

# Integration of Engineering Education with High-Technology Business (by the of ISTU)

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**Nowadays the strong competitiveness for the qualified engineers exists on the labor market. Business and modern level of production allow raising a demand to the quality of the staff training while the existing system of higher professional education continues to graduate specialists who are not very well prepared to the production activity. The solution of the problem is to join the efforts of technical universities and big high-technology companies.**

***Key words:** engineering education, satisfaction of requirements of business societies, partners-employers, confidence in the professional career, discharge of R&D by order of high-technology business.*



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National Research Irkutsk State Technical University is one of the largest universities in Siberia. More than 23 000 students (92 – Specialist's degree, 39 – Bachelor's degree, 19 – Master's degree) study at the university. It offers a challenging intellectual environment with 150 graduate and 30 undergraduate degree programs. Among those who teach and do research at ISTU there are 123 higher doctoral degree holders and almost 630 holders of candidate degrees, the total number of professors and instructors being about 1 130.

The university has over the past 82 years trained more than 145 000 specialists, with 2000 being foreign students. Its alumni constitute 70% of engineering industry and 50 % of high-top and mid-level managers in leading companies of Irkutsk region.

Effective collaboration of ISTU with industrial enterprises is one of the most important factors for its success. Earlier, this kind of relationship

worked only one way. However, the situation has significantly changed over the last 5-6 years. The representatives of industrial enterprises and potential employers become actively involved in discussing the ways to handle the problems in engineering education. It can be explained by the rapid development of real economy sector that led to the staff shortage especially in high-tech field. High average age of workers and lack of knowledge in application of up-to-date technological tools are the current "pressure points" in engineering business. The shortage of qualified personnel is also aggravated by low level of young people mobility.

Besides, low level of student motivation also negatively affects educational and professional achievements especially in the field of science-driven and high-tech industries which are still characterized by low salary level and slow career progress. Today power engineering challenges

outflow of specialists to oil and gas industries [1,2] as they are searching for better working conditions and remuneration's reward. There is strong competitiveness for engineers among different enterprises and industrial sectors, as well [3,4]. The shortage of qualified personnel can be also explained by rapidly changing requirements of modern engineering environment. Contemporary engineering is a profession directed towards the application and advancement of professional and practical skills based upon the deep understanding of up-to-date technological instruments and communication tools [5]. Besides, as companies have to enter foreign markets, their employees must acquire additional professional skills to localize their products so that they can compete with international companies. There is also another problem to be solved, i.e. to accord federal state educational standards of higher professional education with professional standards which have emerged in different fields of high-tech industry, for example in aircraft engineering [6] and communication technologies [7]. Today, most employers are not able to figure out the requirements a modern engineer to meet and as a result engineering education fails to produce a specialist that desired by real-life industry.

On top of this, old-fashioned material and technical facilities of higher engineering establishments can hardly contribute to the quality enhancement of engineering education.

To address emerging challenges concerning staff shortage and quality improvement of engineering education, it is essential to join the efforts of technical universities and large engineering companies focused on competitive and high-tech production fields of national economy. Such kind of cooperation will allow higher education to produce a specialist

equipped with necessary professional skills to confront new challenges and who will be ready to move and contribute to his personal development. This way is also followed by the developed countries. For example, most part of US universities is private-sponsored. Large international companies invest money to the perspective universities in order to train highly-qualified specialists for their business [8].

Based on ISTU experience, the following types of effective cooperation which will assure training qualified and highly-demanded specialists can be distinguished:

#### 1. Monitoring quality dimensions of engineering education and types of profession being in demand.

ISTU offers its students many job placement opportunities through the successful implementation and development of job placement programs. During the whole academic year, staff of the job placement department is seeking for large-scale engineering companies which can easily become potential employers of university graduates. They are asked to inform university about professions being in-demand, working conditions, social security floor and even the assessment of teaching quality provided by the university. In 2010/2011 academic year, more than 300 inquiry letters were sent to large-size and middle-size engineering companies. Based on the obtained results, the staff of the placement department builds up the vacancy database and forwards it to Deans of the faculties or Directors of the institutes. The latter, in its turn, annually examines the results of job placement rate and develops the corresponding corrective action plan.

The detailed information about vacancies and companies is accumulated in the commissions of the faculties and institutes. The vacancies are distributed among the students based

on the GPA being achieved (excluding personal agreements and contracts).

