

# **Innovative Engineering Education in Russian Technical University: Results and Prospects**

*Nikolay Pustovoy<sup>1</sup>, Evgeny Tsoy<sup>2</sup>, Anna Goushina<sup>3</sup>*

<sup>1</sup>Rector, Novosibirsk State Technical University (NSTU), Russia

<sup>2</sup>Vice-Rector for International relations, NSTU, Russia

<sup>3</sup>Director, International Projects and Programs Office, NSTU, Russia

Novosibirsk State Technical University, 630092 Russia 20, Karl Marx, Novosibirsk

*ebcoi@nstu.ru<sup>1</sup>*

## **Abstract**

The paper considers the strategy of development and structural reforms of Russian higher education system. The concept of establishing Russian innovative federal and national universities is presented. The priority national project “Education” as a basis for developing an innovative approach to Russian higher education is discussed. Results of implementing the Innovative Educational Program “High Technologies in Novosibirsk State Technical University” (a winner of the competition of leading Russian universities) at the University are reported. It is emphasized that innovative technologies in education, integration of scientific research with education, international cooperation, and close interaction with employers form a basis for transferring to an innovative-type university.

## **Introduction**

Radical reforms of higher education in Russian Federation introduced about 20 years ago included structural changes in the national system of higher education. The total number of higher education institutions in Russia is 1430, with 730 of these being state institutions. In the structure of training future specialists in the country, some disproportion has been observed recently. In the extended directions of training in the fields of “Economy and Management”, “Humanities”, and “Education”, Russian state and non-state higher education Institutions train about three and half million students. A slightly less number of students are trained in engineering and science. In the physical engineering, scientific, and technological directions, there is an obviously insignificant number of graduates while in the fields of economy and humanities there is an overrunning of specialists in comparison with the real demand. This situation does not meet the needs of the economic development of the country. Besides, giving the priority to the education quality, the federal education management bodies are currently putting into effect measures aimed at optimizing the country’s higher education institutions structure itself. In the field of higher education, the Ministry of Education and Science advanced a concept of federal and national research universities priority. This concept fits with the economic interests of the country, allows improving the quality and increase attractiveness of higher education, and facilitates integration of Russian higher school into the world educational space. It is assumed that in establishing federal university, the geopolitical considerations are basic, while its mission should consist in developing staff and research potential for complex social and economic development of the region.

The strategic mission of national research university (NRU) is rendering assistance to dynamic development of scientific and technological complex of Russia; providing it with the required and balanced (in number) labor resources, directions of training, qualification and age structure with the account of the required rate of their renovation and predicted structural reorganization in science and economy.

Five major criteria allowing a university to aspire to the role of NRU have been formulated:

- Generating knowledge, carrying out a wide range of basic and applied research;
- Effective system of training and retraining personnel for high-technology sectors of economy;

- High degree of integration of science with education;
- International recognition of scientific and educational activity;
- Presence of innovation belt, effective system of commercializing research results

At the meeting held at the Russian Federation Ministry of Education and Science on December 11, 2008, rectors of Russian universities discussed the issue of setting up, on the competition basis, a system of Russian NRU. Novosibirsk State Technical University being one of the leading technical universities of the Asian part of Russia and winner of the Innovative Educational Programs (IEP) Competition within the framework of the priority national project "Education" is regarded as a participant in this prestigious competition.

Novosibirsk, the third in size Russian city, puts in a claim, at the federal level, for establishing two research universities in the city. One of these will be oriented to basic research and training specialists for scientific research, the other to research and training specialists for innovative economy. There are the following pre Novosibirsk conditions for this claim.

Currently, there are 25 state higher education institutions in Novosibirsk, 10 of them being universities. The total number of students amount to 140000 people. 20 thousand staff members are involved in these education institutions, 7000 of them being lecturers (including more than 1000 Doctors of Science and 3000 Candidates of Science). In 2007, the consolidated budget of Novosibirsk higher education institutions was about 8 billion rubles, including 4.2 billion rubles from the federal budget. Students of engineering are offered a wide range of major fields—more than 3000 fields of concentration. Students are mainly offered a two-level system of training, but up to now the number of master students is insignificant (of the order of 1500 of them in eight education institutions). But the Russian Federation Law of Education and adherence to the principles of Bologna Declaration demand to extend the number of master students. At present, Masters of Engineering and Technology are those who received the best and most extensive basic and professional education. Novosibirsk higher education institutions created a clear-cut and well-defined system of training specialists for scientific and technological complex of the region. The institutions offer Engineer's degree, including a system of selecting talented young people and special-purpose specialist training, and train specialists for scientific research, including pre-university training and a system of selecting talented young people as well as "physical-engineering" system of education in higher school, thus providing an opportunity to train highly-qualified specialists in graduate school.

There is close and effective interaction between the higher education institutions and the city and regional administrations aimed at promoting education and raising the level of specialists' skill, bringing up and supporting talented young people, implementing the programs of developing the city and the region. These issues are supervised by the Higher Education Council under the governor of Novosibirsk region. Another social body—the Integrated Cooperation Council determines the policy of interaction between higher educational institutions on the one part and branch and Russian Academy of Science institutes on the other part. Cooperation with enterprises is an important direction of higher school activity. There is close and active co-operation with enterprises and a great variety of interaction forms: special-purpose specialist training, setting up organization departments in the educational institutions, performing joint research contracts. There is a Council of the Enterprises' Employment Service Heads under the Novosibirsk Higher Education Institutions Rectors' Council. Its function is to coordinate work aimed at training specialists being currently in demand. The Inter-Regional Association of Enterprises' Heads which carries out quite an efficient work has close contacts with the Rectors' Council.

