SVEI) vocational education institutions executes integrated orientation and academic programs, as well as, graduate peer training with industrial enterprises. In addition, the technical university coordinates the activities of the ERPC.

Finance coordination of ERPC activities is the exclusive prerogative of the Supervisory board, which includes representatives from Russian Ministry of Education and Science, agencies, ministries, professional institutions, enterprise (employer) associations.

Coordinated activities of ERPC involve the following:

- analysis of employer's applications;
- mutual development and design of curricula and training programs;
- training resources provision;
- competitive selection of students;
- education-research process;
- employment;
- graduate feed-back (further training, refresher training, and professional engineering development certification and others).

The role and function of the technical university within the framework of ERPC significantly increases i.e. the university transform from a «supplier of no-address» graduates into a multi-profile education- research- innovation center. The perspective results are the emerging new-generation engineers, capable of determining potential challenges, developing and implementing sophisticated technological findings. It is these engineers who are of great demand in hi-tech enterprises nowadays.

As an innovative-research center (ERPC) the technical university with its enterprise partners develop and incorporate the students' creative skills in designing and implementing this or that product and transforming advanced engineering proposals into in-demand items.

The fundamental principles of this collaboration include the following:

Complexity – engineering training in collaboration with all interested partners-state, university, enterprise-employer and students.

In-demand – graduate training, complying with the demands of the state, enterprise-employer, society and labor market.

Responsibility – the university is responsible for graduate-engineer training quality.

Permanency – further qualitative training is accomplished throughout the professional life of the graduate as further training, refresher training, and professional engineering development certification.

Balance of interests – mutual interests and commitments of all concerned parties-state, university, enterprise-employer and students.

At the same time the coordination and management functions of the technical university within ERPC changes significantly. It becomes the central institutional body in this complex management system of ERPC, involving not only methodological provision, qualitative education management (accreditation, licensing), but also non-government «tools» to guarantee and provide qualitative education-research activities such as quality management system, self-governed social-professional accreditation mechanism for curricula and post- graduate engineering qualification certification (Fig. 3).

In-university quality management system (QMS) and its certification, providing a stable effective improvement mechanism for university technical activities, is one of the world-wide tools in education quality guarantee. Self-governed professional accreditation of academic programs guarantees qualitative learning «technology» for all participants of the education activities-graduates, employers, university and its staff. The orientation in training in-demand competitive specialists for enterprises and hi-tech industries should involve the enterprise (employer) itself in the education-research process, due to its production feasibility, sophisticated equipment and technolo-

Fig. 3. Structure of ERPC management system complex

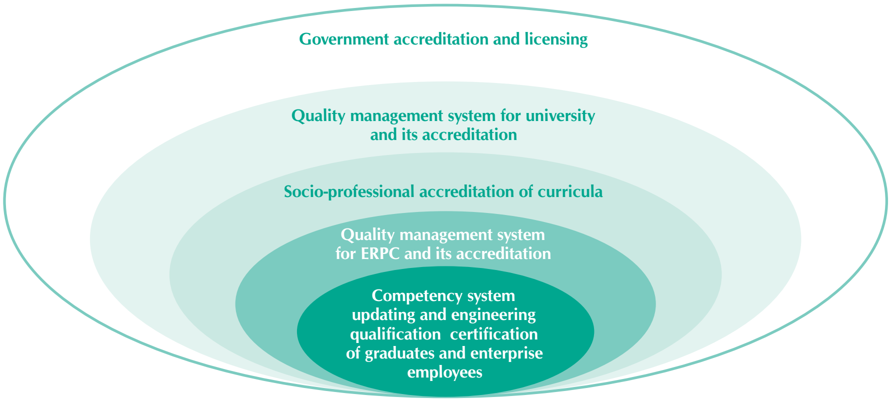
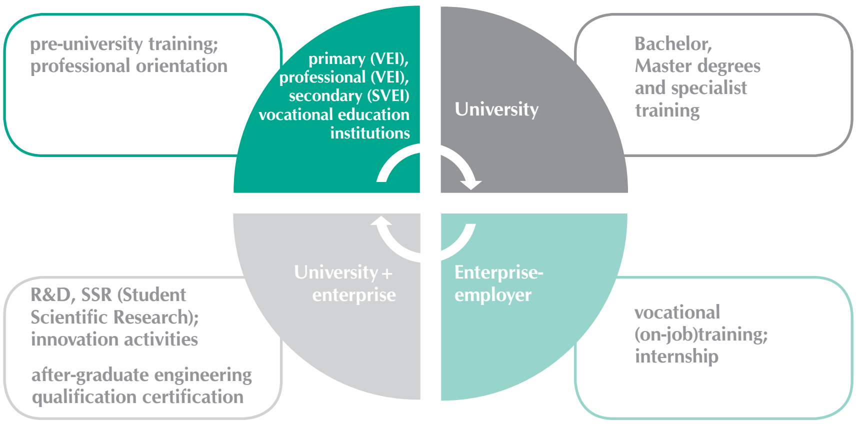


Fig. 4. Distribution of functions within ERPC



gies. Effective collaboration factors are both cooperation within common requirements (mutual development and implementation of curricula and training programs) and interrelations with primary (VEI), professional (VEI), secondary (SVEI) vocational education institutions (organization and management activities within in-university QMS) involving the following scheme: «suppliers» – enrollees and «consumers» – employers (Fig.4).

Integrated QMS for ERPC and its certification ensures the proficiency and performance of training and education (T&E) activities under conditions of collaborated research and development (R&D), production, potential HR organization of enterprise-partner.

This integrated QMS should ensure the quality of engineering training in the education- research process, considering the enterprise-employer requirements.

All factors, especially graduate feedback required in working experience for further training and professional engineering development, are determined by ERPC strategies.

All activity types within ERPC are embraced in regulatory and procedural documents. This portfolio includes basic documents and three standard groups, as well as, requirements to the activity procedures and results of ERPC, documented requirements compliance, methods of matching and evaluation methods of efficiency and monitoring (Fig. 5).

The first group of documents set requirements to graduate competencies, methods of shaping competencies, functions of its members, resource distribution, and responsibility and authorized rights within ERPC.

The major documents of the second group- methods of requirements compliance that regulate the educational and R&D processes, methods of mid-term and final certification, development of so-called » learner and graduate competency portrayal», in-demand analysis, employment and competitiveness, as well as, graduate career forecasting.

The third group of documents includes assessment methods of efficiency and results of ERPC. The management targets of all ERPC members in accomplishing intended graduate training results embraces the following set of competencies: pre-university training in accordance to university requirements, , resource provision, instruction quality, staff competency management, quality curricula level, «technology-tools» shaping graduate competencies, infrastructure, learning environment, information support (Fig. 6).

The management targets within ERPC-key system elements in developing professional, personal and social competencies of the graduates (Fig.7).

These management targets include:

- pre-university training in accordance to university requirements and their profession orientation;
- graduate training under conditions of integrated learning process and student research;
- training of highly-qualified staff in post-graduate and doctoral internships;
- further education training, advanced learning , refresher training;
- facility management, infrastructure management and management of education environment;
- economic-planning and finance;
- international collaboration in education and research, internships, international exchange of students and teachers;
- information support, publishing activities and library services;
- graduate feed-back, engineering qualification certification.

Fig. 5. Structure of regulatory and procedural documents for ERPC activities

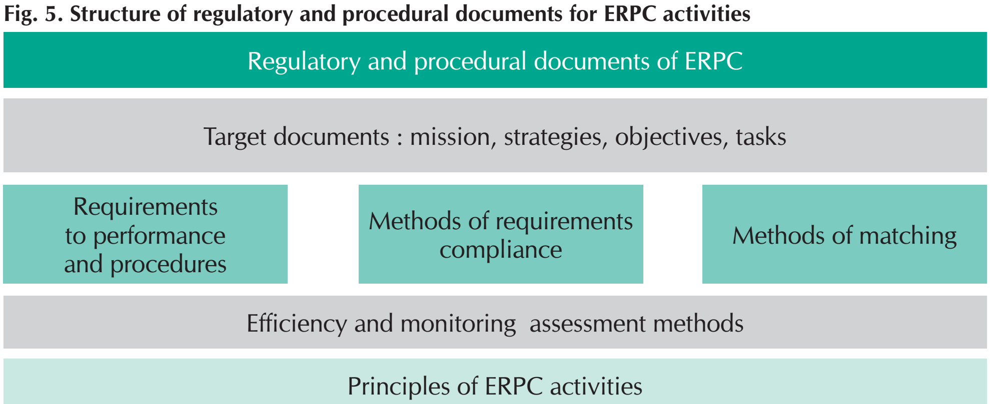


Fig. 6. Transformation from learning quality to education quality

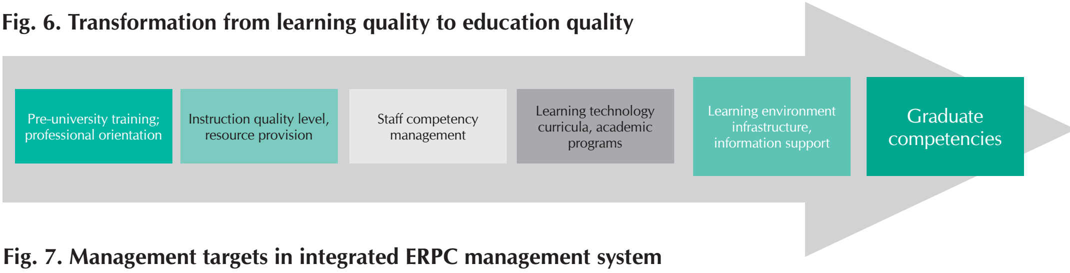
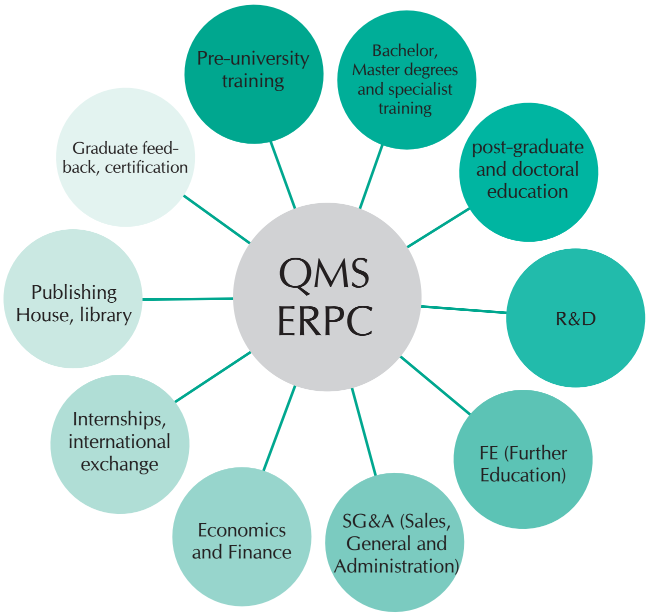


Fig. 7. Management targets in integrated ERPC management system



Monitoring system and efficiency evaluation and further development and implementation of management decisions are those factors providing effective ERPC activities.

The above-mentioned ERPC, including regulatory and procedural documents and interaction principles, could be recommended as a universal integrated model system of employers, research and innovation activities.

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«EleSy» Company Corporate Training System

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In the context of the transition to the two-level system of higher education, Russian IT-companies come up against the problem of personnel deficiency in engineeringsphere. To solve the problem of specialist training, adaptation and further development, EleSy Company has introduced a corporate training system. The system is aimed to provide an effective educational process which can be easily combined with daily job responsibilities.

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Key words: *engineering specialists, corporate training system, personnel adaptation, cross-training, competencies, knowledge management, programs.*

In recent years, engineering companies have come up against severe shortage of qualified engineers who are the core assets of an enterprise. Most of the experience specialists, as a rule, have outdated knowledge or they do not need to look for a job, while young specialists, graduates of Higher Technical Institutions, are not enough qualified for engineering work and require additional training which may take a long period of time.

Furthermore, companies are in need of the specialists who can be rapidly involved in the technological process with minimum time and financial expenditures required for additional training. This need is determined by the drive to achieve effective work performance. On the one hand, not every manager will task a lead engineer with training a young specialist instead of working on an urgent project as it consequently leads to additional time and financial expenditures. On the other hand, not every company will agree to recruit a new employee «as a reserve» to be involved in future projects and train him from the ground up.

Due to the transition to the two-level system of higher education, which comprises Bachelor's and Master's programs, the graduates with Specialist Diplomas faded away with no alternative being proposed. Neither universities, nor enterprises turned out to be ready for such changes. Today, the crisis in engineering education can confidently be stated.

Conversely, such situation, as well as any drastic changes, has triggered universities and enterprises tocooperate in searching solution of the problem encountered. Even now, a number of universities work within the «Triple Helix» concept which comprises three cooperative elements: business, education, and authorities. Besides, almost all Higher Technical Establishments provide now a variety of different programs for the most promising students, while enterprises in its turn respond to their wishes, for example, by giving money for new laboratory equipment. Also, there is a trend for universities to engage engineering companies' specialists into the learning process.

However, everything discussed is under changes and it is still to be normalized and experimentally proved.

Besides, the question of employee additional training is still acute for engineering companies. All the existing programs might effectively reduce graduates' employment adaptation period but it could not be enough for modern engineering companies, especially for those in such fast developing industries as automation, IT, information systems and etc. The employees of these companies must be constantly going through additional training and courses.

Thus, it is obvious that an engineering company must develop its own corporate training system appropriate in engineering specialist education.

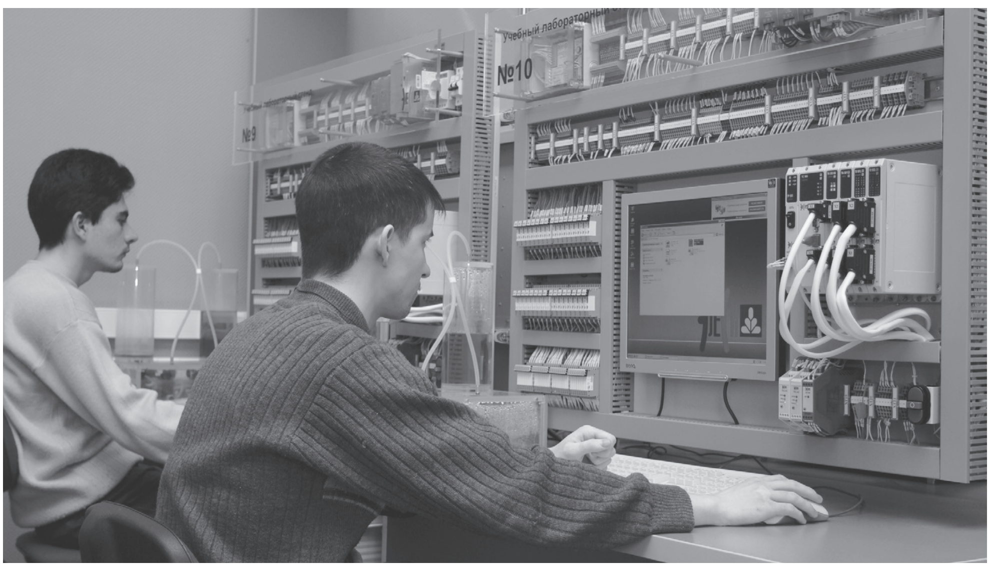
The present article discusses the corporate training system intended for training engineers, which has been developed by «EleSy» Company.

Actually, the corporate training system comprises a number of programs, technologies, joint projects with universities aimed at continuing assurance of knowledge sustenance and company's competence development in accordance with the set strategic objectives.

1. Specialist Adaptation Program (Induction Training)

Induction training is given to new employees during the first three months after their employment in order to reduce an adaptation period and provide them with the information required to begin productive and meaningful work independently. The induction training is followed by an exam. After an employee has successfully passed the exam, he is allowed to work independently (except for the employees who are in charge of in-situ monitoring project sites). During the first business trip, the employees who are authorized to install the systems in customer's project sites must be accompanied by an experienced engineer. After this, a new employee is allowed to work independently.

Induction training comprises three main parts: technical, managerial, and humanitarian. The technical part implies the study of system development bases and standard projects, applied devices and program software, as well as training classes in development, installation, connection, adjustment and interworking of system elements. The instructors of technical disciplines are



the leading specialists. The main purpose of such education is to acquaint future employees with the experts who they can call for assistance.

Technical knowledge and skills are the basic requirements but they alone are not enough. The successful completion of a project is largely dependent on the accuracy and efficiency of the selected procedure for enterprise technology processes. Therefore, induction training must also cover the following aspects: technological standards, regulations and specification, organizational-administrative documentation of an enterprise, organization structure and its personnel, the policies and interaction rules that are in place, and standards for system development and implementation.