Thus, when graduating from university, young specialists are awarded with Diploma and job placement document.

Engineering curricula and learning materials are annually revised by the heads of the departments to adjust the training process to the ever-changing employer's requirements.

The existing system of monitoring allows university to obtain true-to-life assessment of its activity as well as to determine what is needed in the future design of engineering curricula to produce the specialists who will be always in high demand.

**2. Development and implementation of educational programs on demand of potential employers.** In order to prepare engineers to meet new requirements of business environment, ISTU is striving to accord the standards of the existing curricula of various educational programs with the needs of employers.

In 2011, as information technologies play a key role in design and production of high-tech and HVA products ISTU developed its own educational standard for the learning module "Information systems and technologies" in cooperation with Irkutsk Aircraft Plant (branch of IRKUT Corporation), "Irkutskgeofisika" Inc, "Irkutsk Electroprospecting Company" (IERP). Most information technologies are common in structure, although the application procedure will significantly vary depending on industry field. This fact is not considered by the existing Federal State Educational Standards. Our partners-employers were constantly anxious about the fact that a young programmer just graduated from university had to undergo quite a long adaptation period to adjust his professional skills to real workplace requirements. According to their comments, ISTU has devel-

oped the educational standard which makes possible not only to meet the needs of high-tech enterprises for the specialists equipped with necessary professional skills but also to instill additional confidence in graduates within their field of study. New educational standard has been developed on the basis of the existing Federal State Educational one. However, new scientific-and-teaching cycle has been added, additional learning outcomes according to activity areas have been specified and new professional competencies relevant to real workplaces have been outlined. There are 12 compulsory subjects (throughout all cycles) and 38 additional criteria for evaluating learning outcomes.

To facilitate the practical application of knowledge acquired, ISTU alongside with Tomsk State University of Control Systems and Radioelectronics [9] has made a resolution to approve the content of educational engineering programs with the biggest employers of the university graduates. This important step will allow higher education to produce a specialist equipped with necessary professional skills to meet the requirements of modern engineering companies.

In 2010-2011 more than 470 educational programs were developed and accorded with the biggest engineering enterprises and research institutes operating within high-tech sector of national economy. They are: "Irkutsk Aircraft Plant (branch of IRKUT Corporation)", JSC "Angarskaya Neftekhimicheskaya Kompaniya", JSC "IrkutskNIIhimmash", JSC "Russian Railways", JSC "East-Siberian Biotech Combinat", JSC "Irkutskenergo", JSC "Irkutsktyazhmash", JSC "Buryatzoloto", LLC "Vostochno-Sayanskaya Nikelevaya Kompaniya".

The same work is also being carried out in concern with further vocational education programs. In 2010, 64 newly-developed educational pro-

grams were added to the list of 132 curricula. In 2011, more than 5 000 employees of different engineering companies did the refresher courses at the university.

**3. Establishment of research-training centers sponsored by industrial companies.** At the present moment, this kind of interaction of engineering education and high-tech business is considered to be completely new and rather efficient.

In ISTU, there are two research-training centers supported by well-known fuel and energy companies - "TNK-BP" and JSC "Irkutskenergo". The main objective of the centers is to train qualified specialists in accordance with the programs approved by the experts of industrial companies. Besides acquiring specific technical competencies to adjust a specialist to his workplace, attending the courses brings important social and networking benefits to each attendee. The programs are designed to keep employees' skills up-to-date and develop their talents to perform research on the relevant topics.

To meet the requirements of the company to the training quality and to enhance not only technical but also soft-engineering skills, TNK-BP research-training center offers the following educational programs: fundamentals of petroleum engineering (for non-majors); basic concepts of earth science: oil and gas field development and etc., with such learning modules as "Introduction to the Company", "Career growth in TNK-BP", "Success with TNK-BP" and business game "Three Horizons" being of great importance.

Each year more than 1000 workers of petroleum companies located in Eastern Siberia improve their qualification in the research-training center.

The center is equipped with full-scale simulator DrillsIM-5000 which allows us to implement completely

new learning style enabling trainees to develop technical skills and execute real world drilling or well control exercises, prevent and mitigate emergencies and encounter the showings of oil-gas and water. The attendees are rewarded with international certificate entitled "International Well Control Forum". To maintain high level of learning process, two employees of the university were interned in the training centers of Aberdeen Drilling School in Scotland and were awarded with assessor and supervisor certificates which gave them the right to train specialists in accordance with IWCF standards. In 2009, ISTU became a member of International Well Control Forum.