The city and regional administrations lend a strong multi-purpose support to talented young people. These are scholarships and grants intended for undergraduate and graduate students, competitions and students' business-incubators, and work in accordance with the Program for Training Managers and Executives for the Enterprises of National Economy of Russian Federation (Russian Federation President's Program).

This interaction with regional government bodies allows the higher education institutions, at the regional level, to coordinate the structure and number of specialists being trained with the requirements of the labor market and the region development program.

It is impossible to give an idea of Novosibirsk without mentioning Novosibirsk State Technical University (NSTU).

Being the largest higher education institution of the city (24.5 thousand students and 3 thousand academic staff), NSTU always was and is one of the most advanced institutions. The University was the first in the region to introduce the multi-level system of training (since 1992); today it is offered in 29 directions and 84 fields of higher education—engineering, social sciences and economics, and humanities.

Nowadays, NSTU is oriented to continuous engineering education, implementing programs of various levels—pre-higher school training of senior high school students, high school graduates, and former servicemen; higher education (Bachelor, Engineer, and Master Degree programs); additional education (second higher education, in-service training, professional retraining); general secondary and professional education for people with disabilities); post-graduate education.

The University has been successfully integrating not only into regional, but also into Russian and international educational space. There are 11 branches and representative offices on the territory of Russia. Since 2005, NSTU has been successfully introducing combined forms of training: correspondence education based on the distance learning technologies. The University takes part in the experiment aimed at introducing credit units within the framework of the Bologna Declaration and is a coordinator of the project on the development of higher professional education in the Siberian Federal Region according to the Bologna Declaration. The University is a member of a number international scientific organizations, it has agreements on cooperation with 52 universities of Europe, Asia, and CIS countries. In 2002, Rector of NSTU signed the Magna Charta Universitatum. The NSTU academic staff considers the Bologna process as a new vector of development. As from 2006, NSTU graduates are entitled to receive a European-standard enclosure to the Diploma of Higher Education.

In 2007 the University became one of the winners of the All-Russia Competition of Higher Education Institutions adopting innovative educational programs and received about 600 million rubles to implement the program “High Technologies” oriented to complex training of highly-qualified specialists in the fields of information technologies, mechatronics, and materials science.

The University interpreted its victory in the competition of the Innovative Educational Programs as an opportunity to enhance the prestige of engineering education. The Innovative Educational Program became a powerful stimulus to the University development. It allowed NSTU to buy modern equipment and software, to modernize the laboratory base, develop new courses, textbooks and teaching manuals, to provide internships and in-service training for the teaching staff, doctoral and master students. Only during the first year of the program implementation, the University equipped 16 instructional and scientific laboratories, seven scientific and educational centers, three multi-access centers according to the major directions of the Innovative Educational Program: Information Technologies, Mechatronics and Automation, New Materials and Technologies. These include laboratories of catalytic synthesis of nanostructured materials, electronic microscopy, information protection, resource-saving electro technologies, center for laser and plasma technologies, center for molecular beam epitaxy and nanotechnologies; center for new materials on the basis of anthropogenic wastes. A supercomputer grid system, new publishing and printing plant, and modern foreign languages center were put into operation. On the basis of these and other laboratories and centers, the University carries out educational and R&D activity, including activity in the Russian Federation priority directions of development of science, engineering, and technology: in the field of nanosystems and new materials, rational nature management, and information and telecommunication systems.

In May 2007, the University, the first in Russia, set up an educational exhibition center of the German machine-tool concern Deckel-Maho-Gildemeister. A number of authorized educational scientific centers and laboratories of the world leading companies have been established at the University. These are Siemens, Schneider Automation, Texas Instruments, ABB, Karl Zeiss, Motorola, National Instruments, and a number of others. The University Administration made a decision to issue a certificate to each student who took training at the NSTU multi-access center, authorized center, or laboratory as a supplement to the degree diploma. This document is certain to help the graduates find employment.

The University has its innovation structures: innovation technology center, students’ and technological business-incubators intended for 100 work places, center for developing innovative competencies, and NSTU industrial park.

Doctoral, master, and senior students (Bachelor and Engineering programs) take an active part in the university large-scale research projects, including the projects within the framework of the Innovative Educational Program. Of great assistance is the system of university and faculty research grants, and students' business-incubator designed for involving students in research work.

In a short space of time, the training process gained a new qualitative level. During the last twenty-year period Russian higher education institutions lacked financing; so in order to give students an idea of the present-day equipment we had to cooperate with industrial enterprises or Siberian Branch of Russian Academy of Sciences (SB RAS) laboratories. Due to the Innovative Educational Program, we bought the most advanced equipment and set up a number of world-standard laboratories, which considerably aroused interest in the studies at the University on the part of students. The academic staff also changed their attitude to teaching. Many multimedia-equipped laboratories and computer classrooms were put into effect. The teachers understand that they should choose between the two alternatives: either to teach students applying present-day equipment and new technologies or not to be in demand. This means that we changed the outdated teaching stereotypes by providing in-service teacher training to 1500 academic staff members. The teachers saw for themselves new educational technologies and new laboratories at the leading Russian and foreign universities and scientific centers.

The Innovative Program set the University a high rate of development. In 2009, NSTU participates in establishing Russian Nanotechnology Network (111.5 million ruble grant). Within the IEP framework, we have developed only three directions; on the waiting list are power engineering (negotiations between NSTU and the German company Siemens for opening a "smart houses" laboratory are under way) and radio engineering (the University will offer a new degree "Digital Television").

In short, the competition of Innovative Educational Programs demonstrated convincingly to the Russian Federation Government that adequate financing brings about significant qualitative changes in higher education. These qualitative changes will, in turn, bring about enhancing the engineering education prestige, transforming the educational space, raising the quality of training engineers, and increase in competitiveness of the graduates on the job market.

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