Communicational skills are also very essential for an engineer who aspires to communicate effectively with colleagues, customers, suppliers, and supervisors. When working at the customer's project site, engineers, being representatives of their company, must not only show good technical skills and qualification, but also create a more positive company image through their non-verbal behavior, appearance, corporate culture and communicational skills. As an engineering system is implemented and maintained by stages, an engineer has to visit the project site repeatedly, and it is not always one and the same person. A customer can form an opinion on an engineering company based on how its specialists answer the questions about company's activity, history, achievements and failures. To answer these questions effectively, an engineer should prepare the answers which will show solidarity, commonality, and vision of success shared by all company personnel. The bases of corporate culture must be acquired through the humanitarian part of the induction training [1].

2. Competence Development and Sustenance Programs and Technologies

Specialist Orientation Program is the basis for employee further education. Competence development and sustenance programs have been developed to enable employees to progress in their profession and to study the peculiarities and fine points of system development and implementation. The programs constitute an important part of the existing education system. It is these programs which allow employees to convert their competences into the experience, as well as to acquire new knowledge and skills which will help them to stay relevant over the whole working period.

A. Cross Training

The main concept of cross training is to ask an employee to do a different and rather small part of organization's work. For example, an employee can be asked to perform a comparative analysis of similar devices produced by different manufacturers or specify a definite failure diagnostic technique. Besides, there is a time limit given to an employee to complete the task. It allows him to spend no more than 10-20 % per working day.

As soon as the task is completed, the seminar where the employee can present the results is arranged. As a rule, the personnel of the same department or sometimes even other departments should attend such seminars to get new skills and to improve the workflow between the departments.

The fact that either the employee who is making a presentation or other attendees can combine such training with their daily job responsibilities is one of the main benefits. Moreover, it is far easier to arrange such kind of seminar than to organize durable educational programs. Cross training has proved to be an effective technology as even from the psychological point of view, it is more interesting to catch a short break from work and learn something new and useful than to be involved in a long off-the-job educational process. Above all, it is easier to remember things in small parts.

B. Mentoring Program

The leaders within the organization are assigned to serve as mentors

to new employees who have already completed induction training. The main mentor's tasks are as follows:

- provide further education and development of an employee in accordance with an individual program;
- offer useful materials required for further self-study;
- assist or provide guidance to a mentee in completing work-related tasks;
- offer support and advise a mentee based on personal knowledge and company's experience;
- assist employee to be prepared for certification procedure.

In concurrence with the supervisor, a mentor is also authorized to give a mentee various tests required for quick check and consolidation of knowledge and skills.

As a rule, a mentor is a successful employee who is supportive of the organization and two positions higher in company's hierarchy. Actually, mentoring is a two-way relationship which is beneficial to both mentee and mentors where the latter increases his self-esteem and self-confidence, confirms his professional competence, systemize his knowledge and experience by sharing expertise and helping new employees. Due to such work-related activity, mentors can be easily promoted. Thus, mentoring includes education, career interests and motivation.

C. Training Programs

The above-mentioned technologies can be rather effective for corporate employee training. However, there are some competences and skills which can be trained only on the basis of specially developed educational programs. These programs are usually developed not only by leading specialists of a company, but also by commercial organizations and company top management in order to define a number of competences required to be trained now and the competences which are necessary for successful and sustainable future development of a company regarding its strategic objectives.

These educational programs can include such short-term training forms as attendance of the seminars arranged by equipment and software manufactures, organization of refresher courses for a

group of employees (for example, in network technologies) and etc.

Besides, the educational programs can also include longstanding off-job training courses which can be arranged on the basis of local universities (for example, 2 times a week for 4 hours and 3 months) or such courses can be held in the company (in this case seminars are provided in evenings by guest experts).

In particular, due to the application of one of the above-mentioned programs, the company improved employees' level of the English language in response to company entry into the international markets.

D. Knowledge Formalization

Besides the educational programs, there is so-called «memory» of a company, which exists in the form of developed standards reflecting basic approaches and technical solutions within an engineering system development and implementation, i.e. what the company focuses on. The standards which have been developed by leading specialists of the company include not only the concentrated knowledge in system development, but also a number of examples of typical technical solutions, as well as recommendations in finding new ones.

These standards should be occasionally updated alongside with the development of company personnel.

E. Knowledge Management System

Special software platform developed with the assistance of the Cybernetic Center of Tomsk Polytechnic University (TPU) was implemented in the company for knowledge management and systematization. As for now, the company works mainly with the platform part intended to collect and organize knowledge in installation and set-up activities. This kind of knowledge is considered to be unique as it concerns some of the most difficult troubleshooting issues including those problems which may appear under definite launching conditions after all successful test operations. All the collected solutions and procedures are experimentally proved reviewed by the experts. This knowledge base can assist the engineers in installation and set-up activities when testing and eliminating the system troubles, as well as give system developers the ability to retrieve specific knowledge and use it to increase the quality of developed products.

Thus, the training system which is applied by «EleSy» Company enables company management to fill in the blanks in engineering education, which appeared due to the transition to the two-level system of higher education, as well as to collect, develop and sustain the existing company competences.

The list of company personnel competences (not nearly completed) which are trained by the discussed educational system is given below:

Knowledge

- knowledge of modern systems: structure, functions, subsystems, complete problems, possible vectors of development (addition of subsystems and functions), data hierarchy, technical implementation;
- nomenclature of up-to-date and commercially available equipment and software, review and comparative analysis of different manufactures, experience in working with the most famous ones;
- operating systems;
- technical software documentation and interfaces;
- corporate network (knowledge of building-up principle, hardware and software adjustment);
- communication links and equipment;
- applied programming;
- modeling;
- internet-technologies;
- application of analysis, diagnostics and troubleshooting procedures at any system unit;
- information security;
- ergonomics and design engineering;
- IT- company business processes.

Skills

- design and maintenance documentation development;
- system structure and architecture development;
- system development and configuration;
- system debugging;
- troubleshooting;
- development of technical tasks, conditions and requirements;
- problem description;
- information search;
- teamwork experience;
- analysis experience;
- complex plan development and fulfillment;
- planning the working day;
- self-study experience;
- mentoring experience.

Characteristics

- responsibility;
- adequacy (ability to understand a task);
- focus and result orientation,
- quality approach;
- readiness to learn.

The discussed educational technologies have among other benefits two main advantages – efficiency and motivation.

The formalized list of competences which correspond to the professional level of employees (engineer qualification categories) gives personnel a clear idea of what they should know and learn for professional and career development.

The application of the presented technologies can significantly save the time of the leading specialists as they do not have to stop their work regularly in order to develop or update methodological support in accordance with the drastic changes within the field. The methodological support includes only basic and permanent knowledge which is provided in the induction period.

These types of knowledge are concentrated and fixed in company's standards, knowledge management system base, as well as in the presenta-

tions made for cross-training seminars. Knowledge and ability evaluation is based on the certification of employee performance appraisal.

3. Cooperation with Universities

In order to reduce graduates' employment adaptation period and provide feedback on the performance of universities, strong partnership has been established between «EleSy» Company and Tomsk Higher Educational Establishments.

Within the frame work of such cooperation, a number of Tomsk universities' laboratories have been equipped with the training sets including the pilot systems developed by the company.

Besides, the Department of Electronic Systems was established in 2007 on the basis of Tomsk State University of Control Systems and Radioelectronics to provide specialist training regarding «EleSy» Company profile.

Also, the leading specialists of the company are involved in group project learning (GPL), i.e. educational technology applied in Tomsk State University of Control Systems and Radioelectronics, as supervisors.

Above all, mention should be made of student internship supervision provided by the company employees.

To reduce graduates' employment adaptation period (now it is possible to say not adaptation, but training), a part of the competences enumerated in this article could be trained within the university educational program, for example, in a form of elective courses or special program which is proceeded by Bachelor's Degree and taught parallel with Master's Degree program. In this case, the students who are planning to work within the engineering field after graduation have a possibility to acquire applicative knowledge and skills at university. This will help graduates to settle down quickly into the job.

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Educational Model the Case of Master Training in the Sphere of Multimedia Multiprocessor Systems-on-chip

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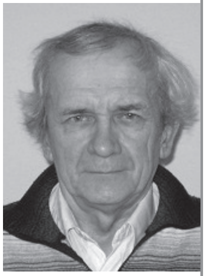

A.I. Popkov

The article describes the educational program «Multimedia multiprocessor systems-on-chip» that is established on TSUCSR basis and implemented in «Elecard Devices» LLC. It is financed by the «Rosnano» PLC Fund of infrastructural and educational programs. The aim of the program is personnel training for developing and production implementation of new generation chips for digital television receivers, technologies 95-65 Nm [1].

Key words: *TUSUR, Elecard, Rusnano, Magistracy, Multimedia multiprocessor systems-on-chip.*

Educational model description

The main idea of master training is maximum immersion in working environment, corporate culture. It also implies competence approach to the training process, which means having training modules to form particular competences [2]. For example, one of the declared competences is the skill to develop digital devices on the basis of programmable logic integration circuit (PLIC). To form this competence the subject «Design basis of systems-on-chip» is included in the program. 21 competences are formulated in the same way and are implemented through 13 training modules (Table 1). Every competence corresponds to a number of requirements.

Our model provides the rotation principle inside the enterprise during the first term. It means that every student should pass three departments: customer support, marketing and sales department, and production testing department. Such rotation inside the company allows a master to choose the direction of his/her future activity.

After the first term the group is divided into three sub-groups according to the following directions:

- Systems-on-chip development
- Audio and video codec development
- Sales and marketing.

Every direction has its own set of disciplines, which are determined

Table 1.

Name of the module	Short description
Design basis of systems-on-chip	Processor modules with ARM architecture. SoC expansion module development. Prototyping for FPGA. Organization principles and basic elements of FPGA-macrocircuit. Languages for description of digital equipment. Introduction into VHDL, Verilog. Functional, structural description and development stages of a digital device. Design of system for digital signal processing. CAD modeling of digital devices.
Design of radio electronic means	The module contains three directions: microelectronics, pc card and mechanics of the body. These directions study the following issues: materials, technologic process, productivity, electromagnetic compatibility etc.
Systems-on chip architecture	Digital signal processors classification. Digital signal processors architecture and their peculiarities. Development and implementation of algorithm of digital signal processor considering its architecture. Architecture of general-purpose processors ARM, MIPS. Cross-platform compiling, remote debugging. Digital signal processor emulation and simulation.
Basis of audio- and video data compression	Basic concepts, color spaces, reception psycho models, quality notion. Digital processing of images. Theory of multimedia file and stream compression: compression with loss, compression without loss. Discrete cosine transform, fractal image compression, discrete wavelet transform, quantization scalar and vector. Video/audio compression standards. MPEG standards. Data multiplexing and synchronizing.
DVB digital video broadcast standards	Use and peculiarities of DVB-systems. Transport streams for reporting digital multimedia data. Coding and organization of digital data. Preprocessing. Error correcting codes.
Operating systems	Functions and architecture requirements to OS. Processes and streams. Time distributing of the processor. Memory architecture. Virtual memory. External device operation. Principles of computer system benchmark evaluation. Multiprocessing OS structure. Communication means of multicomputer system. Virtualization technologies. Protection of OS objects. Peculiarities of embedded OS and real-time Oss.
IP nets	Basis of computer nets. Physical level technologies. Information channel operation. Local nets. Level of network protocol. Level of transport protocol. Structure of an application layer and joint functioning of ULP.
IPTV technology	IPTV complex architecture: middleware, reception sub-systems, subsystems of processing, retranslation and protection of content, subsystems of quality monitoring of streams and customers' equipment. Services: VoD, TVoIP, Time Shifted TV, NPVR, EPG, NVoD. Interactive and Integrated services. Extra services: Video Telephony, Voting, Information Portals, Web, Games. Advantages of IPTV if compared with cabled and satellite TV. Web-TV. Broadcasting on HTTP protocol. RTMP protocol, its implementation and use prospects.
Programming languages and technologies	C/C++ and other contemporary programming languages. COM, SOM, COBRA. Structural, declarative and functional programming. Design patterns, abstraction layers, interfaces and contracts, error processing. Refactoring, specification of action sequences. Stages and types of software testing. Programming culture. Support systems and development of software projects. Effective use of C++ mechanisms.
Object-focused methods of analysis, programming and design	Basic elements of object-focused approach to the software development. Development of methods of object-focused analysis and design. Unified Modeling Language (UML). Direct and reverse engineering. Code re-use engineering. Typical structural, generating and management design techniques. Standard techniques of organization of software architecture. The Concept of independent architecture layers. Peculiarities of Web-applications architecture structure.
Translation techniques	Translation aim. Types of translation (compiling, interpretive translation, emulation, cross-compiling). Formal languages theory, generating grammars. Finite-state grammars, finite automation, lexical analysis. Context-free grammar, derivation trees, push-down automaton. LL(1) – parser. Postfix line and its generation by LL(1) – parser. Generated code optimization.

Name of the module	Short description
Technology of creating commercial software	Software product market research. Software production process stages. Cost estimation of commercial software product. Advertisement and software promotion on the market. Sales techniques.
Parallel programming	Basic notions, terms and basic laws of parallel processing of information. Review of formal models of parallel systems and processes. Connection between elements of parallel systems. Net link metrics. Functions of data routing. Static and dynamic layout of communication nets. Conveyer computers. Superscalar processors: their architecture. CISC and RISC architectures. Program optimization. Hardware optimization. SIMD computing systems. Vector processor. Computing acceleration in vector processors. The structure of matrix computing system. Stream and reduction computing systems. Adaptation of sequential programs to parallel architectures. Languages and libraries of parallel programming.

by individual curriculum. One and the same subject can be often met in the syllabus of both technical directions.

A typical thing for the education process is weekly-held seminars where the masters report on the process and results of their researches. Current educational issues and problems are also discussed on the seminars. Such seminars and masters' reports are beneficial not only for current control but also for good feedback that provides content correction of the program.

Apart from the special modules, the program includes the English language. The practical training is carried out by a teacher who has good language experience. The practical training is mostly focused on listening and understanding authentic dialogues, news, TV programs connected with the sphere of the enterprise activity: digital TV, multimedia data compression etc. Such attention to the foreign language is conditioned first of all by the requirement to modern professional environment: any successful IT-specialist should know English well. The students of the program have the possibility to take part in annual international exhibitions where they can communicate with foreign customers of the enterprise. During such communication it is important not only to understand the questions asked, but also to be able to describe the advantages and peculiarities of the software and hardware solutions made by our company.

Like any social environment, the model under consideration has its system of incentives and penalties. One of the encouragements is the exhibition activity mentioned above. Financial stimulus for the best students is more significant: they have increased university scholarship and salary of the enterprise.

Problems of the model implementation

Most part of the model described above has being implemented since the 1st of September 2010. However, like any real system, it has some problems.

Firstly, it is student quality. In spite of high requirements of the program to the applicants not everybody meets them. The reason is more likely the lack of time for admission rather than defects of admission testing.

Secondly, the degree of student immersion in this or that subject is still unclear. For example, what level of communicative skills should a developer of devices based on programmable logic circuits have? There is an opinion that it is useful for students to know all the subjects they are taught. In this case a student spends a lot of time on subjects he/she doesn't like. This time could be spent on more profession-focused (oriented) courses. This problem refers directly to the education model and should be solved while the discussion between the university and company representatives. One of the solutions might be the possibility for the student to attend non-core subjects in reduced volume.

Thirdly, heads of the departments don't pay enough attention to the rotated students. Not all the heads would agree spending a lot of working time with students. Even less would give them serious tasks (problem) risking to fail it because of students' lack of experience. Such problem can be solved at the enterprise level.

Naturally, the whole set of problems includes more than these three points. There are minor problems that are solved in the course of the program. Time will certainly show even more obstacles but they all can be solved if the university and business find common ground.

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Rosneft oil company and Siberian federal university partnership

Siberian Federal University
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The article discusses a unique experience of a major corporation and a federal university cooperation in personnel training for oil and gas industry.

