

A System of Integrated Field-Oriented Training of Specialists Based on Innovative Research and Developments

Saint Petersburg Electrotechnical University "LETI"
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The article presents innovative university strategy for solving scientific and practical problems and training of field-oriented specialists for science and industry focused on the development of an advanced interdisciplinary training of specialists and modernization of educational environment in the field of advanced radioelectronic measures, as well as on an efficient commercialization of scientific research and developments.

Key words: interdisciplinarity, field-oriented training, semi-active radiolocation, academic mobility.

The further presented concept of solving scientific and practical problems and training of field-oriented specialists for science and industry is aimed at the development of an advanced interdisciplinary training of specialists and modernization of educational environment in the field of advanced radioelectronic measures, as well as at efficient commercialization of scientific research and developments.

Assurance of advanced interdisciplinary training is based on attraction of intellectual and infrastructural resources both of a university and of a wide network of partners – research centers and scientific institutions. One of the dominant technologies is learning through research and participation in real-market developments (both at HEI's scientific centers and industry-based departments).

In the framework of a cluster for radio-electronics, professional equipment development, communication tools and info-telecommunications the key areas for developing cooperation between industry and Saint Petersburg Electrotechnical University "LETI" (SPb ETU "LETI") in scientific and educational fields are the following:

- Development of a targeted work order for specialists.
- Active career-guidance.
- Compliance of the list of Master programs and their contents.
- Fostering of students' professional competences within Bachelor and Master programs.
- Execution of joint (network) study programs.
- Joint targeted training in the interest of military-industrial complex.
- Joint training of PhD students.
- Vocational education (for students and specialists).
- Joint programs for professional development (Presidential Program);
- Professional accreditation of study programs.
- Scientific research and development projects.

Collaboration of universities and industrial enterprises is aimed at solving practice-oriented educational, scientific and technological problems in exploitation of advanced technologies in radioelectronics that respond to the Grand Challenges of Sustainable Development. Among the problems to solve are exploitation of St.

Petersburg scientific capabilities, launching and promotion of innovative products on new markets, contribution to export, human resourcing of innovative development of St. Petersburg economy, training and professional development of specialists for scientific and high-tech industries, fostering the integration of science, education and industry for commercialization of innovations.

A suitable example could be one of the oldest radio engineering enterprises – JSC "Research Institute "Vector" (founded in 1908, is a part of JSC "Radio Engineering Corporation "Vega") that has been successful in working for the defense industry.

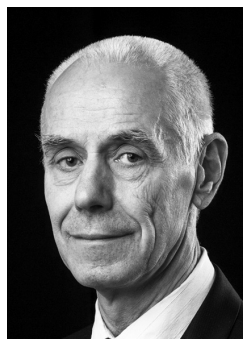
JSC "Research Institute "Vector" carries out the orders of the Russian Federal Ministries for conducting research, design and development of tools for the following fields of radio engineering and radio electronics:

- Electromagnetic propagation physics with respect to various natural and artificial geophysical factors (earthquakes, storms, eclipses, etc.).
- Radio perception on communication hubs, integration of portable and stationary communication hubs.
- Monitoring of electromagnetic interference, direction finding and locating its sources, processing received signals in their stationary, mobile, marine, aero space and portative execution.
- Sonic monitoring.
- Testing radio electronic devices at all frequency intervals.
- Practical application of electronic devices for economic and technical monitoring, medical diagnostics and other.
- Microminiaturization of radio electronic device components.

SPbETU "LETI" has developed an ongoing program "Strategic partnership" that aims to assure high quality of professional training for specialists based on the integrative cooperation of university and interested enterprises and organizations (university's strategic partners) by consolidating the intellectual potential, material, financial and corporate resources [1].

