International Projects in the Integrated Development of Engineering Education at the University

Elena Mishchenko
Tambov State Technical University
Tambov, Russia
e-mail: int@tstu.ru

Nikolay Chernyshov
Tambov State Technical University
Tambov, Russia
e-mail: nchtamb@yandex.ru

***Abstract*— The development of engineering education shows a significant increase in the scale of training engineering personnel both in Russia and abroad. This increases the requirements for the quality of training of engineers, their ability to actively innovate, and this, in turn, determines the economic success of enterprises, industries, regions and the economy of the state as a whole. The relevance of the article is due to the importance of high-quality and effective international interaction of the university in the framework of international projects for the training of engineering personnel. The purpose of the article is to show the directions of this interaction, as well as to highlight the main criteria for assessing its quality. The authors formulated the main directions of international interaction between the university and foreign partners in the training of engineering personnel, as well as formulated approaches to the qualitative assessment of this cooperation within the framework of educational programs.**

***Keywords*— Engineering education, international projects, quality assessment.**

I. INTRODUCTION

Engineering education is a leading intellectual factor in the development of the state, and the priority of state policy in the field of higher technical education is the quality of training of future engineers, their ability to actively innovate, and this, in turn, is one of the decisive factors in the market success of enterprises, industries, regions and the country's economy as a whole.

The leading economies of the world are aimed at technological domination, the introduction of fundamental scientific achievements in the shortest possible time. This allows the state to take the position of a leader, and, consequently, to achieve economic success, to form an updated socio-economic structure of society, this explains the significant role of the quality of engineering education, as well as its growing influence on the development of society. The role of international projects in the field of training engineering personnel, as well as projects aimed at improving the quality of this training, seems to be extremely significant in this regard. This allows accumulating the experience of both Russian and foreign universities, combining the best practices and implementing them in each partner university of the project [1].

II. EXPERIENCE OF UNIVERSITY PARTICIPATION IN INTERNATIONAL PROJECTS IN THE FIELD OF TRAINING ENGINEERING PERSONNEL

International projects in the field of engineering education in most cases rely on international and Russian organizations in the field of engineering pedagogy. Let's consider the main European and Russian organizations dealing with the problems of engineering education.

The largest international and European organizations dealing with the problems of engineering education are IGIP (International Society for Engineering Education) and SEFI (European Society for Engineering Education).

The International Society for Engineering Pedagogy IGIP was founded in 1972 in Austria, in the city of Klagenfurt. The initiator of the creation of IGIP and its president from 1972 to 2002 was a professor at the University of Klagenfurt, Adolf Melecinek. During the work of Professor Melecinek, IGIP became an organization that combined the extended world and European experience in the field of engineering education and formulated a system of simple, understandable and effective methods and criteria for the quality of education that have not lost their relevance up to this day. The current President of IGIP is Hanno Horch, a professor at the Technical University of Dresden.

The European Association for Engineering Education, SEFI, was founded in 1973 and now includes members and universities from most European countries. Both organizations are engaged in solving one important theoretical problem - the study of the patterns of development of engineering education systems, the formation of new approaches, updated by the development of science and technology and their implementation in order to solve applied problems in the field of modern higher technical education. The priority in the activities of IGIP is the professional and psychological and pedagogical training of educators of engineering disciplines, and the main object of SEFI's interests is the development of educational institutions in the system of European and world higher technical education, taking into account the world factors of economic and technological development.

Russian organizations dealing with engineering education make a significant contribution to the interaction of Russian universities with foreign engineering and pedagogical

organizations, participate and involve Russian universities in international projects in the field of engineering pedagogy.

An important contribution to the process of integrating engineering education, production and science is made by the joint activities of the Russian Union of Scientific and Engineering Societies (SNIO RF) and the International Union of Scientific and Engineering Societies of the CIS countries. The predecessor of both Unions is the independent mass public creative organization "Union of Scientific and Technical Societies of the USSR", which was created in 1988. The history of the development of this organization originates from the Russian Technical Society, organized back in 1866 by a group of professors and engineers of St. Petersburg. The company set the ambitious task of accelerating the development of science, technology and industry in Russia, as well as creating an economic potential similar in level to that of the developed countries of Europe.