Key words: *private and state partnership in education, oil and gas, professional competence.*

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V.I. Kolmakov

Today there is a problem of collaboration between the labor market and higher education. It should be recognized that modern universities are often distanced from industry and do not form labor market and employers are poorly involved in the development and implementation of educational programs for training specialists in the field of engineering and technology. Figure 1 shows the lack of feedback and tools for its realization between the labor market and higher education. However, described feedback mechanism makes us consider the following functional roles of employers: development of professional standards, definition of requirements to graduate competence, participation in the development of new concepts of state educational standards, involvement in independent higher education quality assessment , universities ranking. To implement such feedback mechanism on a larger scale «Concept of strategic partnership of the Siberian Federal University with technology clusters» was developed in Siberian Federal University. The main goal of the concept is to identify ways and instruments of private and state partnership of business, regional authorities and the university in the formation of a new profile of the regional economic system. The following issues are concerned in the concept: factors that predetermine need of strategic partnership between SFU and technology clusters, university positioning, goals and logic for collaboration with strategic partners, instruments for strategic partnerships development, targets and system results of partnership. Obviously, the concept realization is impossible without additional financial resources and political will business leaders and regional administrations.

Siberian Federal University is actively cooperating with many large industrial enterprises. First of all, fruitful cooperation with developing companies, which has recently started working on the territory of Eastern Siberia should be noted. One of such companies is OJSC NK Rosneft , actively exploring new major oil and gas province within Krasnoyarsk, Irkutsk and Yakutia regions. Development of oil reserves in Eastern Siberia could have a very significant impact on the economy and education system in the regions where mining, processing and transportation of hydrocarbon resources takes place. So, with coming of OJSC «Rosneft» in the Krasnoyarsk region and putting into operation Vankor oil and gas field (with average four thousand tons of oil daily capacity) dramatically accelerated the development of training and research for the oil and gas branch. The need to provide the oil company Rosneft with advanced engineering staff that can develop innovations and work in difficult climatic and geographical conditions of Siberia has led to the decision of developing a system of continuous education, which includes a set of preliminary training, targeted practical training of students, additional education and retraining in Siberian Federal University. The first step was the organization of professionally oriented «Rosneft-class» in the public schools of Krasnoyarsk, Igarka, Turukhansk, Boguchany, Achinsk. Students of the 10th grade are recruited on a competitive basis. The educational program is designed and implemented in two- year period. SFU professors and teachers are actively involved in the educational process. They not only teach students basic subjects (mathematics, chemistry, physics), but also are engaged in broad vocational guidance and educational activities, support the research work of students. According to statistics, more than 60% of graduates of «Rosneft-class» enter universities choosing oil and gas departments.

Along with this the oil company Rosneft has initiated the development of private and state partnership for constructing new training and laboratory building of the Oil and Gas Institute at Siberian Federal University. The project on designing, construction and commissioning of the Institute's building was implemented in accordance with an agreement «on cooperation in education and science» signed on December 29, 2008 between the Ministry of Education and Science, Government of Krasnoyarsk Krai, OJSC «NK» Rosneft «and Siberian Federal University ' to finance the project. The oil company Rosneft allocated 890 million rubles, the Government of the Krasnoyarsk Krai - 125 million rubles, the Ministry of Education and Science through the Development Program of SFU - 740 million rubles. The project of private and state partnership was successfully completed, and on September 1, 2010 in the presence of Prime Minister

Fig. 1.

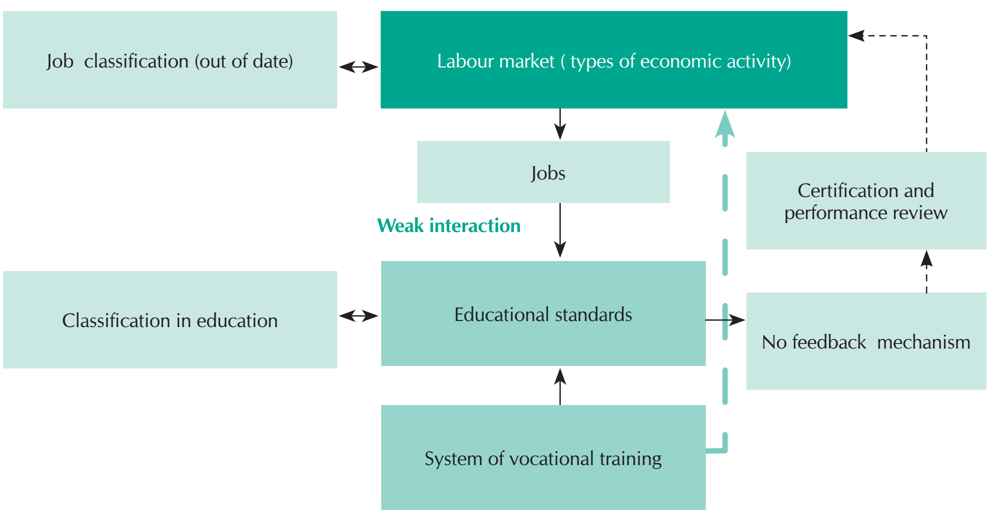


Fig. 2.

Vladimir Putin grand opening of the new teaching and laboratory building took place (Fig. 2).

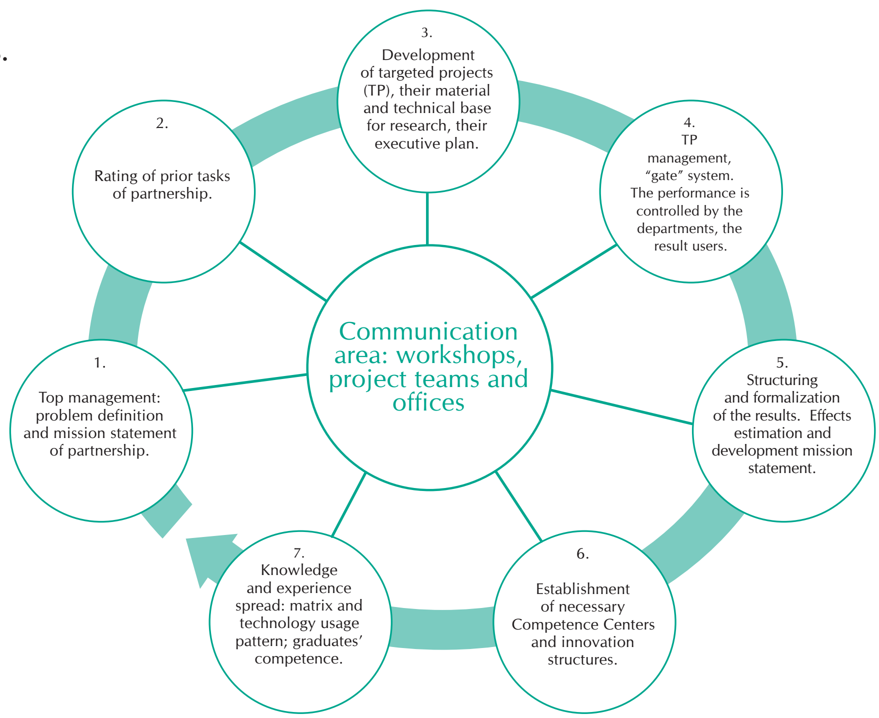
Start-up of new building equipped with all required facilities and involvement of leading experts of the company in the teaching process allowed to introduce educational programs in all areas and specialties of oil and gas industry. The project was not finished with that building but was further developed. Technology of strategic partnership development between the university and the company is described in the form of a diagram in Fig 3. Rosneft and Siberian Federal University assert the Institute of Oil and Gas as a modern scientific and educational complex for practically oriented training of professionals at all levels for oil and gas industry in Eastern Siberia and the Far East. This positioning is based on the fact that the company has developed and submitted a set of competencies, which Institute graduates should have. The list includes the requirements for graduate readiness to decision-making and management processes in difficult climatic and geographical conditions, to applying modern tools and information and communication technologies to improve the competitiveness of enterprises, etc. Generally the set of competencies can be concerned as a unique experience in defining industry requirements including foreign companies to future professionals [1]. This approach required by from the institution faculty hard work on the modernization of basic educational programs, curriculum and test materials. In line with such modifications the educational process was also adjusted: the number of hands-on labs with the latest information technology and modern tools was increased. For training oil and gas industry professionals teaching and research laboratories and classrooms for special disciplines were equipped with modern and unique instruments and equipment, including: oil and gas geology, geophysics and field wells, core analysis and reservoir fluids, drilling equipment and tools, oil and gas refining technology, research, laboratory test on oil and petroleum products, oil and gas transport, automation and control equipment, fire protection oil production facilities, oil and gas storage and transportation. All purchased equipment and devices had been examined and previously approved by the experts of the oil company Rosneft.

Further steps in the development of practically oriented training entailed structural changes in the Institute of Oil and Gas. Together with companies different industry-based departments were established: on the base of JSC Achinsk refinery - Department of Chemical technology of hydrocarbons, on the base of JSK Eniseygeofizika - Department of Geophysical methods, on the base of JSC Vankorneft and KrasnoyarskNIPineft - Department of Development and operation of oil and gas fields, jointly with the Institute of Catalysis SB RAS and the Institute of Chemistry and Chemical Engineering SB RAS - Scientific and educational center for research and development in the field of catalysis and petrochemistry was founded. These structural changes were aimed at creating conditions to bring research results to industrial designs and commercial products, testing and implementation of technical and technological innovations for the benefit of oil companies.

For the purpose of making a system of practically oriented training of professionals ready for research and innovation and in order to create multidisciplinary research teams the president of JSC NK Rosneft Mr. E. Yu. Hudaynatov approved a joint plan of action and effective cooperation to implement the Company program of innovative development and signed an order to establish on the base of the SFU Institute of Oil and Gas Rosneft Innovation Center and Center of excellence in the field of petroleum refining. Currently, a long-term perspective target order was formed by the company to conduct research and development activities at the university.

Subsidiaries of the oil company Rosneft provide motivated and successful students the opportunity to undergo practical training from Novorossiysk to the Far East. The company pays great attention to promote successful learning and research activities of students and young teachers. In view of this there are annual corporate scholarships and grants, funding programs for academic mobility of talented students from foreign universities. In order to attract professors from leading Russian and foreign universities to work at SFU Rosneft has been earmarked donation to the university to purchase a comfort-

Fig. 3.



able dwelling (6 apartments). Rosneft has been also investing funds in the development of the Institute of Oil and Gas through cooperation in the field of retraining and skills development, training courses for trade qualifications at university training ground as well. The above listed examples of large-scale and systematic technical and financial support of the University by one company are rarely met not only in Russia but also in Europe [2].

Partnership with Rosneft has allowed the university to join two Russian technology platforms «Technology of production and use of hydrocarbons» and «Deep processing of hydrocarbon resources», as well as regional technology platform «Technology of extracting and processing of hydrocarbon resources». The main purpose of these technology platforms is providing the transition from resource-based economy to an innovative development of oil and gas industry. The company has initiated the development of cooperation with leading international oil and gas companies and universities to invite visiting professors, transfer of educational technologies, to be aware of the latest technologies in the oil and gas sector, the academic exchange of students and teachers. Agreements on cooperation and (or) memorandum of understanding were signed with such companies as Schlumberger (USA) and Heinemann Oil (Austria), Weatherford (USA), GexCon (Norway),Vinci Technologies (USA), French Institute of Petroleum , National Polytechnic Institute of Toulouse (France), University of Texas at Austin (USA), Agriculture and technology university of Texas (USA, Houston), etc.

Today with the support of Rosneft a non-profit partnership «National Institute of Oil and Gas» is established in Russia by analogy with the French Institute of Petroleum. The founders are presented by 16 universities (including SFU), which train specialists for the oil and gas industry, 4 Institutes of Russian Academy of Science and LLC «All-Russia Research and Design Institute of Oil Refining and Petrochemical Industry». The goal of the Institute is the co-ordination of educational programs in Russia, research, development of new technologies, consolidation of information and human resources for the benefit of oil and gas industry. The interaction between Rosneft and Siberian Federal University has many different aspects - from the cooperation in educating the next generation of professionals in the oil and gas field to the partnership in basic and applied research aimed at solving the problems of tomorrow. Thus, the company is considering the University not only as a worthy partner for staff training, but also as an important source of new knowledge and innovative thinking. Positive experience of private and state partnership between the oil company Rosneft, the Government of the Krasnoyarsk Krai and Siberian Federal University, high-quality and timely implementation of the project represents a good practice that would be useful for further collaboration of the university with other companies as well as for all Higher Education in Russia.

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Challenges and Solutions: Master's Student Training for Post-Industrial Economy

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The paper discusses the problems and their solutions, associated with the quality enhancement of Master's program training in engineering with a view to a post-industrial economy.

Key words: *master's students, post-industrial economy, active training techniques.*

B.L. Agranovich

The basic principles of education program development, training technologies and education system itself depend on the social and economic structure of the society.

We must now subject the main differences of industrial and post-industrial education and economy to a somewhat closer scrutiny (Table 1) [1].

Higher education in the industrial society is widely regarded being a public benefit and it is provided on the bases of technocratic approaches and autocratic class and lesson system originally designed by Jan Amos Komensk in VII century. The system is aimed to provide mass education and meet the requirements of mass production characterized by low-changing nomenclature.

In due time, this reform was considered to be a breakthrough in the system of education.

Unlike industrial society that is motivated by mass production of goods and services, post-industrial economy is focused on an absolutely different type manufacture:

- production of goods and services in accordance with customers' needs,
- development of market driven industry,
- anthropocentric approach,
- science-based production.

In post-industrial society, an economic transition has occurred from a manufacturing based economy (concentrated production areas) to the dispersed production networks, i.e. corporations and transnational companies. Thus, economic globalization can be observed.

High «quality of life», personal fulfillment and knowledge-driven industries are the main characteristics of a new social and economic structure of the society.

As for education, it is no longer viewed being a public benefit, but an educational service obtained through

Table 1.

Social and Economic Characteristics	**Industrial Society**	**Post-Industrial Society**
Predominant manufacturing model	■ mass use of machinery for solving social and economic problems; ■ mass production of standardized goods characterized by low-changing nomenclature	■ production of goods and services to meet consumer's (client) needs
Manufacturing process management	■ succession of technological processes in terms of concentrated production sites (plant, factory and etc.); ■ standardization; ■ centralization; ■ gigantomania	■ transnational corporations; ■ «market-driven industry»; ■ anthropogenic approach; ■ science-based industry
Primary factor of production	financial capital	intellectual capital (human, structural, managerial, innovative, process-driven
Social and economic structure of the society	■ economics of scale; ■ technocratic approach; ■ mass production and distribution; ■ mass culture and education	■ economy globalization; ■ high «quality of life»; ■ personal fulfillment
Education system	■ education as a public benefit; ■ education is out of manufacturing; ■ class and lesson system; ■ authority	customer-oriented system of educational services based on: ■ self-administration, ■ personal orientation, ■ continuity, ■ efficiency, ■ quality, ■ result assurance, ■ naturalness

self-planning, self-education, and self-orientation and characterized by sustainability, efficiency, naturalness and result assurance within a person life pattern.

Several failed attempts have been made since 1960 to modernize traditional class and lesson education system regarding new requirements. Today the class and lesson system is critically reviewed.

To give an example, D. Sanghera, professor of University of Michigan (the USA) said: «We are approaching the completion of a great experiment in mass education».

The class and lesson system of mass education designed by Jan Amos Komenský turned out to be a failure as it educated several generations of unskilled personnel showing absurdly high level of ignorance. This system kills the desire to continue studies both in adults and youths.

The class and lesson system is aimed at training of numerically insignificant elite that can make a success due to its capabilities and talents. Contrary to what one might expect from education, it breeds poorly educated and absolutely indifferent majority of people deprived of any possibilities». (http://www.si.umich.edu), [2].

Today, the study of professional education system which would meet the requirements of post-industrial economy and society is proceeding vigorously.

Let us consider the basic requirements for educational Technology Master's Degree program.

First of all, it should be realized that in terms of the transition to the innovative economy Technology Master's Degree program is viewed as one of the strategic interests of the Russian Federation. Masters of Technology, being the representatives of innovative culture, must accelerate production industry development and contribute towards the acquisition of new technologies.

It is essential to help Master's students to conceive the fact that they belong to the professional elite meant to play a key role in post-industrial economy reconstruction.

Technology Master's Degree program must be focused on the development of the following competitive skills and advantages:

- acquisition of knowledge in engineering problem solution, innovation studies, mechanical and civil design;
- ability to work on projects in interdisciplinary network, interact with the experts of various subject fields through telecommunication media and technology;
- acquaintance with the methodology of automated cooperative design of complex systems at all stages of life cycle (CALS-technologies);
- innovative way of thinking and creativity;
- integrated and interdisciplinary knowledge, application of multicriteria approach to solving complex problems;
- experience in research work, including engineering, economic and ecological decisions, knowledge of technology transfer methods;
- sustainable motivation for continuing education;
- ability to apply self-administration techniques for professional, personal and talent development;
- English language fluency for professional interaction.