SPb ETU "LETI" cooperates with more than 40 largest enterprises of the North-East region of the country, such as JSC "Research Institute "Vector", Group of industrial companies "TIRA" Corporation", JSC RIPR, JSC MART, JSC "NPO Radar MMS", CJSC "Kozitskiy Plant", JSC "Svetlana", JSC "Avant-garde", JSC "Concern "Okeanpribor", JSC "State Research Center for the Russian Federation Concern CSRI "Electropribor", JSC "Power Machines", JSC "REP Holding", the Institute of Applied Astronomy of the Russian Academy of Sciences, the Ioffe Institute and others. Among the international partners of SPSETU there are 18 large industrial enterprises, 7 science and research centers and institutes, and 65 universities from 35 countries. A specific system for field-oriented training has been created. Within this system the organizational and methodological guidance materials have been developed and tested for the joint (university-enterprise) scientific and research projects on development of science-driven high-tech products; professional developments of enterprises' staff and university faculty; Bachelor, Master and PnD students' internships; and targeted training of young specialists for enterprises [2]. Thus, JSC "Vostok" successfully employs a significant number of LETI graduates and holds all types of LETI students' internships. The enterprise forms groups of 12 to 15 students for Bachelor and Master targeted engineering training annually.

With the direct involvement of SPb ETU "LETI" and JSC "Vostok" a program (the "20/80 Program") for training, retraining and professional development of workforce for the high-tech industries has been developed and executed from 2007. The aim of the program was to support St. Petersburg large and medium enterprises that conduct training of their specialists and targeted education of students at field-oriented HEIs through providing grants for 80% of the total costs for training, retraining and professional development programs. During 2007-2011 several dozens of St. Petersburg enterprises, organizations and technical HEIs have participated in this program. More than a thousand specialists and students have



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been trained within the program. Due to the rise of the program's popularity a new Program for training, retraining and professional development of workforce for industry of Saint Petersburg has been launched from 2012 to 2015 by the Order of the Economic Development, Industrial Policy and Trade Committee No. 177-p of February 15, 2012. The program was launched as a sequel to the previous "20/80 Program" and set strict criteria for selection of enterprises and organizations, as well as determined interconnections between all the stakeholders of the training process. The prerogative right for participation in the Program was given to the enterprises and organizations of the military-industrial complex that have high-profile government contracts.

Best practice of executing municipal professional development programs of workforce for high-tech industries have been taken into account when developing a Presidential Program for professional development of engineering workforce for 2012-2014 and a State institutionalized program "Professional development of engineering and technical workforce for 2015-2016", in which SPb ETU "LETI" and JSC "Research Institute "Vector" have taken active parts.

In the framework of the municipal program for training and retraining of workforce for high-tech industries of Saint Petersburg, training and retraining of workforce is conducted under the request from enterprises. Within only the last three years different types of retraining programs at SPb ETU "LETI" have been attended by more than 270 people. At the same time, the SPb ETU "LETI" faculty members get trained by attending professional development programs on the premises of St. Petersburg enterprises.

In 2015, SPb ETU "LETI" won the third place among engineering universities in the Rating of HEIs' relevance (demand for their graduates) conducted by the "Social Navigator" of the International Information Agency "Russia Today" in cooperation with the Center for Labor Market Research (http://vid1.rian.ru/ig/ratings/Rating_uni_2015_Engin.htm). Overall there were 463 state,

corporate, municipal and private HEIs from 80 constituent entities of the Russian Federation included in the Rating. All featured HEIs had conducted professional training on educational and vocational study programs of higher education during 2014. Among the HEIs there were 87 classical universities, 140 technical universities, 56 agricultural HEIs, 61 HEIs from the sphere of management, 72 Social Sciences HEIs and 47 medical HEIs.

An important part of the innovation strategy for solving scientific and applied problems and field-oriented training of workforce for science and industry is the cooperation between JSC "Research Institute "Vector" and SPb ETU "LETI" in the fields of scientific research and development, as well as the conduction of methodical scientific research for the enhancement of specialists' education.

Cooperation between JSC "Research Institute "Vector" and SPb ETU "LETI" in the framework of the Strategic Partnership Agreement includes the development of prospective plans, execution of joint meetings of scientific and technical councils, and, based on these events, the selection of precise objectives and forms for organization of research and developments.

