UDC 378.147
(Universal Decimal Classification)

Enhancing engineering education in the post-crisis period of economical development in Russia

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In the developing economy of knowledge, the task of establishing and strengthening partnership with industry and the labor market as whole assumes 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 article presents the experience of 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.

Key words: *Multi-Level Engineering Education, Strategic Partnership, Industrial Enterprises, Centers of Excellence, Centers for Prototyping.*

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Tendency to a steady growth in industrial production, research and development has revealed lack of highly qualified specialists who are aware of modern technology, able to implement competitive equipment and develop technologies in innovative professional activity within market economy. Today lack of qualified staff is a major obstacle for innovative development of those priority sectors of the economy, which have been supported by large investments in the recent years. .

The main contradiction of Russian higher engineering education today is the mismatch of professional competencies acquired by graduates of technical universities within the learning process with the increasing demands of high-tech enterprises, design and research organizations. As a result, in spite of quite large and often excessive amount of graduates from engineering educational programs business demand for high-quality professionals is not satisfied. The main challenge that higher engineering education faces at the moment and not only in Russia is a strategically important need for modernization of content and technology of education in the field of engineering and technology on the basis of cooperation and integration of human resources, scientific, technological and corporate capabilities of technical universities, research organizations and business. First, predictive analysis should become an integral part of modern engineering education in order to foresee fast-changing technologies of specialty profile. Taking into account that for modern industry a term ' leading-edge technology' became quite common and means fundamentally new technologies that ensure leading positions in the global market, modern engineering education should be far in

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advance of leading-edge technologies. Second, modern engineering education should be interactive and allow students and teachers within the training process to get professional competence to conduct independent research, to acquire and apply new knowledge, including its commercialization. Third, modern engineering education should be open and based on the principles of networking involving all stakeholders in the educational process. This will allow students and university teachers to acquire professional competence in world-class centers of excellence.

Multi-Level Engineering Education

The main problem that the developers of new state educational standards of higher professional education faced with the concerned bachelor programs. After obtaining bachelor degree graduates should be able to start work in the field of engineering and technology, this requires from the educational program to be practice-oriented (now called "applied" bachelor program). At the same time, those graduates from bachelor program who wish to continue their education at master level should get fundamental training: understanding of the natural science (physics, mathematics, chemistry) and professional specialist knowledge (in the chosen field of study).

Multi-level training system provides real flexibility in adapting the content of educational programs and allows students to select individual training profile. Implementing of this approach requires modernization of the educational process infrastructure. Improving efforts should be aimed at providing every student easy access to modern knowledge bases, technologies, advances in science and technology. In this case the most important role plays early career orientation of students (within the first year), which is carried out with the assistance of employers - strategic partners of the university. By the way, this approach is consistent with CDIO ideas in reforming engineering training, that was recently approved by a number of world leading universities [1].

According to the experience of our university the features and benefits of tiered engineering training are as following:

1. Competitive selection for the second level motivates students to be more active at the first level (good progress in studies, participation in research projects and university competitions, choice of employer, etc.). It allows to select most talented, creative and motivated graduates for master level programs.

2. Ability to work on the second level with the selected graduates makes training of elite professionals more efficient.

3. Increased elective component of professional training:

- allows to undertake real targeted training " tailor made training";
- motivates industry - strategic partners to develop and deliver targeted programs together.

4. Flexibility in the implementation of new profiles in bachelor's and master's educational programs introduced by the Academic Council of the university (unlike the traditional system of "engineering" programs with regulated list of professions).

5. Possibility of training specialists at different levels, competent in certain types of professional activities and tasks in accordance with professional standards.

6. Attractiveness of tiered training for foreign students. Programs can be easily harmonized with similar programs in the foreign higher education institutions.

7. Formation a real basis for academic mobility of students and teachers.

Saint-Petersburg Electrotechnical University "LETI" has adopted tiered engineering training system. Within the first two years students acquire engineering fundamentals "being trained in consistent (harmonized) direction, and then they could choose profile of their bachelor program. This choice is

made by students after visiting enterprises - strategic partners of the university in order to get the idea of their possible future professional activities. After studying at bachelor level most qualified and competitive graduates can continue their studies and get a Master's degree in two years. Curriculum of master educational program is developed jointly with employers and meets the current requirements of the labour market and the latest developments in a particular field of engineering and technology. It should be noted that master degree studies is the priority of educational activities of ETU. Admission to state-funded places at master's degree programs is not less than 60% of the admission to the first year of bachelor's degree programs.

Involvement of strategic partners in the implementation of practice-based learning. Centers of Competence.

According to the regulations on development and modernization of master educational programs and bachelor profiles at ETU employers (strategic partners) should take part in formation of the required competencies of graduates, as well as in curriculum development and educational program delivery.

In recent years, cluster approach has proven to be the most competitive form of cooperation and interaction for industry development. As a rule, developed innovative industrial-economic cluster is an interactive complex of high-tech companies, research and design organizations, institutions of professional education at various levels, as well as innovation infrastructure (Fig. 1).