The above-mentioned competitive advantages would enable Master's students to work and take the decisions more effectively in comparison with enterprise's specialists.

Master's students training must be provided through self-directed and self-planned learning in accordance with competence-based programs characterized by interdisciplinary methodology, flexibility (module-based), learner-oriented approach, and liberal structure.

The necessity to combine deep fundamental knowledge with engineering creative work and entrepreneurial skills poses a major challenge concerning Master's students training for post-industrial economy.

To overcome this difficulty it is necessary to change the Master's program itself.

Today, it is obvious that traditional understanding of professional education as an acquisition of a definite set of knowledge, based on teaching of fixed subjects, is not sufficient to provide an effective training of Master's specialists. Moreover, it significantly retards the formation of new ways of thinking.

Not only subjects should become the basis of education, but also the ways of thinking and functioning, i.e. procedures of reflective nature. Knowledge and methods of learning and functioning should be united into organic integrity.

All this poses a task of including the following issues into the requirements to content and level of engineering training:

- fundamentalization of engineering knowledge and activity;
- assurance of innovative thinking development;
- specialist complex training for further innovative activity (abilitation).

An essential point in Technology Master's student training must be fundamentalization of engineering knowledge and activity (Fig. 1).

The development of innovative thinking must be considered as one of the main objectives in Master's training for post-industrial economy (Fig. 2).

Innovative way of thinking comprises creative, strategic, systematic and transformational mental activities, as well as peculiarities of interdisciplinary knowledge.

Complex training of specialists for further innovative activity must be viewed as an integral part of Master's program (Fig. 3).

The application of effective technologies and international information resources for knowledge acquisition, development of professional, educational and personal qualities must be regarded as a crucial point in Master's student training:

- benchmarking, case-technology, personal and professional development courses, business-training activities;
- business games and team building activities;
- problem and project based study;
- workshops;
- project sessions;
- interdisciplinary projects;
- project fulfillment according to customer's needs.

It is very important for Master's students to be involved in real task completion and project work fulfillment in order to stir their creative activity and develop target-oriented education.

All this would contribute to the transition from the entirely educational process to the so-called science-based education in terms of Master's students training.

Science-based education can be represented as a system of workshops organized by distinguished scientists and leading engineers. The updated community of Bachelor's and Master's students, post-graduates and candidates for a Doctor's degree forms a creative team, a kind of scientific school capable of ensuring consistency of educational and professional methodology, developing the concepts of the world and man, forming scientific and engineering ideals, values and targets, and passing the research traditions down to the next generations of engineers.

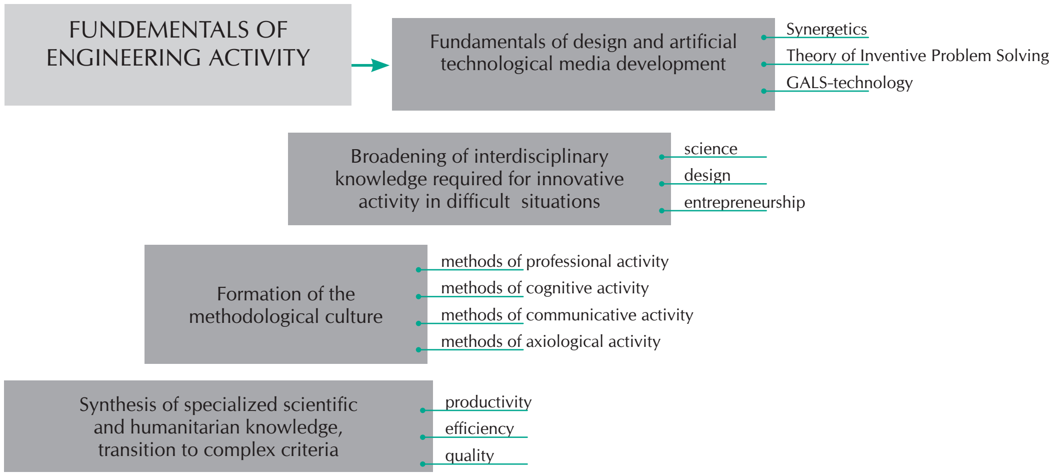
Contemporary educational technologies within the frame of Master's students training must also imply participation of students in various academic mobility programs.

Today all-sufficiency of the university in any country, which is aimed at professional training of engineers competitive on the world market of intellectual labor, has been exposed to fair criticism. The necessity of academic mobility programs that enable students to study both in Russian and foreign universities, as well as to participate in a large enterprise level is generally recognized to be very important.

Based on the above mentioned reasoning and facts, the following conclusion can be made:

- the main objective of Master's Degree program is to ensure competence-based education of specialists who will be able to take decisions under competitive conditions, to settle down quickly in a new job environment and to perform their work better than those who have been already working for a long time. Master's students must be ready to become the representatives of innovative culture who will significantly accelerate industry development and new technology acquisition;
- it is essential to help Master's students to conceive the fact that they constitute professional elite characterized not only by deep knowledge obtained through competency-based training, but also by willingness to work in the terms of post-industrial economy;
- Master's students training must be provided through self-directed and self-planned learning in accordance with competence-based programs characterized by interdisciplinary methodology, flexibility (module),

Fig.1.



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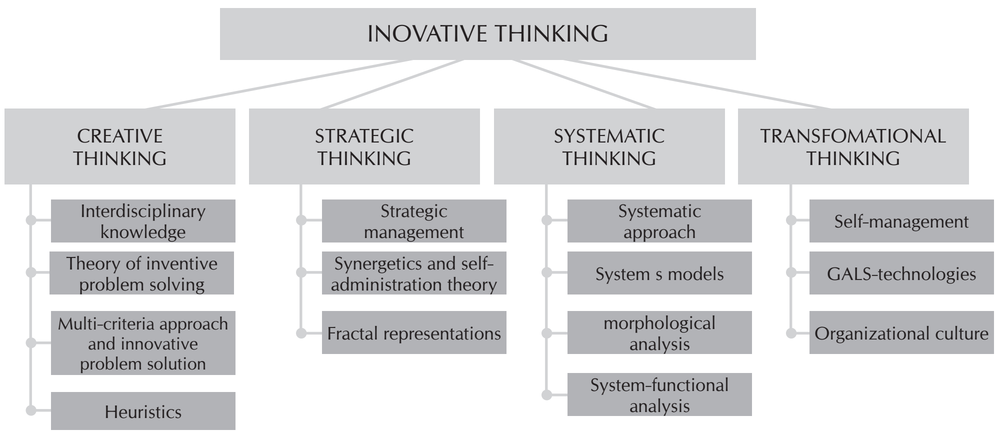

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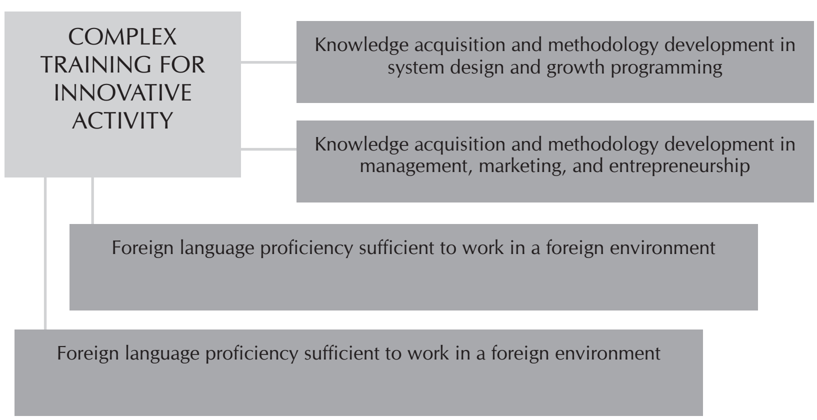

learner-oriented approach, and liberal structure;

- Master's degree programs must be based on active learning techniques, international information resources, intensive study with distinguished faculty, active participation of students in research and project work, carried out in technological incubators and strategic partner's sites;
- To train specialists competitive on the world market of intellectual labor it is crucial to expand student academic mobility by implementing Double Degree programs and active participating of industrial enterprises.

To conclude, I would like to emphasize that in order to succeed in solving problems of Master's student training it is necessary to attract Bachelors from different Russian universities based on competitive selection.

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Interactive Training as a Modern Specialist Training System in Oil and Gas Industry

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The article deals with comparative analysis of interactive training implementation with respect to the specialists working for the leading energy companies of the world such as Shell, BP, TNK- BP, BOUBON, «GAS-PROM» OJSC. The interactive training is viewed as the training built on interaction of the student with the training environment on the basis of real production processes.

Key words: *interactive training, modern specialist training system, leading energy companies, competencies.*

E.G. Leontyeva

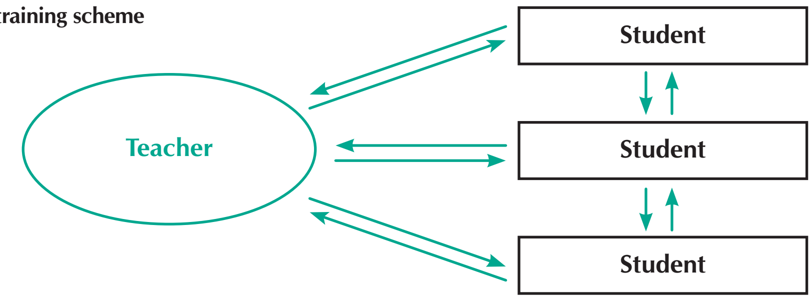
Heard-forgot, saw-remembered, made-understood.
Chinese proverb

The modern stage of the society development is characterized by high requirements to educational level and competences of the operating staff. It is caused by the implementation of new technologies and process units in production, which allows reducing the number of operating staff and even having some units stand-alone serviced. The staff competences, which are necessary at the moment, are the following: the ability to take decision in accident situation, the ability to use system approach, the ability to use different operation systems, etc. These skills are formed and developed in the process of interactive training. In the general form, the interactive training is viewed as a specially arranged form of cognitive activity. The training process, in this case, allows students to be involved in a cognitive process. They have the possibility to understand and reflect on what they know and think. (Fig. 1) [6, p. 25-27].

We consider the interactive training in a particular form, as a training built on interaction of the student with the training environment on the basis of real production processes.

The best way for adults to remember information is to be actively involved in the course of training solving practical tasks and exercises. Psychologist researches show that adults remember 20% of what they hear, 40% of what they hear and see and 80% of what they hear, see and do. That is why the training is less effective if students obtain information in a passive way: listening to lectures and watching teaching slides. Doing is here understood as information compilation, critical evaluation of the obtained information and practical implementation of knowledge. Training is the most effective if it takes into account a real situation.

Fig. 1. Interactive training scheme



The interactive training implementation should include actions that help students to develop critical thinking, to solve real tasks and to acquire skills that are necessary for further effective work on similar tasks. Therefore, the basic components of interactive training are interactive exercises and tasks for students to do. There are two reasons of the effectiveness of interactive training. The first one is direct participation of every student in every exercise. The second reason is a combination of theoretical and practical exercises. The students have to develop the skills which are necessary for everyday working activity [4, p. 158].

The use of modern technical and technological means makes the training very close and true to real production process [2, p. 26]. The elements of interactive training can be a virtual scheme, an automatic training system, a trainer-simulator, a full scale working equipment model.

In this article we try to analyze the interactive training experience obtained by Russian and foreign oil and gas companies in training their staff. To conduct the research the following complementary methods were used: a system analysis, a structural and functional analysis, brainstorming, expert assessments, a historical and comparative analysis and a casual analysis. The interactive training is mostly used in corporate educational institutions as the production safety and efficiency directly depend on competence level of the staff.

Shell Company is an international corporation that unites energy and petrochemical companies in more than 90 countries. The corporation's aim is to satisfy the society needs in energy sources considering economic, social and environmental aspects of today and future [7]. One of the most valuable assets of the company is highly qualified personnel. Shell training centers with KCA DEUTAG company use a drilling trainer DART (Drilling and Advanced Rig Training) to train their specialists. It is a unique computer system that allows developing drilling skills and different engineering situations in real time mode with the use of downhole simulation technology. 3D-graphics, simulation in real time and sound effects made the trainer DART the leading simulator in oil and gas industry. The simulator provides the development of practical skills for working on drilling rigs as well as the optimal ways of drilling. There is software in DART system that effectively integrates and simulates downhole conditions. Thus the trainer can be used in safe conditions by both newcomers and experienced specialists using real project drill hole data. Such training approach contributes to the reduction of time loss while staring up new drill rigs. The full-scale working simulator DART provides realistic practical solutions at the stage of drill crew training before its working on a new drilling rig or before starting a new drilling project. It allows drilling a virtual hole on the set project parameters and identifying potential problems. It also encourages effective communication and friendship in the crew. The financial input into the simulator-trainer is insignificant in comparison with potential product and time loss risks.

BP is an international company, working in more than 100 countries of the world. It does oil and gas exploration and production in 26 countries [8]. TNK-BP is one of the leading oil companies in Russia which is among ten world largest private oil companies in oil output. It was established in 2003 as a result of BP and AAR assets pooling. BP and AAR have the company on parity basis. 50% stake of Slavneft also belongs to TNK-BP. One of the strategy directions of the company is the development of organization potential: that is the development of staff knowledge and skills that meet long-term needs of the business [9].

BP, Shell, Total and other big international companies use the services of BOURBON Company – a leader of offshore oil and gas production [10]. This company works in 35 countries of the world, its staff consists of 8350 people and it has more than 400 ships. BOURBON is based on staff development and quality service for customers. Recruitment and personnel training is the basic point in the strategic plan of BOURBON «SKYLINE -2012». According to the plan BOURBON is going to double the number of ships and the number of staff which is the key to the company's success. To achieve the goal the company has developed a unique training system built on formation of high level skills of all its employees. BOURBON guarantees that its staff is not only qualified and experienced sailors but also specialists that can apply modern exploration techniques. In the frame of its politics BOURBON distinguished key training stages, necessary knowledge and «know how» for every specialty. Then an individual training program for every employee was developed. It includes practical training on shore and at sea to improve professional skills. The training model uses the same methods as the training methods in aviation. The staff qualification is built on basic theoretic knowledge, simulator training and personal professional experience of a student. The training course includes both theoretical and practical training. To train the staff BOURBON established its own training centers equipped with the trainers that simulate real complicated production operations requiring extremely high accuracy from the staff. The use of simulators for personnel training became a compulsory condition to provide safety and high quality service.

Every exercise done with the help of a simulator has three stages:

- Preparatory phase to distinguish and analyze possible accidents and dangers;
- Modeling practical exercises with a simulator;
- Summing-up by analyzing a student's behavior in any emergency situation.

Maritime simulators are excellent tool for maneuvering in 3D naval operations that require maximum accuracy and safety. A particular thing about the simulator «Safe drilling» is a commander's control panel. On finishing the course the specialists have the competences for anchor and supply operations according to safety and quality standards developed by the company for the best quality service in any place of the world. The simulator training allows the students to understand all the system aspects, to learn the control panel using highly realistic settings. After that the students' knowledge is tested afloat. As an extra option there is a possibility to train the work with dynamic positioning. Being a reliable and multi-functional training tool, the simulator trains the students for real operations. It allows them to model exercises on a ship of class 2, to carry out positioning with local maps, to learn regulatory procedures and communication means and to be ready for emergency situations such as program changes, rapidly changing conditions etc.

A «Work ROV UHD» simulator, developed by Shilling Robotics Company (the USA) and implemented in 2008, helps to train captains and crews who work using robot divers. The simulator is the first and the only one in Southern

Europe and Mediterranean. It simulates very realistically technical inspection and maintenance using 3D modeling, it can also simulate different weather conditions (visibility, streams etc.) and take into account different types of operations: pipeline installation, drilling rig installation etc. The simulator can be adjusted to a particular customer. About 50 captains are going to be trained in the next 2 years. The simulator is developed in a mobile version and can be installed in any place of the world to satisfy any requirements of local companies in this sphere.

