

ECDEAST: EUR-ACE STANDARDS AS A FRAMEWORK FOR ENGINEERING CURRICULUM DESIGN

Oleg V. Boev, Evgeniya S. Kulyukina, and Marina S. Tayurskaya

Tomsk Polytechnic University, Russia

ABSTRACT

Financed by the TEMPUS grant the ECDEAST project is aimed to ensure that Russian universities have advanced curricula for programs in line with new development in the chosen engineering areas and according to the Bologna Process (EQF) and European standards for the quality of engineering education (EUR-ACE). The EUR-ACE Framework standards define program outcomes for engineering degree programs. The alignment of EQF & EUR-ACE Standards with Russian educational standards requirements to structure of programs and graduates' competencies is one of the challenging tasks for Russian universities and the project partners as well. A methodology for engineering curriculum design based on the European standards was elaborated and piloted for three master programs. The paper reviews the project state-of-art and outputs.

KEYWORDS

ECDEAST project, EUR-ACE Standards, engineering program, curriculum design

INTRODUCTION

In 2010 the consortium of the Russian and European institutions received the financial support of the European Commission for realization of the ECDEAST project within the TEMPUS program. TEMPUS is the European Union's Program which supports the modernization of higher education in the countries of Eastern Europe, Central Asia, the Western Balkans and the Mediterranean region, mainly through university cooperation projects [1]. It also aims to promote voluntary convergence of partner country higher education systems with EU developments in the field of higher education. In addition to institutional cooperation Tempus also promotes a "people to people" approach.

The Project application was elaborated by the consortium of three leading Russian, three European universities and two European engineering organizations. The official project coordinator is Hochschule Wismar (Germany). The alignment of EQF & EUR-ACE Standards with Russian educational standards requirements to structure of the programs and graduates' competencies is one of the challenging tasks for Russian universities and the project partners as well. The European Qualifications Framework (EQF) [2] acts as a translation device to make national qualifications more readable across Europe, promoting workers' and learners' mobility between countries and facilitating their lifelong learning. The EUR-ACE Framework standards [3] define program outcomes for engineering degree programs. The program outcomes describe in general terms the capabilities required of graduates from accredited First Cycle (Bachelor) and Second Cycle (Master) engineering programs as an entry route to the profession.

The comparative analysis of the EUR-ACE Framework standards and the CDIO approach (Standards, Syllabus, and self-evaluation model) was given by J. Malmqvist [4]. As a framework standards of European system of accreditation of engineering programs the EUR-ACE Standards are to be widely applicable for the variety of the engineering educational models and traditions in Europe and to be accepted by authorized national accreditation bodies. In [4] author also gave an example of Swedish national engineering degree requirements' comparison with EUR-ACE Framework Standards' ones. The paper [5] gave a very detailed example of accreditation against EUR-ACE Standards in Portugal and its compliance with the CDIO approach. Authors concluded "...that CDIO implementation is a relevant success factor to achieve EUR-ACE accreditation/certification by the ENAEE association".

The objective of this paper is to review the state-of-art of ECDEAST project run within TEMPUS program and aimed at development new engineering curricula in 3 Russian universities. It gives project background description (challenges and approach used), describes project activities and outputs planned.

THE PROJECT DESCRIPTION

Objective

The ECDEAST project [6] objective is to ensure that Russian universities have advanced curricula for programs in line with new development in the chosen engineering areas and according to the Bologna Process and European standards for the quality of engineering education (EUR-ACE Standards).

The project rationale

Adoption of the framework for the new Federal Educational Standards (FES) in February, 2007 has substantially changed the situation in Russian higher education. The principal difference of the third generation of the educational standards is the outcomes-based approach. The FES define the framework for learning outcomes both professional and personal that students should demonstrate upon graduation. The new approach assumes an active involvement of the program constituencies including employers and professional community in formulation of program specific learning outcomes.

The amendments to the Federal Law on Education and the Law on Higher Professional Education fixed the two-tier degree system of higher education, with 4-year BS and successive 2-year MS programs. The main changes can be summarized as follows:

- Master programs have been separated from the Bachelor ones (Master studies were considered to last 6 years including 4 years of Bachelor studies according to previous legislation);
- Studies differentiate between research- and practical-oriented profiles and are to prepare graduates for different types of innovative activity, especially in engineering;
- HEIs acquire more academic freedom in curriculum design (up to 70% of MS program content could be designed by HEI).

Integration of the RF into the EHEA and adoption of the third generation of the educational standards stipulates Russian universities to design the new programs. To be competitive in educational market programs should meet the requirements of the professional community. In engineering, the requirements for graduates' attributes are formulated by both national and

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international professional organizations dealing with accreditation of engineering programs and with recognition of professional qualifications.