This approach allowed executing a number of large-scale projects, as well as a significant number of initiative works. Thus, in the framework of realization of the Saint Petersburg Government Decree No. 928 of August 30, 2012, "On amendments of the Saint Petersburg Government Decree No. 835 of June 28, 2011, and the 2012 procedure for granting subsidies for execution of events in the framework of the Comprehensive Program "Science. Industry. Innovations" in Saint Petersburg during 2012-2015" the competition has been won by a scientific research program "Development of a passive radiotechnical control system for metropolitan air environment by means of radio emission of digital video and radio broadcasting" (code "Metropolitan") in total of 30 million rubles. What is meant here is the scientific development of a system that solves core issues of radiolocation – detection of targets

and determination of their coordinates by signals of the digital video and radio broadcasting. The objects of the research are semi-active radar systems – direction of radio radar, joining methods and means for detection of targets and determination of their coordinates by using signals of external sources.

In 2014 SPb ETU "LETI" and JSC "Research Institute "Vector" won the competition for working in the framework of projects on the development of high-tech production in line with the Russian Federation Governmental Decree No. 218 of April 09, 2010, on "Development of a passive coherent location complex for protection of critical facilities". The aim of the project is to develop a batch production of passive coherent location complex for protection of critical facilities notable for its enhanced exploitation and functional characteristics.

The system of semi-active radiolocation (PARLS) that uses illumination signals of external objects (such as broadcasting video and radio centers, basic stations of mobile systems, etc.) is considered today as prospective measure for determination and trajectory guidance of radiosilent terrestrial, offshore and aerial objects [3]. A semi-active radiolocation has a number of advantages: lower production, arrangement and exploitation costs, a lack of need for frequency allotment, a lack of harmful environmental impact and a lack of disturbance for other radio engineering devices, as well as its furtivity. The features of the system for semi-active radio location determine a high potential of their implementation for protection of critical facilities, monitoring of perimeters and territories, including creation of low-altitude radar field. A wide spread occurrence of modern digital broadcasting and telecommunication systems provides PARLS with efficient illumination signals with good correlation characteristics, which allow receiving the needed technical specifications in a wide variety of application conditions.

A comprehensive approach to the development of these systems requires the involvement of specialists from different fields of knowledge and ensures the basis

for interdisciplinary training of students based on joint innovative research and developments. Therefore, on the second Master cycle of education students are invited to choose an enterprise for their practice-oriented work and conduction of certain components of their curriculum. Student's independent work outside of the in-class learning is a necessary component of training Master students – qualified specialists that attend innovation programs and are capable of solving, individually or in groups, various professional scientific, engineering and social problems using creative methods, able to apply to the practice the latest developments of progress in science and technology, able to adapt quickly to the changing economic conditions. Students' scientific and research work in a semester is seen as a constant independent work of a Master student on each of the four study semesters, which is not directly connected with the courses of the curriculum (the learning process of the latter includes their own specific forms of Master students' independent work) [4]. In line with the interdisciplinary projects, industrial and technological internships, design and engineering internships, as well as preparation of Master thesis, the scientific and research work in a semester is a component of Master student's independent work outside of the curriculum courses.

Cooperative activity of the SPb ETU "LETI" and industrial enterprises is executed in the framework of Strategic Partnership Agreements that incline mutually beneficial development in scientific, educational and innovation areas. Only the Faculty of Radio Engineering and Telecommunications of the SPb ETU "LETI" itself guides cooperation with leading enterprises of the region on 14 Strategic Partnership Agreements. The structure of the Faculty includes 5 industry-based departments (on the premises of JSC "Research Institute "Vector", JSC "NPO Radar MMS", the Institute of Applied Astronomy of the Russian Academy of Sciences, Institute of Silicate Chemistry of RAS, Television Research Institute), as well as a number of joint scientific research divisions.

The most severe tension around the issue of field-oriented training of specialists for modernization and development of the real economy is allocated at the administrative bodies of the industrially developed regions. St. Petersburg has approved and executed a Comprehensive Program "Science. Industry. Innovations" for 2012-2015 (approved by the Saint Petersburg Government Decree No. 835 of June 28, 2011). The basis of this program is a cluster model for the development of industry in St. Petersburg that unites highly essential enterprises and organizations.