OAO «Gazprom» is one of the largest energy companies of the world. Its major business lines are geological exploration, production, transportation, storage, processing and sales of gas, gas condensate and oil, as well as generation and marketing of heat and electric power. The Company places high emphasis on the professional development of its team. Practically all the branch enterprises have their own educational institution. In 2009 the Company adopted a program according to which every educational institution should have its own exercise area equipped with modern full-scale simulators. The educational Center of «Gazprom transgaz Tomsk» OJSC is one of the first who put into operation the exercise area. Its aim is practical training of safe activities and skills required during gas hazardous works and maintenance of modern gas equipment and technologies. To achieve these aims an interactive training system was installed in the exercise area. It involves full-scale working equipment and objects, virtual systems, automatic control systems (ACS), central control systems and the system of training control and analysis in real time. The interactive training system has some workstations for the students. They simulate current condition of main gas pipeline facilities. It also has video surveillance equipment for the pipeline facilities to train control (management) of video streams from cameras. The students are trained in group or individually with a teacher's participation, whose workstation is connected with database. The teacher manages and controls the equipped training process. At the first stage he/she presents the structure and working principles of single units of equipment and main gas pipeline in the whole using the full-scale working equipment of main and auxiliary facilities. At the second stage the teacher sets the routine operation of the full-scale equipment facilities. Every student controls and analyzes the work of main gas pipeline equipment either from the ACS or from the operator's workstation. The teacher can change the current settings value by means of simulator and (or) emulator in real time. For example, while a gas distribution station (GDS) works, the teacher changes the value of pressure ratio on one of the GDS filters. The student should analyze the situation and take measures to remove the contingencies. At the next stage the teacher uses simulators instead of full-scale working main gas pipeline equipment. The simulators set parameters either of routine operation or emergency situations according to set scenarios. There is a possibility to change parameters in real time. For example, the scenario of GDS contingency operation is downloaded: the pressure increase is on consumer line. The teacher can simulate a pressure regulator failure on the reduction line in real time. At this moment one of the students should do the corresponding shifts (regulations) from ACS of GDS to remove the contingency while the teacher and other students watch and evaluate his/her actions from their ACSs. Modern technological installations are equipped with efficient automation systems of production processes. However it doesn't reduce the responsibility of operators to take right decisions immediately. It is especially true for contingencies, when people's life depend on operator's actions and good team work. Interactive systems, which simulate real operation systems, are effective way for the staff training. Working in usual environment and having automatic skills it is easy for the student to apply them in real operation system.

Training the right actions in routine and emergency situations, the specialists not only increase their qualification but also gain the confidence to cope successfully with any contingencies. As a result, the risk of emergency reduces decreasing production loss [1, p. 85]

Analyzing the existing interactive training systems in foreign companies (BP, Shell, TNK-BP) and in Russian («Gazprom» company) some key points can be distinguished (Table 1).

The comparative analysis allows showing the scale and distinguishing basic elements of interactive training system. It also shows that the assessment criteria of interactive training efficiency can be error-free operation of personnel as well as accurate actions of the staff in emergency situations with on panic and time loss [5, p. 127].

Thus, analyzing the experience of staff training in the educational centers of Shell, BP, TNK BP, BOURBON and Gazprom, it is possible to conclude that the interaction training model is the prior direction of educational activity in the companies mentioned above, as this is the most adequate form of personnel training in oil and gas industry. But it is necessary to note that these systems need to be constantly upgraded and developed [3, p. 153].

Table 1.

	Basic elements of Interactive system	**Interactive system developers**	**Interactive system development on university basis**
Gazprom	ACS, full-scale working equipment lay-out, simulator, 3D models	Educational Centers of Gazprom branch enterprises and equipment suppliers	Effective interactive training systems for young specialist training
Shell	Virtual system, full-scale working equipment lay-out, 3D models	The IS developers are more often the suppliers of oil and gas equipment	
BP	Virtual system, full-scale working equipment lay-out,		
BOURBON	Virtual system, full-scale working equipment lay-out, 3D models		

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Target-Oriented Training of Computer Engineer-Mathematicians in Kazan Federal University in Collaboration with JSC «Tatneft»

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The authors of this article discuss their collaboration experience between Kazan Federal University and JSC «Tatneft», one of the largest Russian petroleum enterprises, in training IT-engineers.

Key words: *programmers, curriculum, interaction with enterprises.*

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Introduction

From the late 1970s the intensive development and advancement of IT-equipment and software products promoted the key IT industry market development. Large-scale training of professionals in IT areas has emerged as a relevant problem today [1].

Designed updated training programs for IT-specialists should be based on international education standards, edited by such leading international professional organizations as Association for Computing Machinery (ACM) and Computer Society of the IEEE which have been involved in this area since the 1960s of the last century.

During the first decade of the 21st century a series of documents involving typical curriculum models were developed and designed, such as Computer Science 2001 (CS2001) [2,3], Information Systems 2002 (IS2002) [4], Computer Engineering 2004 (CE2004) [5], Software Engineering 2004 (SE2004) [6], Information Technology (IT2006) [7].

A second edition of above-mentioned documents was published. Third-generation State Educational Standards in «Applied Mathematics and IT» were designed on the basis of these documents and recommendations, respectively.

However, the development of future professional competencies should include those professional standards which conform to the actual requirements of Russian economy [8].

High-quality training of specialists is the top target of many Russian universities, one of which is Kazan (Volga) Federal University [9]. The authors of this article discuss their collaboration experience with JSC «Tatneft», one of the largest Russian petroleum enterprises, in training IT-engineers.

Specialist Training Program Organization

Since 2000 target-oriented training of students in Applied Mathematics and IT in collaboration with JSC «Tatneft» has been accomplished at Kazan University, Institute of Computing Mathematics & IT. More than tens of highly-skilled graduates have become leading professionals in the IT-sectors of «Tatneft».

The training program is based on a tripartite agreement (company- university-student), according to which, the company funds tuition fees to students and even scholarships for successful students, whereas graduates have to work for this company over three years. Under the company initiative a new study system was developed including an updated curriculum and new lecture courses, which, in its turn, furthered a new profile area for specialists and integrated Bachelor and Master degree programs. Under such conditions the company's requirements are not only to exclude infringement of the fundamental skills profile in «Applied Mathematics and IT» and State Educational Standards (SES) requirements but also to introduce those integrated courses associated with the problems and issues of the company itself (JSC «Tatneft»). Besides fundamental subject modules in mathematical simulation and IT, the following courses were also introduced- mathematical models in geology & geophysics and GIS (geological \geophysical information system).

Annually, students have internship at TatASC Petroleum Production Enterprise. Problem-solving topics for term and graduate papers are elaborated by the employers of this enterprise as well as within the frame of business contracts.

Training Program Description

The majors are interrelated with information technology (IT) and are divided into two modules: theoretical module based on discrete mathematics and training module courses, involving sophisticated software engineering.

The training module courses include:

- Object-oriented analysis and engineering design (esp. UML and case-technology);
- Specific information processing language (IPL) and their automation design;
- Programming technology in Java,
- Technology of Oracle database (Java and Oracle database are proprietary standards in JSC Tatneft»);
- Operation systems (UNIX);
- Digital signal & image processing;
- Computer graphics;
- Computer architectural design;
- Data design and algorithms;
- Software engineering;
- GIS.

The training program also involves integrated modules specifically designed for JSC «Tatneft», such as courses associated with digital copyright (or security policy) and petroleum engineering, embracing applied tasks and solutions with different engineering approaches. These target-oriented modules include the following courses:

- Mathematic methods in continuum mechanics;
- Fundamental principles in geology and geophysics;
- Reservoir engineering;
- Hydrodynamic well testing (AOF testing);
- Petrophysics and fundamental principles of filter (seepage) theory;
- Mathematical reservoir simulation;
- Hydrodynamic methods in geology and geophysics;
- Numerical methods in hydrodynamic filtration theory.

Conclusion

Here the authors gave a very concise description of their collaboration experience between Kazan Federal University and JSC «Tatneft», one of the largest Russian petroleum enterprises, in training IT-engineers. Further collaboration would involve the establishment of a research-training center of data support in oil field development as well as the development of integrated programs with Institute of Geology and Petroleum Engineering of Kazan Federal University.

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Integrated System of Engineering Education in Aerospace University

Siberian State Aerospace University named after Academician M.F. Reshetneva
V.P. Nazarov, M.G. Melkozerov

The article deals with the basic principles of higher professional education integrated system. The organization and planning methods of tuition process for aerospace specialities in the system of integrated teaching are presented. Some innovative educational techniques aimed at enhancement in training quality are given.

Key words: *integrated educational system, internshiptraining, project-team training, aerospace education, quality management system.*

V.P. Nazarov

M.G. Melkozerov

The ideas of inseparable combination of theoretical training with scientific research and enhanced professional-practical training have always been the basis for the native system of engineering education. In the middle of the 20-th century there appeared the problem of integration of education, science and production in our country with the intensive development of advanced industries, implementation of new techniques, construction and reconstruction of enterprises intended for the production of the international standard. Under these conditions the demands for engineering university graduate capable of quick adaptation at production process, with profound knowledge in production process organization principles, possessing professional skills of engineering jobs has grown significantly.

To solve this problem the Resolution of the USSR Council of Ministers was adopted in December, 30, 1959 №1425 «On organization of plants-technical colleges» as higher engineering institutions of new formation aimed at training specialists of high qualification for competitive enterprises. According to this state resolution, Krasnoyarsk plant-technical college was commissioned to provide the efficient training for rocket-space specialists who had not been trained in Siberia before.

Within 50 years of its life the technical college has passed a long and hard way from the branch of Krasnoyarsk Polytechnic Institute to Siberian State Aerospace University, which at present is a unique specialized university on the vast Siberian-Far-east territory training specialists in the sphere of space rocket design and production as well as operation and maintenance of aviation technology. In some programs SibSAU is a leader in the structure of aerospace education in our country.

Aerospace education takes a special place in the Russian educational system. It is quite reasonably ranked as elite professional education presented its long-term efficiency by high achievements in native aviation and cosmonautics. In spite of some serious social-economic and production problems the Russian aerospace industry has produced items of space rocket and aviation technology that has no world analogues and in terms of some engineering specifications exceed the best foreign samples.

High complexity of aerospace technology, specificity of applied techniques, presence of military component and dynamics of production development require the knowledge of not only theoretical bases in design and production of this equipment but also all the stages of its operation. This fact defines the central role of system approach to the problems of optimal design of educational curricular for specialists' training in the sphere of aviation, aerospace and cosmonautics. It is just the principles of consistency, succession, and continuity that the integrated system of training highly qualified engineers in SibSAU is based on and realized successfully during fifty years of existence.

The integrated training system implies combination of theoretical courses with production professional internship in the structure of curricular. The principles of integrated training in speciality of space rocket profile are basic for all stages of the university development. They are sure to have changed and determined by the tasks of development trends in space rocket complexes of different generations and current production conditions. Integrated system has always been considered as a possibility for realization of flexible forms in educational activity taking into account individual abilities and skills of future graduates in definite type of engineering job: research, design, project, engineering, production. On the other hand, it is obvious that in modern condition integration with knowledge-intensive and high-tech production is the most efficient way of preparing graduates for the leading edge of the scientific progress using human, engineering, and scientific resources of enterprises in the course of training.

Flexibility and adaptability of integrated system is visually demonstrated by the graph of educational process in engineering specialities. For example, students learning at such specialities as «Rocket engines», «Flight Control Systems», «Engineering technology», «Technology and facilities of welding engineering» during one term of the third year and one term of the fifth year combine internship in the first part of the day with class hours in the university in the second part of the day. This stage of the engineering internship during which junior students learn definite working jobs and get working qualification of machine operator, NC machine operator, fitter, electrician, welder. Senior students work in engineering positions in workshops, departments, laboratories of an enterprise.

Of some different view is the curriculum of students specialized in «Cosmic apparatus and upper stage equipment» as well as «Space control and positioning systems», «Technology of cosmic engineering», «Systems of cosmic information and telecommunication». These specialities and specializations are trained at undergraduate departments established in «Information satellite systems» JSC. These departments are headed by leading scientists and specialists, Doctors of Sciences, professors, prize-winners of the highest level – designers of modern native spacecrafts. Most teachers of the undergraduate departments are leading specialists at the enterprises having scientific degree and positions.

Students learning at the undergraduate departments have engineering production internship in the period of specialization (two terms of the fifth year), but within the previous four years students learn common full-time. Training at the undergraduate departments is an elite educational form, therefore students are selected on competitive base with clear perspectives in their future career in design and production departments of «Information satellite systems» JSC.

It is important to note that students from the very beginning of training at the specialized departments are assigned to definite theme-based issues that make educational process a special target training conditioned by not only formal mutual responsibilities of a student and enterprise but also mostly by creative relationship of future specialists and their teachers at the enterprise.

Within the period of internship the students have the chance to study complex economic relations and enterprise structure, to learn real technological problems, to get skills in professional engineering and management jobs. Students get familiar with the latest achievements and features of production via engineering documents, but not only textbooks that often go behind the rate of newest cosmic rate engineering developments.

Hence, integrated system of training enables close relations of teaching methods and individual forms of students' activity. The results of such work are significant engineering solutions and developments. It is particularly obvious in term and diploma paper performance, the common requirement for which is practical application of the theme and possibility to implement in production.

Integrated system of students' training in SibSAU is in fact an innovation system and realized by means of intensive application of up-to-date innovative teaching techniques, effective implementation of advanced methods of scientific teaching activity. Methodology and arrangement of professional students' training in SibSAU has always been based on the latest achievements in science, technology and engineering. At the same time at the turn of the XXI century there is a transition into new, interconnected processes and methods in design, production, testing and operation. They are commonly referred to as technologies of information support at all stages of commodity life cycles – from design to performance.

Special attention is paid in the University to application of project-oriented techniques of students' team training providing the new quality for engineering education.

To realize the project-oriented team method the university together with «Information satellite systems» JSC established the scientific-educational center «Space systems and engineering» where students of different years and specialities are involved in complex project teams presenting an simulation model of production project teams for developments of new items.

As an educational project a complex project in designing small-dimension spacecraft was developed which could be performed from project to launch during the years of study at university. Arrangement of project teams is made on the basis of competitive selection with obligatory development of individual curricula for every student, a project participant. The project management is based on the distributed management Internet-system (http://smka.sibsau.ru//) corresponding to the standard of Project Management Institute, 2004.

For processing the project-oriented teaching methods the project «RA DEC» (radiation screen) has been realized in university. In the course of the project performance students developed a research device under the supervision of the university teachers and «Information satellite systems» JSC specialists. It was fitted at small spacecraft «Yubileyny» launched in 2008 by launch vehicle «Rokot» to the high circular orbit. Satellite control was given to the Students' Center of SibSAU Space Flight Control at definite time. Students participating in the project got unique experience in development of space vehicles, skills in team work.

At present method of project-oriented team teaching is being developed and has become one of the basic terms for establishing a number of small spacecrafts in «Information satellite systems» JSC. Positive results of pedagogical approbation allow for its using in formation of communicative and professional competences of the graduates in different specialities and profiles [1].

From the very beginning of its activity since 1960 the university has trained engineers for military industries of the country. Therefore it is quite logical for SibSAU to participate in researchers' training program for military branches of industry adopted by the Government of the Russian Federation. The university is one of the largest executives of the given program for the enterprises of the Federal Space Agency. Target students' training for plants and institutions of military-industrial complex is performed with highest efficiency when using integrated training system. The basic customer enterprises («Information satellite systems» JSC, «Krasmash»JSC, «Geophysics» CCB) define timely the departments and working positions for students' internship; develop the themes for individual tasks. Students doing well in studies got extra allowance.

Complex and systematic approach to the integrated aerospace education in SibSAU deserved wide recognition. In 2009 the Ministry of Education and Science of RF with the support of Roscosmos adopted the resolution on establishment of the Multiple-Access Resource Center of «Spacecrafts and vehicles». Organized in accordance with the Federal Target Program «Scientific, academic and teaching staff of innovative Russia» SibSAU Recourse Center is intended for solution of essentially new scientific-educational problems related to development and implementation of cosmic production high technologies, training of elite specialists and academic staff in the sphere of applied cosmonautics.

The principles of integrated training forming the basis for aerospace engineering education have been developed in other branches of the university educational activity. For instance, in training engineers-physicists there is a close cooperation with research institutes of the Siberian branch of the Russian Academy of Science. The training in the form of «phystech» is performed in this case when junior students are mostly taught fundamental disciplines in terms of classical university system. Combination of study with students' research work is performed by senior students in the labs of RAS Siberian branch research institutes. Students-physicists are trained on high-tech unique equipment of academic institutes.

In 2007 SIBSAU and Krasnoyarsk Scientific Center of RAS Siberian branch signed an agreement about strategic partnership the major goal of which is arrangement of joint work in enhancement of students' and academic staff quality training by means of involvement of leading scientists from academic institutes in the educational process, joint solution of important scientific problems, participation in federal target programs, development and expertise of local target programs, sharing research equipment, scientific conferences and seminars.

