

The Bauman MSTU: experience, traditions and innovations in engineering and scientific staff training

The Bauman Moscow state technical university (The Bauman MSTU)
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The article deals with the totality of problems concerning engineering education and universities' activity at the present stage of education system reform. It analyzes topical problems and shows possible ways of their solving in relation to historic experience and training traditions of The Bauman MSTU. In fact, it gives the characteristics of a contemporary technical university, the problems of formation of its unique scientific and educational environment within which engineering elite can be trained, using the scientific potential effectively and providing a real universities' contribution into Russian economy modernization.

Key words: *problems of engineering education, history and traditions of the Bauman MSTU.*



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Contemporary technical university, staff training, research work, engineering education plays a crucial role in achieving sustainable socio-economic development, when revival efforts for Russian economy are being taken within the process of economic transition to an innovative socially-oriented model.

However, there is a decrease of prestige, quality and relevance of engineering education as well as most engineering research activities. This is recognized by the state establishment. They place emphasis on the fact that "we are facing a big threat - the threat of devaluation of higher education in general and engineering education in particular. Unfortunately, within the nineties the value of higher education notably decreased" (D.A. Medvedev) [1].

Obviously, the engineering education needs to be reformed. However, we should not forget that the national education system formed through the centuries is unique. So, higher professional education of Russia is competitive in many areas. Its main advantages include fundamental, systematic,

world-view panoramic characteristics and practical orientation.

Most problems of higher education are already defined and obvious. They are constantly and actively discussed in the academic community. In general, these are the following issues: how to optimize the network of educational institutions, organizational, managerial and financial tools of universities. The issues of lifelong learning and the quality of training in-demand specialists at various levels, the structure and content of higher education, the introduction of new educational technologies are of fundamental importance. Acute problems of research activities are as following: insufficient effectiveness of innovation, a gap between "theory and practice", when many scientific and theoretical innovations are not in demand and do not become commercial, poor research and laboratory facilities, undeveloped infrastructure of universities, etc.

As is known, the world's main trend of modern society development is the transition from the paradigm of resource and industrial economy to the paradigm of the

“new economy”, also called “knowledge economy”, “knowledge based economy” or innovative economy.

Priority is given to the development of high technologies, research, establishing world-class technical universities, making engineering profession and engineering work the most prestigious and highly paid ones.

The history of Moscow State Technical University named after N.E. Bauman is a reflection of engineering education development stages in Russia, and specific examples of its work in fact are time-tested, real and possible solutions of challenges in engineering training, development of higher technical education, advanced training educational practice.

MSTU is recognized for a wealth of experience and the quality of engineers’ training, results of research and innovative activities, practice and close cooperation of higher education institutions with industry leaders and research institutions of high-tech complex, development and analytical research on professional education. All of these helps determine objectives, criteria and performance targets for engineering universities of the country.

Historically and currently MSTU develops and positions itself as a high school, giving education and conducting research in a wide range of areas relating to the cutting-edge, critical areas of science and technology.

Our university is one of the oldest engineering schools in Russia, its history dates back to July 1, 1830 when it was founded by Emperor Nicholas I as Vocational School for training “craftsmen in theoretical knowledge, serving for modernization of crafts and factory works”. In 1868, it converted to the Emperor’s Moscow Technical School with the “Statute on the Vocational School”.

The system of training of future engineers gained recognition all over the world. The so-called “Russian method of training engineers” became widely known, especially after its successful demonstration at international exhibition in Vienna (1873), where it was awarded the Big Golden Medal [2].

MSTU was the first among technical higher educational institutions that received the status of technical university in 1989.

Today Moscow State Technical University named after N.E. Bauman is the National Research University of Engineering and Technology. The category “national research university” is established by the Government of the Russian Federation according to the resolution dated November, 2, 2009.

The main principle of training specialists in Bauman Moscow State Technical University is “education through science”, based on the best traditions of the Russian school of engineering, in-depth knowledge of basic sciences, vocational and practical training.