Starting from 2009, SPb ETU "LETI" and JSC "Research Institute "Vector" have been actively involved in the execution of study programs for academic mobility of students and faculty. The Government of Saint Petersburg (The Committee on Science and Higher Education) provides financial support to the HEIs taking part in the programs for academic mobility of students and faculty from other HEIs according to their level of participation in the programs. Academic mobility can be executed in a form of students' participation in the following programs: network (joint) study programs (NSP); exchange programs; programs for short-term partial education; traineeships or internships; summer schools.

At the same year, SPSETU has started executing a project on organization of development and experimental approbation of a project on academic mobility enhancement for students, PhD students and faculty of HEIs that conduct training of workforce for industries securing modernization and technological development of Russian Federation economy. Study programs (modules) have to correspond to one of the prioritized areas of modernization and technological development of Russian economy: energy efficiency, nuclear technologies, space technologies and telecommunications, medical technologies and pharmaceuticals; strategic information technologies and software.

Starting from the fall of 2014, SPSETU together with JSC "Research Institute "Vector" and JSC "NPO Radar MMS" execute two projects: "Training of highly

qualified specialists in the field of special radio electronics systems" and "Training of qualified specialists in the field of Super-High Frequency systems, ultrabroadband radiolocation and radio contact" in the framework of performance of the open public tender terms for providing support for programs on workforce training system development for military-industrial complex at educational organizations of higher education under the jurisdiction of the Ministry of Education and Science of the Russian Federation (minutes of the tender commission meeting No. AK-158/05pr of September 19, 2014, and No. AC-68/05pr of September 25, 2014).

From 2012, the Ministry of Education and Science of the Russian Federation has organized the work in line with the Presidential Program for professional development of engineering workforce for 2012-2014, approved by the Order of the President of the Russian Federation No. 594 of May 07, 2012. Based on the evaluation of the Presidential Program's productiveness, it has been decided to continue it in the form of an institutionalized targeted program "Professional development of engineering and technical workforce for 2015-2016", approved by the Order of the Ministry of Education and Science of the Russian Federation No. 490 of May 12, 2015.

An important component of specialists' training assessment is the professional accreditation of HEI's study programs, which for engineering majors is carried out by the Association for Engineering Education of Russia. SPb ETU "LETI" has already received the EUR-ACE label for its 34 study programs that are being executed from 2014 to 2020.

In the courtesy of the network cooperation development between the university and scientific and educational organizations, enterprises of high-tech fields of economy, SPb ETU "LETI" has modernized and developed a professional environment that allows to generate, apply and disseminate knowledge on prioritized areas of modernization and technological development of the university, which is highly demanded by the society and the government.

In a close cooperation with potential employers the interdisciplinary study programs have been developed and executed. The innovative Master programs with industry-targeted component are set atop. Based on them the programs for vocational education, professional development and retraining are executed in a modular format. A joint training of PhD students is being developed. Joint systematic execution of methodical science and research work allows a constant targeted modernization of educational process's forms and contents both in the interest of enterprises and with a focus on an advanced development of interdisciplinary training of workforce and modernization of teaching and learning methods in the field of advanced radio electronics.

A longstanding fruitful cooperation between SPb ETU "LETI" and enterprises in the spheres of scientific research and development assures the development of interdisciplinary training of workforce and modernization of educational

environment in the field of prospective radio electronic devices, as well as an efficient commercialization of R&D results. Such cooperation is a good example of development and consecutive exploitation of innovation strategy for solving interdisciplinary scientific and applied problems and targeted training of specialists for science and industry.

The outputs contribute to the development of scientific potential and innovative infrastructure of St. Petersburg, launching and promotion of innovation products on new markets and contribution to export, as well as the human resourcing of the St. Petersburg economy's innovative development, the training and professional development of workforce for science and high-tech production industries, the development of integration processes in industry, science and education for commercialization of innovations, and the support of clusters' development in Saint Petersburg.

When working on the article the results of the design and development project "Development of a passive coherent locational complex for protection of critical facilities" have been used. The project is conducted by SPb ETU "LETI" under the agreement with JSC "Vostok" in the framework of a Comprehensive Project on development of high-tech production and is financed by the Ministry of Education and Science of the Russian Federation (RF Government Decree No. 218 of April 09, 2010).

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