A significant contribution to the training of engineering and teaching personnel is made by the All-Russian public organization "Association for Engineering Education of Russia" under the leadership of the President of the Association Yu. P. Pokholkov. The main activities of the Association for Engineering Education of Russia are the improvement of engineering education and engineering activities in all their manifestations. This applies to educational, scientific and technological areas, the processes of teaching engineering disciplines, consulting, research, development of engineering solutions, technology transfer. An important place in the activities of the association is occupied by the provision of a wide range of educational services, ensuring public relations, production, science and integration into the international scientific and educational space.

Russian higher education institutions have acquired the right to independently establish direct contacts with foreign partners, which has led to increased participation in the implementation of educational programs in conjunction with European partner universities.

Among the first and most significant jointly implemented international projects in the field of education are the projects of the international program TEMPUS-TACIS, aimed at providing technical assistance to educational structures of the CIS countries, a program for enhancing academic mobility in the field of higher education. Participation in this program was an important step towards the development of mutual understanding in the field of higher education in European countries, provided conditions for the exchange of technologies and teaching methods, strengthened the material and methodological base of the educational process.

TSTU has a great experience in participating in international projects in the field of engineering pedagogy: TEMPUS DIERUUNP 22265-2001, Tempus Networking Project NP 22296-2001, MULTICEP, TREM, ERASMUS+ ENTER and others. Many TSTU educators went through an advanced school of tutors together with their European colleagues and subsequently passed on their experience to other educators. Those who achieved the best results received the prestigious title of European Lecturer in Engineering ING-PAED IGIP. As a part of the implementation of the international projects, under the MULTICEP program, a specialized laboratory "Center for Engineering Pedagogy" was created at the university. Let's take a closer look at some projects [2].

ERASMUS + CBHE project, MARUEEB 561890-2015 "Master Degree in Innovative Technologies in Energy Efficient Buildings for Russian and Armenian Universities" (MARUEEB). The project contributed to the achievement of the goals of capacity building in the field of education related to the modernization, accessibility and internationalization of higher education, its compliance with the needs of the modern labor market and society, through the development and implementation of new innovative programs in two participating countries: Armenia and the Russian Federation. The project involved the development of a master's program in the field of energy efficient buildings. The main focus of the program was on energy conservation and environmental protection. The project provided for the formation of a Project Board, including a representative from each organization. In each partner country, a main organization was appointed to oversee the implementation of the activities of all partners in Russia and Armenia. As a result, educational programs were developed within the framework of the Bologna process using the latest teaching methods - interdisciplinary and interactive, and they also meet the requirements of European quality standards.

Project TEMPUS 544405-TEMPUS-1-2013-1-AT-TEMPUS-SMHES "Validation of Non-Formal/Informal Learning in Russian Higher Education" (VALERU). The VALERU program was intended to provide a methodological framework for the recognition of the results of non-formal / informal learning in the Russian Federation based on a European approach to this problem. Validation of learning outcomes in a non-formal or informal way in higher education is an invaluable resource in the context of rapidly changing labor market needs and the development of the idea of lifelong learning. The main goal was to train future specialists and to recognize the results of non-formal / informal learning in all Russian regions, so that in the future these specialists can force changes on the working places. These specialists will be able to train staff at their universities and, therefore, ideas about the recognition of the results of non-formal / informal learning will be able to spread throughout Russia. The project was an excellent experience in initiating the process of qualitative change in the education system.

The VALERU project was funded under the Tempus program as a national structural program based on close cooperation between European and Russian universities, as well as the Higher Education Network - a leading expert in the recognition of non-formal / informal learning, networks of small and medium enterprises and professional associations.