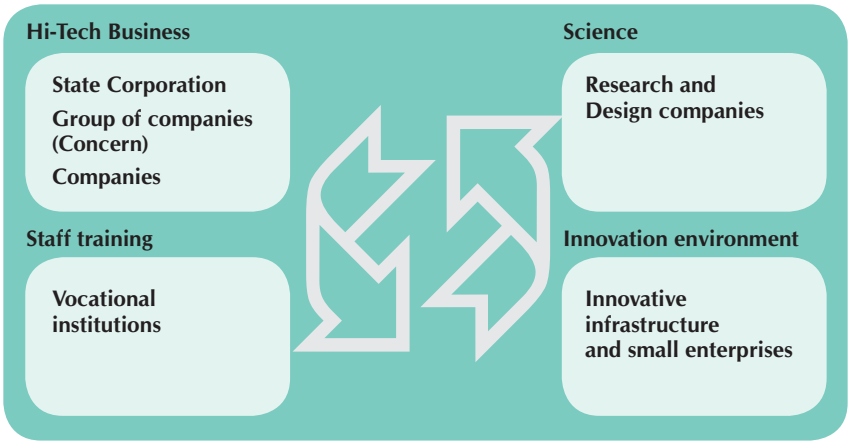
The following ETU profile industry cluster was approved by the Government of St. Petersburg as priority: cluster of electronics, power engineering, shipbuilding, information technology and medical industry. The university has established long-term contractual relationship with enterprises and design organizations of listed above clusters, involving cooperation in the field of vocational training and skills development [2].

At the initiative of ETU the Council for cooperation of universities and industrial companies was established. It operates under the auspices of the Union of Industrialists and Entrepreneurs (RSPP) and the Council of Rectors of St. Petersburg Region. At the initiative of the Regional Council innovative program "Training and skills development for the benefit of high-tech enterprises of St. Petersburg" was introduced in 2008. It is funded by the Government of St. Petersburg. To coordinate the activities of the technical universities of the city together with enterprises of electronic cluster Innovative educational consortium was established. It has a distributed infrastructure used for the preparation of target engineering training.

Development of common information space provides a distributed cooperation network of the university with strategic partners and other Russian and foreign universities and research organizations. One of the promising features of the university regarding development and delivery of network educational programs is to provide access to scientific and educational resources, including unique equipment and software systems of Centers of Competence and Centers for Prototyping as well as the possibility of rapid communication between all participants of the educational process.

According to the definition, Center of Competence is a special structural unit of the organization, including university, which main function is to control the most important areas of activity, gathering the appropriate knowledge and finding ways to maximize their efficiency. The role of the Center of Competence is to ensure the integration of knowledge and processes that enable all stakeholders (teachers, management, students, employers) access to information resources and establish effective communication. Simply said, Center of Competence is aimed at providing opportunity for close and fast cooperation

Fig. 1 Industrial-economic cluster



with each other and receiving all the necessary information to be efficient.

As practice shows Centers of Competence can be exploited in different ways, depending on the problems we need to solve.

1. Center of Competence collects best practices. The main "object of interest" for such a center - the so-called best practices that have been implemented in different areas of university activities. Center is working to identify and systematize these practices, develop relevant standards and benefit universal application of best practices.

2. Center of Competence aims to develop technology standards.

Domain-specific knowledge collected by such center covers technical field, in particular, relating to the development of software products, technologies and equipment. The aim is to standardize the process, creating a common technology platform and related data stores.

3. Center of Competence maintains numerous projects and initiatives related to knowledge management, for example, staff training on new products and services, evaluations of applied technologies, etc.

4. Center of Competence is in charge for overall integration of processes and data throughout the organization, its main purpose is to provide a global sharing of staff knowledge.

In general, Competence Center has the following functions:

- Monitoring the current state of knowledge management in the organization and provision of appropriate materials from which users will be able to find out where to get necessary knowledge and guidance - to draw conclusions about the effectiveness of this type of activity.
- Identification, formalization and distribution of tacit knowledge of the organization.
- Tracking the innovations in technology and revealing of new trends.
- Collection and description of the knowledge obtained while completing specific projects.
- Management of university knowledge base: maintenance, updating, integration, development of user-friendly search engine.
- Providing communication between users who have the necessary knowledge.
- Protection of intellectual property of the university.
- Training of new employees, sharing best practice with them.
- Distribution of accumulated knowledge throughout organization.

Establishment of Center of Competence requires a great deal of work and a significant investment of resources. However, it can bring a lot of benefits to the company: the preservation and enhancement of critical knowledge, the most efficient use of human and intellectual resources, optimal expert time allocation, and finally, solution of many business problems using its own organizational capacity.

Quite often there is an obstacle on the way from a concept to mass production of high-tech products. There could be a problem to make pre-production prototype. First of all, this problem concerns small innovative enterprises working at universities. The second major problem is the preparation of documents, that must comply with specific requirements. In Saint-Petersburg Electrotechnical University "LETI" Center for prototyping and contract manufacturing was established. The main aim of the Center is to use efficiently scientific and technological, informational and human resources to ensure the ETU contract manufacturing of high technology electronic products like the new perspective for the region shape services for prototyping and innovation rapid commercialization of ideas and technologies. It will consist of the center to design micro-and nanotech products, and laboratory-industrial complex for prototyping of products based on main components and 2D and 3D build procedures "microsystems in the body". This project will be completed jointly by the teams of research and education centers, "Micro technology and Diagnostics" and "Nanotechnology" as well as a number of departments. One of the first prototypes to be made in the Center should be miniature moving robotic systems to monitor and collect information of the main systems; chip micro laboratory for rapid diagnosis of antibiotics activity as well as projects to create the element base of radio electronics.

The three-year university experience has shown significant efficiency of using the best practices of many institutions and enterprises of the Russian Federation in joint development and delivery of the network of educational programs for graduate and post-graduate students (the university introduced more than 50 educational programs, which involved about 400 graduate and postgraduate students).

Conclusion.

To draw conclusions from gained experience of implementing tiered practice-based system of engineering training it should be noted::

- In post-crisis modernization of the Russian economy multi-level system for training engineering staff is the most appropriate organizational form of educational process at universities.
- Additional benefits can be obtained through the implementation of university-enterprise network (joint) degree programs.
- In the transition to the new Federal state educational standards and tier training system universities should undertake significant measures and innovative changes in all spheres of their activity.

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