The program learning outcomes outline the required knowledge, abilities and skills to be gained by students upon graduation. Creation of common European system for quality assurance resulted in elaboration of several documents that describe requirements to graduates' attributes and teaching/learning process. The ENQA document "A Framework for Qualifications in EHEA" and so-called 'Dublin Descriptors', define general requirements for graduates' attributes. Another ENQA document "Standards and Guidelines for Quality Assurance in the EHEA" contains an 'agreed set of standards, procedures and guidelines' for internal and external quality assurance, and for external quality assurance agencies. The requirements for engineering programs' graduates are formulated in the "EUR-ACE Framework Standards for the accreditation of engineering programs [3]". The universities should take into consideration the requirements of the EUR-ACE® Standards in developing the new programs in engineering and technology to achieve successful external evaluation and recognition in the EHEA.

The EUR-ACE Standards have been elaborated within the EUR-ACE (EUROpean ACcredited Engineer) project supported by the European Commission. The EUR-ACE Standards can be used in both the design and the evaluation of the programs in all branches of engineering and for different profiles. They are expressed as program learning outcomes that describe in general terms the capabilities required from graduates of accredited engineering programs.

The EUR-ACE system has already been introduced in Russia thanks to two Tempus projects (EUR-ACE and PRO-EAST). Faculty of Russian universities (including this project partners: TPU, BMSTU, SPbSPU) actively participated in elaboration of the EUR-ACE standards during several seminars and conferences organized within EUR-ACE and PRO-EAST projects. Some of TPU engineering programs were accredited within the first programs in Russia with awarding of the EUR-ACE labels.

The main practical objective of the project is designing new master engineering curricula for Russian universities based on the experience of European partners and EUR-ACE requirements to graduates' competencies. Now it is an urgent topic for the Russian Ministry of Education and Science together with leading Russian universities to develop master programs in engineering within areas of specialization in accordance with 3rd generation of national and European quality standards. The essential input to this initiative could be the Guidelines for Russian HEIs on engineering program design aligned with EQF and EUR-ACE Standards which is to be prepared in accordance with the ECDEAST partners experience and results of implementation at TPU, BMSTU, SPbSPU. At the end of the project these universities are expected to apply for the EUR-ACE label after implementation of the new programs. The successful external evaluation results in graduates' and students' mobility.

Partners

The project consortium consists of the following partners:

- TPU – Tomsk Polytechnic University (Russia)
- BMSTU – Bauman Moscow State Technical University (Russia)
- SPbSPU – Saint-Petersburg State Polytechnical University (Russia)
- HSW – Hochschule Wismar (Germany)
- KTU – Kaunas University of Technology (Lithuania)
- LBUS – Lucian Blaga University of Sibiu (Romania)

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- SEFI – Société Européenne pour la Formation d'Ingénieurs
- ENAEE – European Network for Accreditation of Engineering Education.

TPU, BMSTU and **SPbSPU** are top-ranking engineering higher institutions in Russia and having the greatest traditions in engineering education. These three universities were awarded with a status of a *national research university* and were granted to develop its own educational standards and programs. They are actively involved in cooperation with international organizations, funds and programs. TPU engineering programs were successfully evaluated by international bodies (ABET (USA), CEAB (Canada)) and awarded by EUR-ACE Label among firsts in Russia.

BMSTU is the highest ranking engineering school in Russia. The Educational and Methodological Association of Engineering Institutions of Russia (an entity based at BMSTU) is responsible for development of framework of national educational standards in engineering. It contributes to the project providing linkage with national governmental bodies and dissemination of project outcomes throughout Russia.

SPbSPU is one of the largest and oldest engineering universities of Russia. The university will significantly contribute to the elaboration of curriculum design methodology by its high-qualified faculty of almost all engineering disciplines. SPbSPU is responsible for development and implementation one of three master curricula being developed within the project.

HSW, KTU and **LBUS** share their experience in curricula design in accordance with Bologna principles and European quality standards. Each university provides the project with its experts in specific discipline area and in evaluation of quality of engineering programs.

ENAEE consists of 20 associations engaged in engineering education. ENAEE has launched and is running the EUR-ACE® European accreditation system of engineering programs. Within this system a national agency accredits study programs and the EUR-ACE® label is added to the accreditation if an agency is authorized by the ENAEE. To be authorized, an agency must be pass periodically evaluation by the ENAEE members to prove that its accreditation practices are in line with the EUR-ACE® Framework Standards those include requirements to study program and graduate competencies. The label distinguishes between BS/MS programs in accord with the EQF. At present, the EUR-ACE system is being implemented in nine countries within the EHEA (UK, Ireland, France, Germany, Portugal, Russia, Turkey, Romania, and Italy). ENAEE provides the project with its experts in evaluation of the quality of engineering programs and will be responsible for organization of evaluation programs developed against the EUR-ACE Standards.