Project TEMPUS 543727-TEMPUS-1-2013-1-IT-TEMPUS-SMGR "On-line Quality Assurance of Study Programs" (EQUASP). The project was aimed at promoting the development of student-oriented technological training programs aimed at determining learning outcomes in accordance with the needs of stakeholders and is intended to bring in the process of internal quality assurance of educational programs in Russian universities in line with European standards and principles of quality assurance, to improve the quality, transparency and comparability of

training programs in the Russian Federation, so that all interested parties have the opportunity to give a reasoned assessment of the educational process proposed by the training programs, and to strengthen mutual trust in the quality of educational programs. The project contributed to the modernization of higher education through an online system of documentation and monitoring the quality of training programs, the recognition of internal quality assurance systems and online documentation and monitoring systems at the level of competent national authorities, in order to guarantee their dissemination among all universities in the Russian Federation and their subsequent sustainable development.

Project TEMPUS 517138 -TEMPUS-1-2011-1-CZ - TEMPUS-JPCR "EU-PC Double Degree Master Program in Automation / Mechatronics". The main objective of the project was to harmonize Russian, Ukrainian and European engineering education and achieve mutual recognition of degrees through the development and implementation of a double degree master program in automation / mechatronics. The results of the project were: development of a joint master program in automation / mechatronics and the use of dual degree technology in teaching students; advanced training of educators in Russia and Ukraine and methodological support of the educational process; use of the European quality assessment system; creation of an international educational space; organization of pilot training for students; quality control and monitoring; dissemination of project results; sustainable development of project results.

Project TEMPUS 159311-1-2009-IT-JPCR "Network for Master Training in Technologies of Water Resources Management". The main goal of the project was to develop and disseminate, within the already existing two-level education system, a new unique Russian master program in the field of water treatment to train specialists and technical personnel capable to introduce an effective management mechanism for water resources management. The main objectives of the project were: to reform the existing curriculum in 6 Russian universities-members of the consortium in order to introduce a new program focused on obtaining a joint degree, both at the Russian and European levels, ensuring the comparability of courses in Russian and European universities - members of the consortium; to develop a new curriculum taking into account the Russian educational standards of the third generation; to expand and improve the knowledge of Russian educators on environmental issues related to water treatment technologies, with the help of public authorities and industrial enterprises; develop a policy of " Lifelong learning ", teaching not only students, but also managers and specialists of other organizations with environmental knowledge, as well as employees of companies involved in water resources management. The project was intended to focus the educational process on new methods, such as interdisciplinary and interactive approaches, assessment strategies, to practically apply these approaches and strategies to improve the curriculum existing in Russian universities, to ensure joint teaching, mobility and research activities with the help of an organization in each of Russian universities, water purification laboratories, or technology transfer centers.

TEMPUS project 530620-TEMPUS-1-2012-1-IT-TEMPUS-JPCR – "Training and Master in Innovative Technologies for Energy Saving and Environmental Control for Russian Universities, Involving Stakeholders". The goals of the GREENMA project were: reforming the existing curriculum at 11 Russian universities - project participants, through the development and implementation of a new educational program "Energy Saving for Environmental Protection and Monitoring". At the same time, the program had to meet the requirements of employers and the labor market. The project involved the creation of a network of universities, enterprises and organizations for the implementation and dissemination of a new curriculum, provided for the development of the " Lifelong learning " policy, teaching not only students, but also managers and specialists of other organizations. The task was to focus the educational process on new methods, such as an interdisciplinary and interactive approach, to ensure joint teaching, mobility and research activities with the help of associate members of the consortium.

Project NEPTUNE. The NEPTUNE project was a network of 12 European universities providing practical training for students in planning and exploring the technosphere, created as a result of the human activity. Students gained the skills of cooperation and communication in an international and multi-disciplinary environment, working in unfamiliar surroundings, in an international team on topics related to their future profession. Involving in real projects gave students the opportunity to improve management skills - discussion, planning, collaboration under a lack of time, presentations, language skills. The project, implemented in Tambov, was called "Recreation of active rest in the suburbs of Tambov" and involved the development of a plan and project by students to create a modern complex for summer vacation in the sports and recreation camp "Pine Corner" with a full range of necessary services with rational use of resources and territory.