In association with academic institutes of RAS SB the university arranged innovative scientific-education centers «Institute of cosmic research and high technologies», «Closed space systems», «Safety of engineering systems» where educational process is performed for bachelors, masters, specialists, and post-graduates in close cooperation with researches in the sphere of nanotechnology and space materials science, remote sensing of the Earth surface, modeling of heat-mass exchange processes in closed cosmic biosystems, reliability evaluation of engineering systems and other promising fundamental and applied scientific trends.

Quality assurance in students' training is a basis for university strategic policy. In SibSAU the Quality Management System (QMS) has been developed and introduced. It is formed on the principles of international standards of ISO 9000 series. As the base standard giving requirements for QMS development and certification GOST R ISO 9001 – 2001 is accepted. In the process of QMS formation the necessary standard and methodical documents describing and regulating the main stages of university inner activity have been designed. SibSAU QMS was certified by the State

Quality Management System Certification Body in the sphere of education and scientific research and included in the state quality system register [2].

One of the main functions of Quality Management System consists in permanent monitoring of educational process and analysis in dynamics of educational activity results. Due to independent estimation of students' knowledge the university takes part regularly in federal Internet-examination that is held by the National Accreditation Agency in the sphere of education. The results of Internet-exam along with those of students' current and final attestation are the basis for correction decision.

Long-term successful experience of SibSAU in training specialists in the sphere of space rocket engineering, high-tech engineering production shows great potentials of the integrated system in engineering education. Scientific generalization of such an experience, development of methodical base for integrated professional curricula in the condition of all-round transition to conditional structure of Russian educational system is an urgent problem of academic and engineering staff of our country.

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Evaluation of Graduate Qualification Works in Engineering University

Moscow State University of Radio-Engineering, Electronics and Automation, MIREA
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Performance of graduate qualification work (GQW) is the most effective method of revealing knowledge, skills, and competences formed in the process students' training in university and presented in a concentrated form for the State Examination Board (SEB) for thesis defense. The restricted time of diploma defense, graduates' personal qualities, membership of SEB and a number of other factors decrease significantly low enough degree of objective evaluation of GQW by the expert method. In the condition of permanent growth in demand for engineering graduates on the part of employers and increase in importance of graduates' evaluation at his/her certification in the further professional activity and career development designing methods and techniques for objective evaluation is of particular significance. In this paper the technique of GQW evaluation of engineering graduates tested at specialists' and bachelors' assessment of «Design and Technology of Electronic Instrumentation» is presented.

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V.V. Sidorin

Key words: *graduation thesis, technical university, singular quality indicator, complex quality rating indicator, measures, indicators, weighted coefficients, State Examination Board, graduate certification.*

Performance and defense of graduate qualification work (GQW) is one of the stages in assessment of an engineering university graduate to reveal his/her level of qualification and correspondence to the requirements of the Federal State Education Standard (FSES). General requirements for GQW and the procedure of certification are specified in the Regulation of Final State Certification of University Graduates of the Russian Federation approved by the order of Education Ministry of Russia of 25.03.03 № 1155. The regulation suggests the subsequent development of methodical standards in GQW evaluation by every university where specificity of each university's activity, peculiarities of provided progrmas and other aspects of students' training are to be taken into account. These standards are to include factors, indicators and criteria for GQW assessment and evaluation of graduates' training level, their preparation for professional performance. Such a standard can be the presented technique in which general regulations of final state certification of the university graduates are elaborated and indicators, criteria and the procedure of bachelors', specialists', masters' GQW evaluation are stated.

Quality assessment of GQW and evaluation of graduates' training level is performed by the State Examination Board (SEB) as a result of defense in 12 indicators (Table1). The first ten indicators assess the work itself and its defense. In terms of each 10 indicators GQW is assessed in ten-point scale – from 1 to 10 points. The eleventh indicator includes students' performance in the process of training and is assessed in three-point scale – from 3 to 5 points. The twelfth indicator accounts for a reviewer's assessment and is evaluated in four-point scale taking the values from 2 to 5 points. Evaluation of GQW is performed by the members of SEB. Every member assesses GQW independently in terms of 10 single quality indicators presented in Table 1 and places his/her grade in the individual questionnaire.

Different significance degree of indicators is found by weighted coefficients. The magnitudes of indicator weighted coefficients include current requirements for GQW and graduates' competences from the part of the government, employers, and labour market and can be changed in some cases taking into account definite circumstances, social-political and economic conditions, priorities in GQW evaluation.

Evaluation of GQW in points using four-point scale (excellent – five points, good – four points, satisfactory – three points, unsatisfactory – two points) is performed in terms of complex criterion including:

- complex quality indicator normalized to its maximum possible magnitude: $Q\Sigma_{mean}/Q_{\Sigma max}$;
- every mean single indicator normalized to its maximum magnitude: $Q_{mean\ n}/Q_{n\ max.}$

Criteria for GQW evaluation using four-point scale are presented in Table 2.

Adding all grades of SEB members the complex quality indicator is calculated:

- complex quality indicator for each work normalized to its maximum magnitude: $Q_{\Sigma mean}/Q_{\Sigma max}$;
- Mean single indicators normalized to their maximum magnitudes: $Q_{mean\ n}/Q_{n\ max}$;
- Mean defining single quality indicators normalized to their maximum magnitudes: $Q_{i\ def.}/Q_{i\ def.max}$.

Table 1. Indicators and Criteria of GQW Evaluation

№	Indicator	Indicator conventional sign, Q_n	Scale Δ_{min}-Δ_{max} Of indicator value Q_n, point	Weighted coefficients, k_n	Minimal value of indicator, $Q_{n\ min}$, point	Maximum value of indicator, $Q_{n\ max}$, point
1	Correspondence of GQW to the task requirements	Q_1	1÷10	3	3	30
2	Personal contribution to the project	Q_2	1÷10	2	2	20
3	Practical significance and expected results	Q_3	1÷10	1	1	10
4	Novelty and originality of work	Q_4	1÷10	0,5	0,5	5
5	Quality of work conclusion (completeness and Correspondence to the design requirements)	Q_5	1÷10	0,5	0,5	5
6	Quality of developed materials	Q_6	1÷10	0,5	0,5	5
7	Quality of material presentation to SEB	Q_7	1÷10	0,4	0,4	4
8	Answers to the SEB members' questions	Q_8	1÷10	0,5	0,5	5
9	Quality of economic part of the work*)	Q_9	1÷10	0,3	0,3	3
10	Quality of the section devoted to ecology and labour protection*)	Q_{10}	1÷10	0,3	0,3	3
11	Mean rating score during the period of study	Q_{11}	1÷5	0,5	0,5	5
12	Reviewer's evaluation	Q_{12}	1÷5	0,5	0,5	5
	Total sum of work evaluation				$Q_{\Sigma min} = 10$	$Q_{\Sigma max} = 100$

**) Indicator is not taken at evaluation of graduate qualification papers in economic specialities.*

Final evaluation of GQW in terms of four-point scale is performed with the expert technique by expert committee using complex criterion that includes:

- complex quality indicator normalized to its maximum magnitude: $Q_{\Sigma\ mean.}/Q\Sigma_{max}$;
- mean single indicators normalized to their maximum magnitudes: $Q_{mean\ n} / Q_{n\ max.}$

Complex quality indicator normalized to its maximum possible magnitude, for each of the evaluated work is counted by the formula:

$$Q_{\Sigma\ mean}/Q_{\Sigma\ max}, \% = \frac{1}{m}\sum_{m}\sum_{1}^{n}\frac{Q_n}{Q_{n\max}}, \quad (1)$$

where m – the number of members in the Board,

Qn – evaluation of work in terms of the n-th single indicator by every member m of the Examination Board,

Qn max = kn Δmax – maximum possible magnitude of the n-th single indicator,

kn – weighted coefficient of the n-th indicator.

Δmax is the maximum magnitude of the evaluation scale for the indicator Qn.

Normalized to their maximum possible magnitudes mean single quality indicators are calculated for each of the evaluated work using the formula:

$$Q_{mean\ n} / Q_{n\ max}, \% = \frac{1}{m}\sum_{1}^{m}\frac{Q_{nm}}{Q_{n\max}}, \quad (2)$$

where Q nm is evaluation of the n-th single indicator by the m-th member of the Board;

Mean defining single indicators normalized to their maximum possible magnitudes are determined similarly by the formulas presented in Table 3.

Calculated by the formulas (1), (2) GQW evaluations are matched with the numerical values of the criteria (Table 3).

The technique as a tool for GQW evaluation in terms of a vide range of indicators allows [1, 2]:

- objective gradation of university graduates' preparation for professional performance and correspondence of training to FSES requirements;
- revealing the correspondence of a graduate's professional, personal, and social competences to employers' requirements, ability to work creatively and independently, acquire knowledge, skills and readiness to solve professional and social problems;
- assessment of a graduate's professional competence rate, creative potential, ability to solve practical problems;
- increasing the role of university in students' professional orientation, training of competitive graduates being in demand at labour market, contributing to the development of students' and graduates' motivation system, encouraging their innovative and research activity;
- development of teachers' motivation and stimulation system to increase the quality of graduates' training.

Table 2. Gradations of GQW Evaluation in Four-Point Scale

Normalized to the maximum magnitude evaluation of work in terms of complex indicator, $Q_{\Sigma\ cp.}/Q_{\Sigma\ max}$, %	Normalized to the maximum magnitude evaluation in terms of every mean single, $Q_{cp.\ n}/Q_{n\ max}$, %	GQW evaluation
$Q_{\Sigma\ cp.}/Q_{\Sigma\ max} > 95$	$Q_{cp.\ n}/Q_{n\ max} > 95$	Excellent (five points)
$80 < Q_{\Sigma\ cp.}/Q_{\Sigma\ max} < 95$	$80 < Q_{cp.\ n}/Q_{n\ max} < 95$	Good (four points)
$70 < Q_{\Sigma\ cp.}/Q_{\Sigma\ max} < 80$	$70 < Q_{cp.\ n}/Q_{n\ max} < 80$	Satisfactory (three points)
$Q_{\Sigma\ cp.}/Q_{\Sigma\ max} < 70$	$Q_{cp.\ n}/Q_{n\ max} < 70$	Unsatisfactory (two points)

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Typical Form of Questionnaire for Evaluation of GQW by a Member of SEB F.1

Questionnaire for Evaluation of GQW

Student ____

(Applicant's name)

The theme of work____

Department ____

Member of SEB ____

(name and academic degree)

№	Indicator	Indicator conventional sign, Q_n	Scale Δ_{min}-Δ_{max} Of indicator value Q_n, point	Weighted coefficients, k_n	Minimal value of indicator, $Q_{n\,min}$, point	Maximum value of indicator, $Q_{n\,max}$, point	Grade, Q_{nm} points	Grade normalized to its maximum magnitude, Q_n / Q_{nmax}, %
1	Correspondence of GQW to the task requirements	Q_1	1÷10	3	3	30		
2	Personal contribution to the project	Q_2	1÷10	2	2	20		
3	Practical significance and expected results	Q_3	1÷10	1	1	10		
4	Novelty and originality of work	Q_4	1÷10	0,5	0,5	5		
5	Quality of work conclusion (completeness and Correspondence to the design requirements)	Q_5	1÷10	0,5	0,5	5		
6	Quality of developed materials	Q_6	1÷10	0,5	0,5	5		
7	Quality of material presentation to SEB	Q_7	1÷10	0,4	0,4	4		
8	Answers to the SEB members' questions	Q_8	1÷10	0,5	0,5	5		
9	Quality of economic part of the work*)	Q_9	1÷10	0,3	0,3	3		
10	Quality of the section devoted to ecology and labour protection*)	Q_{10}	1÷10	0,3	0,3	3		

**) Indicator is not taken at evaluation of graduate qualification papers in economic specialities.*

Member of expert committee ____________

Table 3. Calculation Formulas of Mean Defining Single Indicators.

Mean defining single indicator normalized to its maximum possible magnitude $Q_{i\ onp.}/Q_{i\ onp.max}$.	Calculation formula
$Q_{1\ onp.}/Q_{1\ onp.max}$	$Q_{1\ onp.}/Q_{1\ onp.max} = Q_2 / Q_{2\ max}$, %
$Q_{2\ onp.}/Q_{2\ onp.max}$	$Q_{2\ onp.}/Q_{2\ onp.max} = Q_3 / Q_{3\ max}$, %
$Q_{3\ onp.}/Q_{3\ onp.max}$	$Q_{3\ onp.}/Q_{3\ onp.max} = 1/2\ [Q_2 / Q_{2\ max} + Q_3 / Q_{3\ max}]$, %
$Q_{4\ onp.}/Q_{4\ onp.max}$	$Q_{4\ onp.}/Q_{4\ onp.max} = 1/2\ [Q_2 / Q_{2\ max} + Q_6 / Q_{6\ max}]$, %
$Q_{5\ onp.}/Q_{5\ onp.max}$	$Q_{5\ onp.}/Q_{5\ onp.max} = 1/2\ [Q_3 / Q_{3\ max} + Q_6 / Q_{6\ max}]$, %
$Q_{6\ onp.}/Q_{6\ onp.max}$	$Q_{6\ onp.}/Q_{6\ onp.max} = Q_4 / Q_{4\ max}$, %
$Q_{7\ onp.}/Q_{7\ onp.max}$	$Q_{7\ onp.}/Q_{7\ onp.max} = 1/2\ [Q_2 / Q_{2\ max} + Q_4 / Q_{4\ max}]$, %

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The Problems of Engineering Universities' Adoption to the Two-Level Education System

National Research Ogarev Mordovian State University
P.V. Senin, Ye.A. Nuyanzin

Educational system of the Russian Federation has been reformed over the recent years. Accession of Russia to Bologna process has obliged all university to adopt the two-level bachelor-master system. The given paper deals with the key problems of university adoption to the new educational system by the example of students' training in speciality «Agricultural engineering» and «Thermal engineering» in Ogarev Mordovian State University

Key words: *bachelor's student, master's student, speciality, specialist's degree program, competencies.*

P.V. Senin

Ye.A. Nuyanzin

According to the Russian Federation Legislation of 24.10.2007 №232-FL it is mandatory for all universities to adopt such levels of higher education as «bachelor-master». In this case the current system of engineers-specialists' full-time education is virtually eliminated. Engineering training is assigned only for some leading universities in specially defined for different reasons specialities. The given draft law was accepted by the State Duma and approved by the Federation Council.

In fact universities have adopted the given system since September, 1, 2011.

Ogarev Mordovian State University was not of exception in this process.

The adoption to the system is sure to have started as early as about ten years ago, all this time the universities of the Russian Federation were gradually preparing for possibility of the new approach in the educational process. Even in 2000, when the educational standards of II generation were introduced into university training, along with the existing specialities some other qualifications were specified for bachelor program. A number of subdivisions of Mordovian State University (institutes and departments) have started their bachelor and master training since 2005. But this was true mostly for humanitarian and natural-science specialities. Thus, engineering profile training was not realized in the given system.

Undoubtedly, the innovation involved has both its merits and drawbacks. The advantage is certain to be the fact that now at last one can match the obtained degrees in Russian and Europe that has been impossible before. However, there are a lot of problems and challenges in adoption to two-level education which are necessary to solve in the nearest future.

Firstly, this step would result in correction of not only university system but also components of secondary and secondary vocational and technical education.

At present the level of secondary education (to say nothing of secondary vocational education) does not meet the requirements specified by universities for students' admission. Therefore, the system of private lessons and additional preparation for different courses is common everywhere. Their main objective is to prepare school leavers for passing Universal State Exam and enrollment into university in such majors as mathematics, physics or chemistry. However, in spite of first year students' left-out the level of senior students' engineering knowledge does not satisfy teachers and final left-out amounts 30% as compared to entrants. It should be noted that engineering students have a rather low level of humanitarian knowledge and are slightly familiar with history and literature. Students' ignorance is of particular concern. That is why the courses in Russian, History are introduced in higher engineering institutions. All these subjects are to be studied at school.

Secondly, when developing new curricula for training engineering students there appeared uncertainty in some professional disciplines. For example, there is a number of profiles in training bachelors students in «Agricultural engineering» that are recommended by the University Education and Methodic Association in agricultural training. Each profile is assigned a list of recommended disciplines, but for some of them there is no such information. On the other hand, even with the list of disciplines the question arises how to make a reasonable choice to provide the proficiency in necessary competencies [1, 2]. This problem can be solved by, for example, developing an educational program taking into account the opinion of future employers. However, in this case there are also a number of problems as the absence of developed legal relations results in the situation when applying for a job favor is given to the graduates with specialist engineering degree. It is considered to meet the production requirements to greater extent than, for example, master graduates obtaining academic-oriented education. In some cases future employer cannot define what graduate is more necessary for him (her) in this or that fields of national economics.