In 2012, full-scale simulation center was acquired due to the financial assistance of "TNK-BP". The simulator offers immense flexibility in the software and simulated drilling equipment to drill a well equipped with electrical submersible pumps. It is also planned to establish training ground where it could be possible to launch simulating modules designed to enhance understanding

of the fundamentals applicable to operation and maintenance of different oil and gas field facilities.

JSC "Irkutskenergo" research-training center offers a number of enhanced educational programs designed to provide students with deep knowledge in the following modules: installation, operation and maintenance of heat engineering facilities and network; equipment of electric power plants; automated control systems of thermal stations; protection equipment and relay ladder logic system of plant equipment and machinery. High quality of teaching process is provided by the experts of JSC "Irkutskenergo", leading educators of Melentiev Energy Systems Institute of Siberian Branch of the Russian Academy of Sciences (ESI SB RAS)

and teaching staff of power engineering faculty.

The center includes Equipment Protection Laboratory and Electromagnetic Compatibility Laboratory which are equipped with the state-of-the-art fixed installations and portable devices – consoles of relay protection and automated control system manufactured by leading Russian and foreign companies. In the short term, it is expected to establish new electro-technical laboratory equipped with a full-scale simulator of electrical power unit.

One of the basic learning techniques widely applied in research-training centers is a team work which is based on the results obtained in current research ordered by the companies-partners.

#### 4. Attraction of young specialists by organizing company presentation and launching scholarship programs.

Through the established partnership with our partners, we are able to successfully interact in questions concerning the ways of attracting young specialists to work in industrial companies. We usually hold the meetings where the managers of the companies provide students with information about the company, its history and mission, working conditions and career growth. Such meetings significantly motivate students to study and acquire professional knowledge. More than 60 meetings were held during the last three years: "Irkutsk Aircraft Plant (branch of IRKUT Corporation)", OJSC "Norilsk Nickel", JSC "Arsenyev Aviation Company PROGRESS"; JSC "Kolskaya Mining-Metallurgical Company", JSC "TNK-BP", CJSC "Alrosa", OJSC "Polyus Gold", Priargunsky Industrial Mining and Chemical Union (JSC PIMCU), OJSC "Sayanskchimplast", JSC "Angarskaya Neftekhimicheskaya Kompaniya", JSC "Buryatzoloto", Polymetal International plc, JSC "Irkutskenergo", "En + Group",

OJSC "Raspadskaya", CJSC "Rusburmash" and etc.

Due to heavy media coverage of the events, technical professions have become of great interest to university applicants.

The scholarship programs provided by a number of companies have become another motivation for students to study hard acquiring deep knowledge and professional skills: LLC "Rusengineering", JSC "Sibirsko Uralskaya Aluminum Company", JSC "Irkutskkabel", JSC "Irkutskenergo", "BP", "En + Group" and etc.

#### 5. Developing innovative training infrastructure in cooperation with potential employers.

Over the last three years, 22 unique laboratories and classes were established at the university due to the assistance of the following companies: OJSC "Sayanskchimplast" (Laboratory of technological process automation); JSC "Angarskaya Neftekhimicheskaya Kompaniya" (Laboratory of petroleum chemistry and organic synthesis, semi-industrial installations for hydromechanical and heat-and-mass processes); JSC "DANFOSS" (Laboratory of asynchronous energy-conservative electric drive); JSC "Irkutskenergo" (Laboratory of complex analysis of power fuel, heat exchange and heat transfer); "Irkutsk Aircraft Plant (branch of IRKUT Corporation)" (computer complex "Technical Operation of Aircraft Equipment"); JSC "TNK-BP" (Laboratory of computer well logging simulation); JSC "SUEK" (Laboratory of numerical rock modeling); JSC "Buryatzoloto" (multimedia room "Underground development of ore and other deposits"); Polymetal International plc (bedded deposit development training room); CJSC "Alrosa", (classroom) and etc. All laboratories are sufficiently equipped with instrumentation and experimental setups. What is more important, the rooms are decorated in compa-

nies' corporate styles, which plays a key role in advertising and promoting companies' interests. The volume of investment in ISTU training facilities exceeded 360 million rubles over the last 5 years.