Special focus on the fundamental knowledge allowed creating a unique scientific and methodological school, and becoming a real elite technical university. Well-known scientists, who conducted here their research, became founders of scientific schools that gained recognition all over the world. Notable public figures, business leaders and heads of scientific organizations, designers and leading experts in the field of engineering, rocket and space technology, electronics and instrumentation, automation, defense industry worked and studied in the university.

The quality of training at the university is determined by the educational standards and programs. MSTU was granted the right to work according to its own sets of educational standards and requirements. Currently, the university has developed new, mostly unique and competitive programs that meet modern trends of innovative economic development of the country. A large variety of programs, opportunities to diversify learning trajectories completion dates create good preconditions to meet the broad queries in relation to a variety of career guidance and level of training of graduates of the university.

Knowledge in the field of engineering and technology tends to get out of date quickly, and the universalism (flexibility) of modern specialist is not based on the volume of acquired knowledge and skills. Knowledge of an engineer is based on his background in natural sciences, mathematics and philosophical foundations, scope of interdisciplinary system-integrative knowledge about nature, society, thinking, as well as a high level of general and spe-

cific knowledge required to act successfully when solving a problem.

To meet the challenges of modernization of the Russian economy and to develop a national innovation system it is required to have a pool of highly qualified competitive professionals of different levels (bachelors, masters, engineers) who are ready for creative and proactive activities and are able to combine comprehensive research, design and entrepreneurship. Regarding the claims of employers to graduates of technical universities: the point is that in modern industry (design bureau, research companies) there is requirement for design and development engineers - highly qualified specialists should be able to create new technologies and techniques, and in particular enterprises there is requirement for service engineers.

All educational programs of the university are systematically provided with the necessary methodological, financial and human resources: textbooks, computer labs and modern laboratories, appropriate organization of training process and its control, mandatory involvement of students in research work, all kinds of practice training at leading enterprises and research companies in the field of high technology.

MSTU is intensely focused on creating unique scientific and educational environment aimed at the fulfillment of tasks of the research university and the ability to form a scientific and engineering elite.

Engineering Education and Research Center "New Materials, Composites and Nanotechnology" provides the opportunity engineering activities based on "closed-loop" principle: from development of new materials and technologies and their processing to design and manufacture of products. The Center combines scientific and engineering knowledge of Bauman Moscow State Technical University with its experience in applied research and production capabilities of federal state unitary enterprise "All-Russian scientific research institute of aviation materials".

In April 2012, "Photonic and IR-technic Scientific and Educational Center" was opened in MSTU. The opening ceremony was attended by the President of Russia Dmitry Medvedev, representatives of the Russian Academy of Sciences and and

leading research institutes, famous Russian and U.S. scientists. The Center is aimed at creating a Russian world-class scientific and engineering school in the field of optoelectronics. Scientific management of the center is carried out by outstanding scientists in the field of research of semiconductor structures - Victor Ryzhyi, professor of Aizu university (Japan) and Vladislav Pustovoyt, member of the Russian Academy of Sciences, Head of Department of Moscow State Technical University n.a. N.E. Bauman.

The structure of the university is also improved and modernized. Basic structural unit of the University is a Research-Educational Complex (REC). It consists of faculties and research institutions, representing a combined research and educational center in the direction of its activities. At first, this allows to integrate the educational process and scientific activity, and second, to ensure the interdisciplinary nature of the research, the need for which arises almost in all modern research and applied scientific papers that are usually integrated.

Branches of departments founded at enterprises and research companies ensure close relationship with academia and industry. In the structure of the REC there are also industry or corporate departments, based in the leading companies in the space and defense sectors, such as JSC "Concern "Almaz-Antey", S.P. Korolev rocket and space corporation "ENERGIA", "Military and industrial corporation JSC "MIC "Mashinostroyeniya" (Reutov), JSC "Krasnogorsky Zavod", JSC "Moscow factory of electromechanical equipment" and Center for operation of space ground-based infrastructure (TsENKI). These firms provide all conditions (classrooms, science labs) necessary for the full-time training process of students and their research work [3].