The problem with bachelor graduates is even more urgent. A large number of them without entering master program and getting necessary engineering knowledge cannot be appointed for senior positions and can apply for low-paid jobs only. Hence, there appears a social problem.

As for master-students' training the situation is as following.

Training master students in «Agricultural engineering» and «Thermal engineering» in Mordovian State University started in 2010. To perform the educational process the master programs were approved, curricula were developed, research themes and content of students' autonomous research work were defined for the whole period of training.

Master students' training as a part of research constituent in «Agricultural engineering» and «Thermal engineering» specialities is rather topical nowadays. As a rule, Master students' research work get further development in post-graduate. Thus, there appears a possibility to increase time so necessary for making experiments, processing the results etc. But at present three years are not enough for completion of research in engineering speciality.

Introduction of III generation educational standards makes possible to train master students prepared for practical activity. The given innovation allows for widening the spectrum of master-graduates' employment. In addition, it should be noted that in recent years in Mordovian Republic the demand for the personnel of such qualification is growing. The support for this fact is numerous inquiries of Saransk leading machine-tool plants managers for specialists capable of working with special programs, competent modeling the engineering operational processes etc.

The important event in the existence of Mordovian State University that will influence significantly the master-students' training in future and assist in solution of a number of problems is assignment of the rank «National Research University» (The RF Government resolution of 20.05.2010 № 812-p). A new status of the university during 2010-2011 has allowed for significant innovation and strengthening the University's material and technical base. Within this period of time two new research laboratories were established for students' training of «Agricultural engineering» and «Thermal engineering» specialities as well as post-graduates and junior scientists at the general cost of equipment more than 50 mln. rubles. Besides, the research labs were arranged for making investigations in natural-scientific and fundamental fields (physics, biology etc.). To implement the developed technologies in Mordovian State University in 2010, five small innovative enterprises (SIE) were established, two of which are engaged in master-students' training in specialities mentioned above. In future it is also planned to develop university in the given status up to 2019 inclusively.

All these permit for efficient development of research and practical (SIE operation) constituents in master-students' training in mentioned specialities.

The development program of Mordovian State University within the «National Research» status allows for elaboration of own educational programs that permits adaptation of educational process to the conditions of definite region of Russia and eliminate partially all stated drawbacks in two-level training system.

Of not less importance in removing shortcomings of engineering training including two-level training is recommendation suggested by rectors of Russian and European leading universities at the International Scientific-Practical Seminar held in Czech Technical University (Prague). The main idea of the recommendations consists in the following: convergence of universities and industries, improvement in fundamental training in engineering universities, teachers' and students' academic mobility etc.

Nevertheless, analyzing the experience in engineers', bachelors', masters' training as well as candidates and doctors of science in both Mordovian State University and other universities of Russia one can make a conclusion that adoption to the two-level educational system is likely to occur during a longer period. In this case it is possible to use foreign and domestic experiences such as establishment of specialized engineering training centers for bachelor-graduates, arrangement of additional training courses etc. It will permit keeping positive experience stored in Russia, at the same time approaching to the international level of education [3].

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Fengineering education development in federal university

Kazan (Volga Region) Federal University
N.F. Kashapov, A.M. Galimov

The paper examines the questions concerning the development of multilevel engineering education system in a federal university in terms of Kazan (Volga Region) Federal University. The proposed model of engineering education, which is based on the fundamental training and project-oriented Master's programs, is considered by the authors as a necessary condition to increase innovative capability of federal university.

Key words: *engineering education, innovative activity, educational cluster.*

N.F. Kashapov

A.M. Galimov

Development of engineering education in the Russian Federation is nowadays mainly carried out with reference to the priority areas of science, technology and engineering, and critical technologies of Russian Federation. In this regard, President of the Russian Federation approved a Decree «on the approval of the priority areas of science, technology and engineering in the Russian Federation and the list of critical technologies of the Russian Federation» dated July 7, 2011 № 899 [1]. Being a special educational institution and playing a leading role in higher education federal universities cannot stay away from such crucial for the country activities. We can say that the development of engineering education at federal universities, in particular in the Kazan (Volga) Federal University (hereinafter KFU), is needed not only for training of engineers in certain sectors of the economy of the region and country, but above all, to maintain and develop innovative activity and engineering and technological capabilities of the university.

In the approved by the Russian Government development programs of federal universities one can find activities and evaluation criteria that are directly related to engineering and technology component of the scientific and educational activities. For example, the development program of Kazan (Volga) Federal University includes the following evaluation criteria: proportion of funds obtained through the implementation of research and development activities in the total income of the University; number of registered intellectual property; number of license agreements; number of small innovative enterprises operating in the innovation system of the university; annual turnover of small innovative enterprises founded by university.

Almost all priority areas of science, technology and engineering in Russia and the critical technologies are already being implemented at KFU within the framework of activities to promote innovation at the university. However, results achieved under completing the development program at KFU still do not create atmosphere of full confidence that KFU innovation infrastructure is sufficient for the successful transfer of knowledge and technology in the broadest sense. There is still lack of confidence that KFU innovation infrastructure is mature enough to be a self-reproducing system of innovative products, as well as has enough resources for their successful commercialization. We believe that another factor for innovations development at university, that is unfortunately not included in the official program of KFU, is the availability of engineering education. Engineering education at federal university should not be regarded as the mass training of engineers for manufacturing companies. This is a matter of technical and technological universities. From our point of view development of engineering education at federal (classical) universities is required mostly for improvement of innovation infrastructure of the university. Engineering education should help in creating at federal universities appropriate environment and conditions for research and development, as well as to strengthen cooperation links of higher education institution with the real economy.

The main idea of our proposal is to train Masters in Engineering and Technology on the basis of classical university undergraduate (bachelor) education. At the moment KFU has been developing the concept of engineering education which will determine development priorities that meet the requirements of the region and country, taking into account capabilities and capacities of the university.

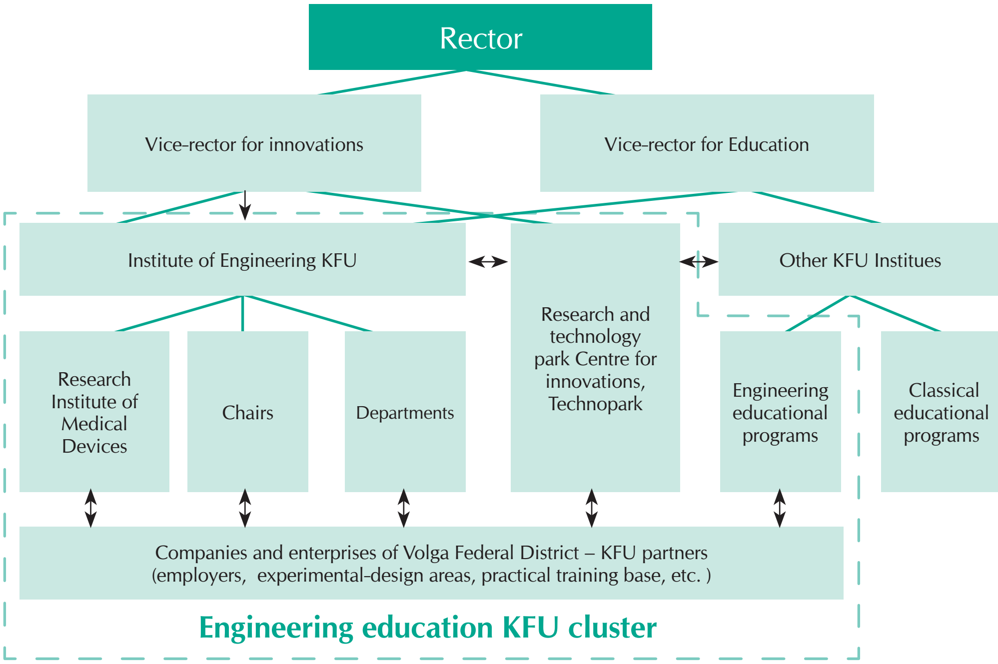
Experts point out that now, when the country begins to develop nanotechnology industry where engineering education plays a vital role, the need for deep fundamental training of engineers is becoming more obvious.

Let us consider two possible ways of development of engineering education at federal universities. The first one deals with creation of separate educational and research engineering unit as the base for developing engineering education. This option seems to be labour and time-consuming, and looks like it resembles or even duplicates the functions of existing engineering schools. Second way deals with distributed implementation of engineering programs, primarily master programs, on the basis of various training units along with establishment of coordinating centre or cluster for the whole university. Main objective of this approach is to train masters in engineering and technology based on the classical university undergraduate education.

We find the second approach more successful. The proposed model (Fig. 1) of engineering education development at federal universities tends to be more perspective and is based on the following principles:

- Multi-level training of engineers: basic training at bachelor level (classical university education) and specific training at master level (engineering program). Graduates of different universities of Volga Federal District (VFD) will be able to apply for admission to Master programs in engineering on a competitive basis, as well as for university places funded by business representatives of VFD.
- Practically oriented master training in the field of engineering and technology depends on close cooperation with industrial companies of VFD. Master programs are designed to meet requirements and solve real engineering problems VFD companies. Educational programs are developed and implemented on a project basis involving experts from VFD enterprises. Due to the fact that graduates will be trained to make specific engineering decisions, employment rate will increase and graduates will be able to solve real engineering problems that companies of VFD face with.

Fig. 1. Model of engineering education at KFU



- Cluster technology for organization and implementation of training programs for engineers. Development of close partnership with universities of Volga Federal District for students and faculty mobility. Universities and enterprises belonging to the cluster will sign agreements on cooperation and sharing of teaching laboratory, research and production facilities as part of the engineering programs. Joint engineering centres, technology parks, innovation support funds, etc. should be established
- Credit-modular technology training, allowing students to choose the trajectory of learning (in different institutions), taking into account the proposals of the labour market. Modular technology lets you quickly adapt educational programs to the current problems of engineering, credit technology will increase students mobility

The first stage of engineering education development at KFU is focused on the implementation of programs related to the automobile industry and the development of medical devices. Therefore the possibility of creating engineering centre «Design engineering and technology for the automobile industry» is considered, as well as the establishment of the Institute of engineering with a research project institute of medical devices within university structure. Thus, professional engineers trained at KFU aware of latest research achievements will be able to find develop solutions of engineering problems of the real economy. Within the educational process graduates of engineering educational programs will participate in design and development, testing, production or maintenance of high-tech innovative products and technologies. Their research, educational and project activity is the link between fundamental scientific developments and their commercialization.

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The role of leading classical universities in engineering education development

Saratov State University named after N.G. Chernyshevsky
S.B. Venig

The paper is focused on the role of leading classical universities, sponsored by the government, in the development of engineering education in Russia. The possibility of successful engineering training in a classical university is justified by fundamental and interdisciplinary nature of education provided, appropriate training facilities which have been renovated due to the state aid. The universities can establish innovative business associations in cooperation with industrial enterprises. Such business associations could provide students with internship and future work places, as well as they could contribute to the increase of new industrial capacity.

Key words: *engineering education, innovation activity, educational cluster.*

S.B. Venig

The last 20 years were full of problems for engineering education of Russia. Production decline, reducing number of businesses and low wages at still operating enterprises, declining prestige of engineering profession, uneven development of industry in different areas and region, dramatic decline of relative teachers'wages, obsolescence of facilities at universities - all this factors predetermined decrease in the quality of training of engineers in our country. Today, the list of the problems has been added by challenges associated with the transition to a two-tiered education system and changes in universities admission procedures based on the results of the unified state exam. All above mentioned and other problems of engineering education are well known and have been repeatedly discussed at meetings, conferences and seminars with participation of Association for Engineering Education of Russia [1]. From my point of view it becomes more important to search for ways how to improve the quality of engineers under the given circumstances. It should be noted that recently there have been positive developments and changes in the attitude of government towards engineering education.

According to the Order dated 18.05.2011, № 1657 on a large number of training areas in the field of engineering and technology graduates will be awarded degree diplomas with the degree of «bachelor-engineer» or «master-engineer». Governmental Decree № 1944-r approved a list of training areas that meet the priorities of modernization and technological development of the Russian economy. In 2012 students of educational programs in these areas could be appointed on a competitive for a special scholarship of President of the Russian Federation. Lately several presidential, governmental and corporate contests for universities (that implement innovative educational programs for the status of «national research university» or are engaged in innovation and commercialization process) were held according to the regulations of the Government № 218-220, ROSNANO corporation and Skolkovo Innovation Centre regulations. Implementation of innovative projects, commercialization of intellectual property rights is impossible without an engineering component. Thus, the state creates an opportunity for leading universities to modernize the methodology, content and facilities for engineering education. And what role should classical universities play in this situation? For decades, engineers were trained at technical and technological universities, although many classical university graduates were successful in engineering. There was a fixed system of training, with its own methodology and established links with industry.

Today it is required to develop new competencies to train advanced professional engineers. We live in a time of great change, when a new dominant technological system of the world economy as a base for nanotechnology is emerging. According to a universally shared definition for nanotechnology it is a broad and interdisciplinary field. In addition, development of Nano systems, Nano materials, and solution of Nano engineering problems requires fundamental knowledge in physics and chemistry of atomic structures, quantum-mechanics description of phenomena at the atomic level. It is easier to provide training of such specialists at classical universities, where there is a long tradition of fundamental training in physics and chemistry, there are academic schools, and subdivisions of related disciplines: mathematics, biology, computer science. Availability of humanities schools would assure high quality of students' social skills. There should not be any difficulty to create interdisciplinary teams and structures within a multidisciplinary university to solve educational, research and innovative problems. For example, one of the first Russian educational and research institutes of nanostructures and biological systems was established in Saratov University [2]. This institute brought together physicists, nanotechnologists, mathematicians, chemists, biologists, physicians, programmers. Students of Electronics and Nano electronics department, Materials Science department, Chemical Engineering department, Biomedical Engineering department had an opportunity to undergo practical training in interdisciplinary laboratories, take part in solving real tasks of the Institute.

Another area, where classical universities could contribute to the development of engineering education is connected with the capacity of federal and research universities to invest in modern equipment and start up business entities together with industry. Training of engineers is impossible without collaboration with industry. But unfortunately today industry is uneven resented in our regions. There is almost any shipbuilding, aircraft building, mechanical engineering, engineering tools industry in Saratov region. And electronics industry enterprises have reduced 10 times the number of employees and their equipment has become obsolete. What way out of the situation could be suggested? The solution could be found in cooperation of university and industry in creating business entities. Companies have enough area, energy resources, engineering services and qualified personnel. National research universities have scientific and innovative potential and moreover funds to purchase modern equipment. Thus, a unique environment id developing: together with existing businesses new «industrial shoots» are developed. Two problems can be solved at once: industry is developed and a base for training professional who will develop it further is created.

Special features of this partnership between leading universities and industry are as follows. Through joint establishment of new businesses or otherwise enterprise get access to high-tech equipment. Availability of such equipment opens up opportunities for enterprises to develop and produce world level products (goods), and therefore, apply for funding from state corporations. Receipt of government defense contracts, sale of high technology products provides enterprises with an opportunity to renew and universities with additional funds for research and development and improvement of new technologies and products. Thus, within 4-6 years after the process was started a company could update its range of products, material and technical resources, reach a new level of profitability, and a university could receive funds to cover the cost of purchased equipment and ensure further development.

One of the examples of such cooperation is the establishment of new small business company Ltd Conversiya by joint efforts of Saratov University and JSC NPP Contact.

The company's main field of activity is connected with development and production acoustoelectric microwave devices: radio-frequency identification tags, filters, resonators, delay lines and sensors of physical quantities on the surface and bulk acoustic waves. The company uses under lease equipment purchased by the university (coating equipment, electron lithography, clean room) to the tune of 150 million rubles. The company has provided a platform and services. The company became a base for creating department of micro- and Nano electronics, which provides students trained in the field of electronics and Nano electronics an opportunity for hand-on labs and project learning. Use of equipment (coating equipment) has allowed the company to sign in 2011 contracts worth around 40 million rubles. In 2012 when the company will work at its full capacity it is supposed to reach the contracting level at about 80 million rubles.

Thus, the leading classical universities on the one hand may become a germ of new businesses and provide cooperation with industry for development of engineering education and on the other hand due to the fundamental and interdisciplinary education to train engineers for the new modern fields such as nanotechnology.