SEFI is a network of 380 institutions of higher engineering education, educators, engineers, companies and international associations in 42 countries. Via its involvement in ENAEE (from which SEFI is the funding organization) and in the EUR ACE projects, SEFI can bring a useful expertise in the project. SEFI will act as a consultant for the coordinating team and will serve as a relay as far as dissemination of the project work and outcomes are concerned.

Specific Project Objectives

Three leading Russian engineering universities supported by the European partners will:

- develop a methodology for engineering curriculum design based on the alignment of EQF & EUR-ACE Standards with Russian educational standards requirements to structure of programs and graduates' competencies;
- train the universities' faculty to design engineering curricula according to EUR-ACE requirements with application of ECTS;
- develop/update and implement 3 master engineering programs and course modules materials at TPU, BMSTU and SPbSPU according to EUR-ACE requirements using ECTS and Dublin Descriptors;
- prepare the developed programs for accreditation with awarding of the EUR-ACE label.

The universities from Russia and the EU has formed the pairs closely involved in curricula developed as follows

- MS in *Computer Technologies for Design of Thermal and Nuclear Power Plants* (TPU and HW);
- MS in *Cryogenic Engineering and Technology* (BMSTU and KUT);
- MS in *Intellectual Systems and Technologies* (SPbSPU and LBUS).

Activities and working methodologies

Steps done

The first meeting of the Project partners was held in November 8, 2010 at Hochschule Wismar. Project organizational issues were discussed and the Project Board was composed. To ensure project objectives the Project Board (consisted of representatives of all the partners from the EU and Russia) meets regularly to develop the strategy of the project and responsibilities of partners, to schedule, organize and monitor all the planned activities, to coordinate and plan the faculty exchanges and evaluation visits to Russian universities. Among its other tasks, the Project Board responsibility includes selection and approval of peers from academic staff and students nominated by partners and student organizations. The Project Board meetings are mostly planned jointly with workshops, seminars and conferences within the project activities.

After the kick-off meeting Workshop on European and National Standards Alignment was held in February 21-22, 2011 at Kaunas University of Technology [6]. The partners met to discuss of the EUR-ACE requirements to engineering program graduates and their alignment to the Federal Education Standards of Russia (FES). European partners shared their experience on design of two-tiers programs in engineering.

Partners agreed on the structure of master engineering curricula and graduates' attributes taking into account EQF, EUR-ACE and Russian FES Standards. The Guidelines on engineering curriculum design based on alignment of Russian and European requirements to engineering graduates' competences was developed as methodological recommendations for academic staff of partner universities and is available through the project website [6] in Russian and in English.

The faculty training workshops were organized at each Russian partner universities those included lectures, discussions, case studies, and practical exercises on curricula design. The attention was also paid to active methods of student-oriented learning (team work, problem-based learning). The experience of European partners in these topics is of great importance for the project objective. The methodological materials was published and distributed among faculty involved in the project and posted at the project website.

Three engineering master programs were updated/developed at TPU, BMSTU and SPbSPU. The programmes are met both national and European quality standards for engineering education. The extensive faculty exchanges were organized in order to share experience with EU partners for development/updating of new modules/courses, teaching materials, and methods for assessment of achievement of program learning outcomes. The updated syllabi and teaching materials of courses and modules with ECTS credits mapped to learning outcomes were elaborated by September 2012. The modern textbooks for areas of program specialization were selected with advising of European partners and purchased for TPU, BMSTU and SPbSPU. The modern powerful software packages for engineering design from leading European companies were purchased as well to extend the opportunities for advanced master studies.

Discussion and approval of the new master programs was held in the end of the second year of the project within the VII International Conference “International Cooperation in Engineering Education” at SPbSPU with broad participation of all the partners, Russian engineering universities, professional community (Russian and European), and representatives of the Ministry of Education and Science of the Russian Federation [6].

The Russian universities (TPU, BMSTU and SPbSPU) have started teaching students following the developed curricula since the autumn of 2012. The first classes of students (10 students in TPU, 5 students in SPbSPU, and 8 students in BMSTU) have been enrolled. The new developed teaching materials and methodologies are applied, as well as purchased up-to-date software and textbooks are used in corresponding modules.

Future steps

The important part of the project is self-evaluation of the programs developed and external evaluation by peers against EUR-ACE standards requirements. As far as a formal requirement for accreditation are graduates completed the program that wouldn't be available in project duration, the result of evaluation by the ENAEE would be considered as a preliminary conclusion about compliance of programs to EUR-ACE standards and used for programs' improvement. The peer team will include the representatives of student organizations and will actively use questionnaires of students for evaluation program and teaching process. The Russian partner universities will develop the improvement plans for period beyond the project duration. The experience gained through development and implementation of new programs will contribute to the Book on engineering curriculum design to be prepared and published at the final stage of the project. The Book will also include detailed description of the developed program and examples of the best practices of programs' modules implementations. The ECTS credits mapping to the program learning outcomes (professional and personal competencies) and the assessment techniques for their achievement will be under discussion in the book.