At the present stage, Tambov State Technical University is implementing a project of the ERASMUS program + 598506-EPP-1-2018-1-PT-EPPKA2-CBHE-JP «Engineering Educators Pedagogical Training» (ENTER).

The aim of this project is to develop and implement a new multicultural and international approach to formal postgraduate professional and pedagogical education for engineering educators. This approach is focused on the maximum use of e-learning technologies, a thorough analysis of the needs of the labor market and the needs of engineering universities. The training of educators is planned to be organized taking into account the best European practices and methods. The project program provides for the development of three structured educational programs for teachers of technical disciplines. First level program - Short-focused study (2 ECTS = 72 academic hours). Second level program - Professional retraining (8 ECTS = 288 academic hours). And the third level program - International Specialist (20 ECTS = 720 academic hours) is a full program leading to international accreditation as "Engineering Educator".

The consortium of the project included: Polytechnic University of Porto (Portugal) - project coordinator, Dubnitsa Institute of Technology (Slovakia), Tallinn Technical University (Estonia), Tambov State Technical University (Russia), Tomsk Polytechnic University (Russia),

Kazan National Research Technical University (Russia), Don State Technical University (Russia), Vyatka State University (Russia), Association of Engineering Education of Russia (Russia), Agency for Strategic Initiatives in Education "Bologna Club" (Russia), Karaganda State University. E. A. Buketova (Kazakhstan), Kazakh National University named after Al-Farabi (Kazakhstan), Kazakhstan Association for Engineering Education (Kazakhstan). Such a wide coverage of various pedagogical schools will make it possible to synthesize the best pedagogical practices of training educators of engineering disciplines. Tambov State Technical University acts as the coordinator of the work package "Assessment of the quality of educational programs" in this project [3].

III. Assessment of The Quality of Implementation of Educational Programs In The Context of The Implementation Of International Projects

To assess the quality of the implementation of engineering educational programs in the context of the implementation of international projects, a system of key criteria has been formulated, which can also serve as criteria in the accreditation of individual educational programs. The world agencies for assessing the quality of education have determined the parameters characterizing the professional training of engineering specialists, the main emphasis in which is placed on the final result - the result of comprehensive practical training, the professional development of a specialist and the level of his professional competence. The most common recognized system of quality assessment criteria is the European Standards and Recommendations for Quality Assurance in Higher Education (ESG) [4].

Let us consider the generalized and most important criteria for a comprehensive assessment of the quality of interaction between the university and the partner enterprise, based on recommendations ESG:

- general assessment of the educational program;
- financial, material and technical and information resources of the university and partner that provide complex network interaction;
- representatives of the partner and the teaching staff of the university involved in the process of interaction between the parties;
- educational methods;
- teaching materials used for auditorium and independent work of students;
- joint research activities, including grants and federal programs;
- the degree of participation of the partner in the implementation of the educational program;
- the level of competence formation and satisfaction with the learning outcomes in the format of network cooperation;
- analysis of the dynamics of professional and career growth of participants in international projects and programs.

IV. Conclusions

The recent changes in the field of economics and politics, in the professional environment of high-tech industries and the educational environment, have become a powerful catalyst for the emergence of new directions and forms of training, institutional changes in the education system, which are directly reflected in the practice of training scientific and pedagogical personnel.

The modern educational process is characterized by the intensification of joint activities of international organizations dealing with the development of engineering education with partner universities. This allows, within the framework of international projects of the university, to jointly search for ways to improve the quality of training of engineering personnel, taking into account the multidimensional, multifunctional nature of the activity of a modern engineer. A competent specialist is able to choose the most optimal solution among a variety of possible, reasonably refute false decisions, question effective but not effective ones, i.e. have analytical and critical thinking. The competence of an engineer implies constant updating of knowledge, possession of new information for the successful solution of complex problems at a given time and in given conditions, and engineering pedagogy is an integral tool for competent and effective transfer of knowledge to future specialists. Thus, international projects in the field of engineering education are a kind of driver that ensures the attraction of the best pedagogical practices, exchanges experience and thus improves the engineering education at a technical university.

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