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Issues and Future Engineering Education

Moscow Engineering- Physics Institute «MEPI»
K.V. Nigmatullina, A.V. Astafeva

Development of modern engineering education is the fundamental cornerstone in the technological modernization of Russia. Reorganization of the engineering personnel training system is a global challenge due to the increasing complication of the socio-technological system itself and associated risks within this system.

Key words: *engineering education, conference, training requirements for technical personnel.*

K.V. Nigmatullina

A.V. Astafeva

The Conference «Issues and Future Engineering Education» was held in the National Research Nuclear University (NRNU), Moscow Engineering-Physics Institute (MEPI) on November 10, 2011. Representatives of leading engineering universities and corporate training centers discussed the following issues within the framework of this Conference: pilot projects in training engineering personnel, engineering training problems and further development of future engineering education.

Keynote speaker P.G. Schedrovitshki, Head of Strategy Planning & Management Methodology Department, NRNU MEPI, in his opening speech stated: «Our request to all speakers is to outline only those changes occurring within their education institutions, express their opinion on existing moments in engineering education and, of course, underline today-tomorrow solutions to the key challenges in engineering education.» In fact, the conference included a highly topical and informative program.

The first speaker was M.N. Strikhanov, Rector of National Research Nuclear University (NRNU) Moscow Engineering-Physics Institute (MEPI). In his speech, «Engineering Personnel Training for the Nuclear Sector», he emphasized the major development trends in the collaboration between universities and hi-tech industry sectors. «It is very essential that today academic research is supported by the Federal State. This support involves the participation of different universities in State Progam of Accelerated Industrial &Innovative Development, including State Atomic Energy Corporation «Rosatom». A sophisticated technology platform integrates communications network to discuss future breakthrough projects in global and Russian economy».

In his speech D.V. Livanov, Rector of National Research Technological University (NRTU), Moscow State Institute of Steel & Alloys (MSIS&A) discussed the problems of engineering education and modern engineering curriculum design. Dmitri Viktorovich highlighted the fact that under existing

university conditions there is a dramatic shortage in qualified personnel who would implement technological modernization projects. Such factors as technical merit gap, insufficient language competencies and management competency, low engineering education prestige and negative image of engineering professions hinder the further enhancement of engineering education.

V.S. Sheinbaum, Rector Advisor of Gubkin Russian State University of Oil & Gas, discussed the development of engineering competencies in e-learning environment.

A.I. Chuchalin, Vice-Rector for Academic & International Affairs, National Research TPU, in his presentation «Academic Standards of Professional Training in Priority Areas of TPU» discussed innovative educational standards, international accreditation and certification.

D.A. Kozorez, Vice-Dean of National Research University, Moscow Aviation Institute, in his speech gave a detailed summary description of their experience in the development of problem-solving research labs.

V. Yu. Stolbov, Director of Education Quality Management Center, National Research Perm Polytechnic University, discussed the partnership strategies between universities and different companies. L. V. Zabezhinski, Executive Vice-President of IBS Co. L.V. Zabezhinski described their experience in the development of IBS Master programs.

V.N. Knyaginin, Director, Center of Strategical Developments «North-West» presented his speech «What Determines the Demand in Engineering Education», where he gave an in-depth analysis of today's issues in engineer training.

Within the framework of the Conference a panel, involving top managers of technology companies, was organized to discuss the requirements and qualifications of today's engineer.

The moderator of this panel was A.E. Volkov, Rector of Moscow Management School «Skolkovo». Participants of the panel included the following representatives of different companies: N. N. Karnaukhov, General Director, Lukol-Engineering Ltd., D.Yu. Kolodyazhni, Managing Director, JSC Incorporated Engine Holding Co., E.Yu. Smelov Senior Executive of General Director, JSC Rosenergoatom Inc., Yu. N. Barmakov, Senior Executive of Research Supervisor, Federal State Unitary Enterprise, Russian Research Institute of Automatics, S.B. Egorov, Director of Scientific &Production Commercial Firm, JSC Rosenergoatom Inc., S. A. Frolov, Advisor of General Director in Economy, JSC Roszheldorproject, G. A. Tikhonova, Director of Management Broad, Euras-Holding Ltd. and others.

Representatives from different hi-tech sectors of economy discussed the following issues: the image of the future engineer, approaches and methods in training future engineers, problems in two-tier education system, international accreditation and certification. Top managers also discussed the problems of engineering which they encounter during their work as well as they expressed their opinion on the current development project in engineering education.

The Conference «Complex Technological Systems: Development of Modern Engineering Training Education», held within the framework of National Research Technological University (NRTU), Moscow State Institute of Steel & Alloys (MSIS&A) on April 27, 2011, marked the beginning towards new conferences, the second of which was the above-stated one. The next Conference is in April, 2012.

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Summary

ENHANCING ENGINEERING EDUCATION THROUGH THE UNIVERSITY-INDUSTRIAL ENTERPRISES STRATEGIC PARTNERSHIP

V.M. Kutuzov, M.Yu. Shestopalov, D.V. Puzankov, S.O. Shaposhnikov
St.Petersburg State Electrotechnical University «LETI»

In the developing economy of knowledge, the task of establishing and strengthening partnership with industry and the labor market as whole becomes of the top priority. It needs developing a network of organizations interested in mutually beneficial collaboration in the area of training highly qualified engineers, improving the technical facilities of the academic process, conducting joint research, upgrading manufacturing facilities, etc. To make such collaboration a success, it is important to realize how to establish the university-industry partnership based on mutual interests and benefits. The paper presents the experience from St.Petersburg State Electrotechnical University «LETI» in launching and running a University-Industrial Enterprises Strategic Partnership Program aimed at enhancing engineering education at the university.

CORPORATE CHAIR IN THE SYSTEM OF HIGHER VOCATIONAL EDUCATION

B.C. Meskhi, N. N. Shumskaya
Federal state budgetary educational institution of higher professional education «Don state technical university»

In article are considered questions of the integration of industrial structures and institutions of higher education of a technical profile for the preparation of bachelors, engineers in accordance with the modern tendencies in the domestic and global education and the requirements of the production to the level of training of modern specialists.

MULTI-LEVEL INNOVATIVE SCIENTIFIC AND EDUCATIONAL COMPLEX: INTEGRATION OF SCIENCE, EDUCATION AND BUSINESS

V.B. Moiseyev, N.V. Kozlova
Penza State Technological Academy

The authors consider multi-level scientific and educational complex as a good example of vocational education updating, that is based on effective cooperation of educational institutions and scientific and business organizations.

TEAMWORK OF JOINT STOCK COMPANY «TOMSKNIPINEFT» AND TOMSK POLYTECHNIC UNIVERSITY FOR MODERN PETROLEUM ENGINEER TRAINING

A.S. Latyshev, I.N. Koshovkin
JSC «TomskNIPIneft»

The problems of training modern petroleum engineer are analyzed. Also authors consider effective programs of development and training for research and design institute staff.

TRAINING RESEARCH AND PRODUCTION COMPLEX ENGINEER TREATMENT SYSTEM MODEL

V.V. Sidorin
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Human resources formation is the process which demands engagement of all participants and concerned parties such as higher education institution, employer enterprises, elementary education institution and secondary vocational education institution. In virtue of economical and organizational principles technical universities are not capable to provide and to renew academic activity laboratory and production basis, to fit laboratories

with modern expensive (and in some cases unique) equipment. Taking into account that demands to modern engineers' competence and to their hand-on experience and skills keep growing, it is necessary to update and constantly confirm their essential qualities correspondence and to unify higher education institutions, students, graduates and employers activity into training research and production complex. In this book such complex is seen as an engineer treatment system model conforming modern demands.

ELESY CORPORATE TRAINING SYSTEM

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In the context of the transition to the two-level system of higher education, Russian IT-companies face such a complication as personnel deficiency in the sphere of engineering. Tosolvetheproblemofemployeetraining, adaptation and further development EleSy Company has introduced the corporate training system. Thesystemisaimedtoprovideaneffectiveeducationalprocess which can be easily combined with daily job responsibilities.

AN EDUCATIONAL MODEL BASED ON MASTERS PROGRAM «MULTIMEDIA MULTIPROCESSOR SYSTEMS-ON-CHIP».

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Educational program started at Tomsk State University of Control Systems and Radioelectronics, being realized in «Elecard Group» and financed by Infrastructure and Educational Programs Fund («Rosnano» public corporation). The educational program's purpose is preparation of specialists for the development and mass production of new generation 65-90 nanometer chips for digital television receivers.

ROSNEFT OIL COMPANY AND SIBERIAN FEDERAL UNIVERSITY PARTNERSHIP

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A unique for contemporary Russia experience of integrated cooperation of a major corporation and a federal university for the purpose of personnel training for oil and gas industry is shown.

INTERACTIVE LEARNING AS A MODERN METHOD OF TRAINING OF ENGINEERS FOR OIL AND GAS INDUSTRY

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A comparative analysis of interactive systems for training of engineers at such the advanced oil and gas companies as SHELL, BP, THK BP, BOURBON, and GAZPROM is given in the article. An interactive learning in this analysis has been perceived as the kind of learning which is organized as the interaction of the trainees with the learning environment established on the basis of the real work processes.

AN INTEGRATED SYSTEM OF ENGINEERING EDUCATION IN AEROSPACE UNIVERSITY

V.P. Nazarov, M.G. Melkozerov
Siberian State Aerospace University named after academician M.F. Reshetnev

The basic principles of an integrated system of higher education. The methods of organization and planning of the educational process in the field of aerospace profile in the system of integrated education. Are some innovative educational technologies to improve quality of

training specialists.

GRADUATION THESIS RATE IN TECHNICAL UNIVERSITY

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Graduation thesis fulfilling is the most effective method of knowledge, skills, experience and competence revelation formed during education at university and performed to State Examination Board on thesis defence. Limited time, graduate personal skills, State Examination Board members – all that influence thesis impartial assessment. Under conditions of permanent requirements severization which employers demand from technical universities graduates and growing significance of graduate rate in certification, following professional activities and career development method and procedure elaboration becomes very important. In this book you can find graduation thesis estimation procedure evaluated during specialists and bachelors certification in the areas 'Electronic means engineering and technology'.

CHALLENGESANDSOLUTIONS: MASTER'S STUDENT TRAINING FOR POST-INDUSTRIAL ECONOMY

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Thepaperdiscussestheproblemsand their solutions, associated with the quality enhancement of Master'sprogram training in engineering with a view to a post-industrialeconomy.

FORMING OF CREATIVITY IN THE TIME OF TRAINING FOR ENGINEERS OF MASS PROFESSIONS

V.I. Livshitz
Ben-Gurion University of the Negev, Beer-Sheva, Israel

Consideration of complex problem for forming of creativity in the time of training for engineers of mass professions. Foundation of creativity consist in overcoming of «embryonism» and incompetence of graduating students in compliance with requirements of professional approach in engineering education.

ABOUT TARGET STUDENTS TRAINING IN THE DIRECTION «THE APPLIED MATHEMATICS AND COMPUTER SCIENCE» FOR OPEN SOCIETY «TATNEFT» AT KAZAN UNIVERSITY

R.H. Latypov, A.M. Gusenkov,
V.S. Kugurakov
Kazan (Volga Region) Federal University

In given article we share our experience in interaction of the Kazan federal university with one of the largest Russian oil companies - Open Society Tatneft in IT-specialists training.

PROBLEMS OF TRANSITION OF ENGINEERING HIGH SCHOOLS ON A TWO-LEVEL EDUCATION SYSTEM

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of N.P. Ogaryov

As it is known, the educational system in the Russian Federation during the last years is exposed to reforming. The introduction of Russia into Bolonsky process obliges to pass all higher educational institutions to two-level system of preparation the bachelor-master. In given article the basic problems of transition of high schools on a new education system on an example of preparation of students in directions «Agroengineering» and «Power system» of the Mordovian state university of N.P.Ogaryov are presented.

ENGINEERING EDUCATION DEVELOPMENT IN FEDERAL UNIVERSITYE

N.F. Kashapov, A.M.Galimov
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The paper examines the questions

concerning the development of multi-level engineering education system in a federal university in terms of Kazan (Volga Region) Federal University. The proposed model of engineering education, whichisbasedon thefundamental training and project-oriented Master's programs, is considered by the authors as a necessary condition to increase innovative capability of federal university.

THE ROLE OF LEADING CLASSICAL UNIVERSITIES IN ENGINEERING EDUCATION DEVELOPMENT

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The paper is focused on the role of leading classical universities, sponsored by the government, in the development of engineering education in Russia. The possibility of successful engineering training in a classical university is justified by fundamental and interdisciplinary nature of education provided, appropriate training facilities which have been renovated due to the state aid. The universities can establish innovative business associations in cooperation with industrial enterprises. Such business associations could provide students with internship and future work places, as well as they could contribute to the increase of new industrial capacity.

CONFERENCE ON «CHALLENGES AND FUTURE OF ENGINEERING EDUCATION»

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The development of modern engineering education - an essential component of the technological modernization of Russia. Reform of training technical personnel today - a global challenge due to the increasing complexity of socio-technical systems and related process risks.

List of AEER Accredited Programmes

One of the basic activities of Non-commercial Association for Engineering Education of Russia (AEER) is the accreditation of educational engineering programs.

The Association has become one of the founders of Russian national accreditation system and actively participated in development of international evaluation criteria of engineering programs, which makes possible to award a common European quality label (EUR-ACE® label, European Accredited Engineer). Since 2007 it has conducted national professional; accreditation of educational programs in accordance with both the accreditation standards for engineering programs applied in European high education establishments and the criteria approved by the member-countries of the Washington Accord.

151 educational programs of 29 Russian high educational establishments have been accredited, with 71 programs being awarded EUR-ACE® label by 31.12.2011. Meanwhile, 34 educational programs of 7 Kazakh higher educational establishments have been accredited by AEER and awarded European quality label.

The list of the accredited programs approved by AEER is given below.

List of Accredited Programmes, Russian Federation (as of 01.01.2012)

	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 State Technical University named after A.N. Tupolev					
1.	150600	FCD	Science and technology of new materials	АИОР EUR-ACE®	2011-2016
2.	160100	FCD	Aircraft construction and rocket production	АИОР EUR-ACE®	2011-2016
3.	230100	FCD	Computer science	АИОР 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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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®	2005-2010
6.	230105	INT	Computer Technology and Automated Systems Software	AEER	2005-2010
7.	230201	INT	Information Systems and Technologies	AEER	2005-2010
8.	230101	INT	Computers, Systems and Networks	AEER EUR-ACE®	2008-2013
9	210104	INT	Microelectronics and Solid State Electronics	AEER EUR-ACE®	2010-2015
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
Moscow Power Engineering Institute (Technical University)					
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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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	Metallurgy (Physical Metallurgy of Non-Ferrous, Rare-Earth and Precious Metals)	AEER EUR-ACE®	2011-2016
6.	150400	FCD	Metallurgy (Functional Materials and Coatings)	AEER EUR-ACE®	2011-2016
7.	150400	FCD	Metallurgy (Metal Forming)	AEER EUR-ACE®	2011-2016
Samara State Aerospace University					
1.	160301	INT	Aircraft Engines and Power Plants	AEER EUR-ACE®	2008-2013
2.	160802	INT	Spasecraft and Rocket Boosters	AEER 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
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
Tambov State Technical University					
1.	210201	INT	Design and Technology of Radioelectronic Devices	AEER	2006-2011
2.	140211	INT	Electrical Supply	AEER	2006-2011

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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
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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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
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	Industrial Welding Technology and Equipment	AEER	2007-2012
7.	130602	INT	Transportation organization and transport management (automobile transport)	AEER EUR-ACE®	2008-2013
8.	150202	INT	Oil and Gas Fields Machinery 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

	Program Code	Qualification	Program Name	Certificate	Accreditation Period
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

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List of Accredited Programs, Republic of Kazakhstan

(as of 01.06.2011)

	Шифр образовательной программы	Квалификация	Наименование образовательной программы	Сертификат	Срок аккредитации
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. 10.	050720	FCD	Chemical Technology of Inorganic Substances	AEER EUR-ACE®	2011-2016
11.	050721	FCD	Chemical Technology of Organic Substances	AEER EUR-ACE®	2011-2016
12.	050722	FCD	Printing	AEER EUR-ACE®	2011-2016

13.	050724	FCD	Processing Machinery and Equipment	AEER EUR-ACE®	2011-2016
14.	050729	FCD	Construction	AEER EUR-ACE®	2011-2016
15.	050731	FCD	Life Safety and Environmental Protection	AEER EUR-ACE®	2011-2016
16.	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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