One of the main tasks of MSTU is not only to maintain and not lose the leadership position, but also to reach a new level in all areas. To this end, the Development Program of MSTU as a National Research University of Engineering and Technology has been developed and implemented.

The effectiveness of the use of scientific and intellectual potential of the university, development and production of innovative products is a measure of its

scientific and technical innovation. Close cooperation of university research and industry is most evident in the research and development projects on the orders of the enterprises. Over the past few years important for the national economy results were obtained on the basis of the research conducted by the scientists of MSTU. For example: development and implementation of integrated systems for evaluating the condition and reliability of complex technical systems (such as nuclear power plants, facilities at the spaceport, large gas pipeline system etc.), their residual life analysis. A set of robotic systems is being developed: mobile robots designed to work in extreme conditions (including anti-terrorism efforts and for the purpose of remedying the consequences of man-made disasters and emergencies), the unique deep-sea vehicles for special underwater operations. Medical and biomedical equipment, equipment for the use of molecular genetic methods in biotechnology and bioengineering were developed. Radio-electronic and opto-electronic devices and next generation devices, often unmatched in performance were developed and implemented. Research in the field of nanotechnology engineering is being conducted. All these achievements are the result of research conducted by world-known scientific schools of the university.

Science and research at university always played a particularly significant role as an essential part of high quality education.

These are the main objectives of the university in its research activities:

- improving the quality of training through the active use of research in the learning process and the involvement of students in their implementation;
- foundation and development of teaching schools and training of scientific and pedagogical personnel;
- advanced development of basic and applied research as the basis for the creation and development of new technologies;
- exploration, development and implementation of innovative projects to facilitate formation of the market of high technologies and intellectual property;
- development of international scientific and technological cooperation, active foreign-economic activity in order to consolidate and expand the position of the university research team in the world scientific community;
- protection of intellectual property and copyright of researchers and developers, enabling output of research teams in the world market of high-technology products.

One of the main goals of preservation and development of scientific and pedagogical potential is to create conditions to attract talented young people and keep them working in science, engineering and education.

Nowadays universities training specialist for high-tech sector and the defense industry face with admission problems for the professions that used to be prestigious. A significant part of applicants to innovative engineering educational programs have insufficient knowledge and are not prepared for learning, many students do not connect their future careers with the direction of their educational programs.

MSTU implements a unique method of support and development of scientific work with young people and students, provides conditions for the full development and nurturing creative person's individuality, gradual formation of professional competence and lifelong learning. For many years unique and the most ambitious Russian scientific and social program "Step into the Future" has been successfully implemented at MSTU. Its main purpose is to create conditions for school students to graduate successfully from secondary education, prepare for university and adapt to post-secondary education. The program is aimed at screening and attracting talented, well prepared and professionally oriented youth. Graduates from Bauman Moscow State Technical University do not have employment problems, and their diplomas do not need to be confirmed abroad. Therefore Bauman graduates easily find work in any country, they are very popular in Germany - a country with a great technical education.

Doctoral and post-graduate training are the main forms of training research

staff. Today, such concept as philosophy of scientific training, selection and orientation of the best students for research and teaching acquires a special meaning. There is no secret that according to opinion polls among the reasons why many graduates are not willing to continue their career as a scientist or university teacher are as following: low salary, lack of modern facilities for scientific research; excessive bureaucratization of scientific work organization, low prestige of scientific and pedagogical work. (Modern engineers and scientists face the challenge of realizing their full research potential and solve their social and economic problems, significant difficulties in conducting research, etc.).

There are positive trends in this work. More than 300 young, talented teachers who connect their lives with Bauman Moscow State Technical University are highly motivated while working in MSTU. They remember and continue traditions of scientific and pedagogical schools.

It must be noted that on the basis of scientific schools of Moscow State Technical University nearly 30 higher educational institutions, military academies, industrial research institutes were founded. All of them got great initial impulse from MSTU at the very beginning that allowed them promptly to become leading research and educational centers of the country.

We often look back and repeat the words about past successes of Russian education.