The project main outcomes will be summarized in the Report that will be prepared for the Ministry of Education and Science of the Russian Federation. As far as all the Russian partners of the project are the leading engineering schools in the country, the project results are to contribute to development and implementation of the third generation of national educational standards in other areas of specialization.

Outputs

The project duration is three years. The following outputs are expected:

- Guidelines on engineering program design;

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- New curricula of 3 engineering programs at TPU, BMSTU and SPbSPU (one in each);
- Updated syllabi and teaching materials of courses and modules with ECTS credits allocated to learning outcomes;
- Trained faculty of TPU, BMSTU and SPbSPU for curriculum design (at least 25 faculty staff in each);
- Experience gained through teacher exchange, then shared;
- New programs implemented at TPU, BMSTU and SPbSPU (one in each);
- Programs evaluated by peers against EUR-ACE Standards;
- Informative project website, promotional materials disseminated;
- Book on engineering curriculum design.

CONCLUSION

The programs developed within the project are to meet the requirements of the third generation national standards and EUR-ACE Standards for engineering programs both. The development and implementation of master programs in engineering by leading Russian engineering schools is an important step for Bologna process in Russia where the introduction of 3 cycle degree system goes very slowly. The experience gained in the project by the universities will be distributed through the Educational and Methodological Association of Engineering Institutions of Russia, which being an entity of BMSTU responsible for framework standards of engineering study programs and their dissemination among a great deal of technical universities of Russia. While the implementation of the CDIO approach was not initially covered by the project objectives however authors are confident that CDIO adoption by the programs developed provide them with additional value and facilitate successful accreditation. The detailed description of the curricula developed and discussion of the lessons learned in compliance with CDIO Standards and CDIO Syllabus will be published on completion of the project.

Finalizing the project the consortium will organize the conference in Moscow (2013, June) with broad participation of the Russian academic and professional community and governmental structures. Besides presentation of the project outcomes, the program of seminar will cover the issues of Bologna process development and implementation of the EQF in the EHEA countries.

After first graduations from the programs developed the Russian universities are expected to apply for formal accreditation against the EUR-ACE Standards. The recognition of the program quality through the EUR-ACE label will contribute to spreading project outcomes through its positive impact on governmental structures and professional engineering organizations. The project outcomes and the best practices are to be spread among the Russian engineering schools and the engineering community.

ABBREVIATIONS

- BMSTU – Bauman Moscow State Technical University (Russia)
- ECDEAST – Engineering Curricula Design aligned with EQF and EUR-ACE Standards (project)
- ECTS – European Credit Transfer and Accumulation System
- EHEA – European Higher Education Area
- ENAEE – European Network for Accreditation of Engineering Education.
- ENQA – European Association for Quality Assurance in Higher Education
- EQF – European Qualifications Framework

- EUR-ACE® is the European quality label for engineering degree programmes at Bachelor and Master level awarded by the ENAEE members
- FES – Federal Education Standards of Russia
- HEI – Higher Educational Institution
- HSW – Hochschule Wismar (Germany)
- KTU – Kaunas University of Technology (Lithuania)
- LBUS – Lucian Blaga University of Sibiu (Romania)
- SEFI – Société Européenne pour la Formation d'Ingénieurs
- SPbSPU – Saint-Petersburg State Polytechnical University (Russia)
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BIOGRAPHICAL INFORMATION

Oleg V. Boev is Director in Center for International Academic Programmes at Tomsk Polytechnic University. Experience in international cooperation, quality assurance, curriculum design, and professional accreditation. Expert in development of Double-Degree programmes, module-structured curricula, Bologna principles implementation, ECTS system, international standards of engineering education quality.

Evgeniya S. Kulyukina is Project Coordinator in Department for International Cooperation at Tomsk Polytechnic University. PhD in Engineering Pedagogy: Development of professional and personal competences taking into account international standards of engineering education. Coordinator of international cooperation activities, experience in realization of TEMPUS projects aimed at development, elaboration and professional accreditation of educational programs in engineering.

Marina S. Tayurskaya is Deputy Director in Centre for International Academic Programmes at Tomsk Polytechnic University. She is responsible for organization of academic mobility programmes for students and faculty. She is involved in elaboration and implementation of cooperative (incl. double-, dual-, joint degree) programmes with leading European universities.

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Corresponding author

Dr. Oleg V. Boev
Tomsk Polytechnic University
30, Lenin Avenue
Tomsk, Russia, 634050
+7(3822)563-350
ovb@tpu.ru