#### 6. Student involvement in research projects commissioned by high-tech business companies.

Quality enhancement of engineering education can be achieved through intensive involvement of students in research projects commissioned by high-tech companies. In 2011, approximately 1000 students pursuing technical degrees were engaged in fulfilling such projects. For example, more than 100 undergraduates and master's students performed scientific work in modern research laboratories equipped with up-to-date facilities and tools in compliance with resolutions of the Government of the Russian Federation № 218 "Development and implementation of a complex of high efficiency technologies in design and manufacture of aircraft MS-21" and "Development of technologies and high effective facilities to produce high-purity spherical quartz grains for electrical component base of the Russian Federation". To implement the project commissioned by Ministry of Industry and Trade of the Russian Federation "Liquidation of arsenic pollution in the industrial area of Angarsk Metallurgical Plant in Svirsk, Irkutsk region" more than 30 students were attracted. There are a lot of examples of this kind when students while studying get engaged in research and industrial experiments, conduct the research based on the obtained results, enter post-graduate program and defend dissertations on time.

#### 7. Application of modern training equipment in teaching and learning process.

Over the last three year, 18 modern research-training laboratories have been established to address special needs in such nation-

ally important technological areas as nanotechnologies, aircraft industry and mechanical engineering, power engineering, mining and oil and gas industry, chemical engineering, construction industry and architecture. The centers provide students with possibility to analyze and simulate virtual models of true-life constructions and technological processes revealing technical constraints to their enhancement.

Besides, three new training laboratories designed to support learning process in "Electric Engineering" and "Electronics" have been established within the framework of the projects implemented in compliance with the resolution of the Government of the Russian Federation № 220. These laboratories share the common goals of providing superior training capabilities in the fundamental engineering sciences, which, in its turn, will significantly enhance the quality of our graduates, especially those whose qualification is "Power Engineering and Electronics".

#### 8. Learning through work placement while studying.

Beginning in the third year, graduates should take blue-collar jobs, which can contribute to improving the quality of engineering education. For example, the graduates pursuing qualification in "Oil and Gas Well Drilling" are usually interned in petroleum companies to get insight into the field and gain experience in well site construction and drilling, with an average monthly pay being 45 thousand rubles. The students of the Aircraft and Machine Building Industry and Transport work as programmers, designers and engineers in Irkutsk Aircraft Plant beginning in the fourth year. Their course and graduating papers are focused on solving real technical problems they face at workplace. As the same approaches are followed by other institutes and faculties, it is possible to reduce the

adaptation period of our graduates and prompt their career growth.

Besides, each year more than 200 future specialists are involved in development and market promotion of innovative products and services in enterprises of high-tech sector which have been established in compliance with Federal law № 217 and the resolution of Russian Federation № 219.

The discussed types of partnerships for engineering education and business which are rather effectively applied in our university assure high demand in engineers graduated from ISTU. For example, in 2011 demand of engineering companies for our graduates exceeded the supply by 1,54 time, 98 % of students being employed to major industry companies in such sectors as mining and petroleum engineering, civil and power engineering, chemical industry, aircraft and machine building located in Urals Federal District, Siberian and Far-Eastern regions.

The fact that our graduates are found working in the vast territory of the Russian Federation shows that business community is satisfied with quality of their education that can be also proved by the survey results. For example, according to the analysis of the statistics gathered through the survey which was conducted among 300 large-scale Russian companies

in 2007 and 2008, ISTU was ranked 11th and 18th correspondingly among the universities of the Siberian and Far Eastern regions [10,11]. Based on the data obtained through the surveys which were conducted among 1100 leading companies by Russian Public Opinion Research Center on commission from Russian public organization "Business Russia", ISTU twice became a member of Russian universities' Alpha League (2007 and 2008).

As the result of the 5th Russian Mining and Exploration Forum "Minex-2009", ISTU was pronounced the winner in the category "Mining University of the Year" among Russian universities for high quality of graduate education in mining engineering. Above all, the student survey conducted by OJSC "Polyus Gold" among 12 universities of Russia in 2011 revealed that ISTU students took the 1st place in the employment rate within manufacturing engineering and the 3d place in mobility potential.

Thus, universities and business will need to cultivate mutually beneficial and lasting relationships with one another in almost all areas of activity to handle the problem of staff shortage, enhance the quality of graduate training and develop effective engineering education system.

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