The task of preparing a new corps of engineers is not new, conforming to the new stage of the country development.

We should just look back in our history. V.I. Grinevetsky, the first rector of the Moscow Higher Technical School in the report of the Polytechnic Society Meeting on January 17, 1915 "On the reform of engineering education", when analyzing the reasons for the technological development lag of Russia and listing the most topical problems of that time and prospects of the development of engineering education, made proposals how to meet this challenge. He was convinced that "... the development of engineering education has to develop in two directions. On the one hand specialization of teaching staff should constantly increase, on the other hand,

interaction of various disciplines should become closer".

Below you can find some extracts from the report [4].

"What could be the objectives of the necessary evolution of our engineering education? We have to talk about a solid mastery of general scientific subjects, about need to strengthen technical training, develop it in new directions required by the evolution of technological tasks, the overall vitality of scientific training to make more use of appropriate methods and knowledge to conduct training in the economic area ...

One of the solutions is, of course, specialization of technical education, which certainly requires our large industry. Under such conditions it is possible to get a specialist who is ready (well prepared theoretically and practically) for the work he had learned independently in at least one specific area and after that he will be able to easily specialize in new directions. It is hard to get experts from those who have smattering of knowledge, and we constantly make sure of this fact on practice.

Link of professors with engineering practice is weak and random. Only close enough contact with real life allows revealing new tendencies and implementing new technical material. ..We have to accuse our curriculum of lack of flexibility...

The current situation demands from schools at least large enough independence, and sufficient level of responsibility. And it is hard to require all these from those institutions, which are tied to the last detail".

It cannot be denied that this exact assessment and objectives formulated to improve engineering education for development of the Russian economy at the time are quite topical and you even actual.

Of course, the current approaches to the solution of the above stated problems are very different. However, they are fully based on the tradition and modern practice of engineering education.

New challenges require a new generation of university professors. There are specified requirements to their personality, competence, professional and pedagogical culture, scientific knowledge. In fact it means restructuring of research and teaching staff. We have two major

problems with research and teaching staff : age (high average age) and professional competence. It is obvious that we need to include teachers in research and innovation, and this should become one of priorities. Development of new courses and disciplines, methodologies and learning technologies requires new motivation, knowledge and skills. In this regard, there is a system that provides a systematic professional development of our teachers, exchange of good practice in the field of methodological work, its improvement, development of specific methods of engineering education, study of international experience.

The tasks and objectives to establish world-class universities that should be completed by the leading universities of Russia, including MSTU, are complex and comprehensive. Such university is characterized by a set of unique qualities, including high prestige and international reputation in the field of training, research, creating of innovative ideas, providing high quality and favorable conditions for training and research (modern buildings and equipment), etc. It takes time to achieve these characteristics and the following measures should be taken: qualitative changes in the university system, its structure, management system and financial security.

Academic community with a certain anxiety looks forward to governmental steps in reorganizing of higher education institutions. There are objective reasons for reorganization of universities that include: demographic decline, structural changes in the economy. The ultimate

goal of universities merging should be to improve the quality of learning outcomes and graduates through the integration of financial, material, technical and intellectual resources. We hope that the inevitable reorganization of the "ineffective" schools will be carried out carefully and cautiously, and at the same time will define the risks and negative effects. Just merging and consolidation of educational institutions, the artificial restriction of state support of universities according to their priority, may cause damage to education system, lead to irretrievable loss of the unique teaching staff and scientific schools. There should be well-defined criteria for evaluation of higher education institutions on various activities, principles of reorganization of universities, public discussion of these issues by all stakeholders.

The concept of development of Russian engineering education is almost determined, but it requires continuous improvement, adaptation to the new socio-economic conditions and to the needs of society. This problem is topical for all universities.

All the above mentioned facts do not mean that there are not any problems at the University, its activities fully meet current requirements. We associate development of Moscow State Technical University n.a. N.E. Bauman with that margin of safety and, above all, with the historical experience, traditions and intellectual potential, that help us to hold one of the leading positions among Russian technical universities.

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