MASTER CURRICULUM DESIGNED IN ACCORDANCE WITH EUR-ACE STANDARDS (ECDEAST PROJECT)

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INTRODUCTION

The idea of usage of professional accreditation standards as a basis for curriculum design was implemented within the ECDEAST project *(Engineering Curricula Design aligned with EQF and EUR-ACE Standards)* [1]. In 2010 the consortium of the Russian and European institutions received the financial support of the European Commission for realization of the project within the TEMPUS programme. TEMPUS is the European Union's Programme 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 [2]. 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 programmes and graduates' competencies is one of the challenging tasks for Russian universities and the project partners as well. The European Qualifications Framework (EQF) [3] 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 [4] define programme outcomes for engineering degree programmes. The programme outcomes describe in general terms the capabilities required of graduates from accredited First Cycle (Bachelor) and Second Cycle (Master) engineering programmes as an entry route to the profession.

New master curriculum in Power Engineering is developed by Tomsk Polytechnic University in close cooperation with ENAEE, SEFI, and European universities. The paper overviews the educational learning outcomes and curriculum elaborated and piloted since September 2012. In April 2013 the programme underwent a preliminary evaluation against the EUR-ACE Framework Standards. The observations of ENAEE review team on the curriculum and recommendations on its improvement are given. The project state-of-art and other outputs are discussed as well.

1 THE PROJECT DESCRIPTION

1.1 Objective

The ECDEAST project [1] objective is to ensure that Russian universities have advanced curricula for programmes 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).

1.2 The project rationale

Integration of Russia into the EHEA and adoption of the third generation of Federal Educational Standards (FES) stipulates Russian universities to design the new programmes. To be competitive in educational market programmes should meet the requirements of the professional community. In engineering, the requirements for graduates' attributes are formulated by both national and international professional organizations dealing with accreditation of engineering programmes and with recognition of professional qualifications.

The programme 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 requirements for engineering programmes' graduates are formulated in the EUR-ACE Framework Standards for the accreditation of engineering programmes. The universities should take into consideration the requirements of the EUR-ACE Standards in developing the new programmes 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 programmes in all fields of engineering and for different profiles. They are expressed as programme learning outcomes that describe in general terms the capabilities required from graduates of accredited engineering programmes.

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

1.3 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)
- 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 programmes. They are actively involved in cooperation with international organizations, funds and programmes. TPU engineering programmes were successfully evaluated by international bodies (ABET (USA), CEAB (Canada)) and awarded by EUR-ACE Label among firsts in Russia.

1.4 Specific Project Objectives

Three 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 programmes 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 programmes and course modules materials at TPU, BMSTU and SPbSPU according to EUR-ACE requirements using ECTS and Dublin Descriptors;
- prepare the developed programmes for accreditation with awarding of the EUR-ACE label.

The universities from Russia and Europe 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 HSW);
- MS in *Cryogenic Engineering and Technology* (BMSTU and KUT);
- MS in *Intellectual Systems and Technologies* (SPbSPU and LBUS).

1.5 Project Outputs

Within three years of the project duration the following outputs are expected:

- Guidelines on engineering program design;
- 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.

2 MASTER PROGRAMME DESIGNED IN ACCORDANCE WITH EUR-ACE STANDARDS

In this paper as an example we discuss some of curricular aspects of the Master Degree Programme "*Computer Technologies for Design of Thermal and Nuclear Power Plants"* designed and implemented at Tomsk Polytechnic University.

2.1 The programme conception

The programme "Computer Technologies for Design of Thermal and Nuclear Power Plants" is one of the programmes within the field of study 140100 "Heat and Power Engineering" of Tomsk Polytechnic University. It focuses on advanced studies in natural and engineering sciences, computer and information technologies. The graduates gain experience in usage of modern soft- and hardware tools for design equipment of power energetics and for operation of Thermal and Nuclear Power Plants (TPP and NPP). The graduates are prepared for research, simulation of strength properties and technological processes of heat transfer, development and implementation of new technologies of conversion the natural energy into electricity.

The acquisition of managerial and economic competencies is incorporated in the study process to ensure carrier prospective in national power energy industry and research/design institutions. The graduates are employed at "*Atomenergoproekt", "Teploelektroproekt", SibCOTES*, All-Russian Thermal Engineering Institute, Russian Research and Design-Engineering Institute of Nuclear Power Machine Building and other.

2.2 The programme educational objectives

The programme graduates are prepared for:

O1: research and problem solving in development and optimization of techniques and machinery for TPP and NPP using computer-aided technologies;

O2: engineering design of TPP and NPP machinery and equipment taking into account the requirements and standards of process engineering, environment protection and safety regulations;

O3: independent life-long learning and professional development.

2.3 Programme learning outcomes

The programme graduates are able:

P1: to use in-depth knowledge of natural sciences, mathematics and engineering in TPP and NPP design;

P2: to identify and solve problems of engineering analysis related to TPP and NPP equipment and machinery development using the system analysis;

P3: to apply computer and information technologies in design of TPP and NPP and development of thermal and mechanical equipment;

P4: to conduct theoretical and experimental research of thermodynamic, heat and mass transfer processes in thermal and power equipment, interpret, present and give practical recommendations for results implementation;

P5: to develop mathematical models of engineering processes, calculate strength properties of complex systems using modern tools and design databases for TPP and NPP;

P6: to use scientific knowledge and creativity, analyse, synthesize and critically evaluate data;

P7: to demonstrate knowledge of foreign language at the level allowing to communicate effectively with the international engineering community, work out documentation, present and defend outcomes of innovative engineering activity;

P8: to function effectively as an individual and as a member and leader of a team that may be composed of different disciplines and levels, take responsibility for the results and follow the corporate culture of organization;

P9: to demonstrate in-depth knowledge of social, ethical, cultural and sustainable development issues of innovative engineering activity;

P10: to engage in independent learning and continuous professional development.

2.4 Alignment of requirements to learning outcomes

The Federal Educational Standards (FES) define requirements to the graduates in two groups – professional and personal (or transferable) skills. Within the curriculum design we found the correspondence of FES's professional skills to five groups of the EUR-ACE Framework Standards (Knowledge and understanding, Engineering analysis, Engineering design, Investigations, Engineering practice).

The FES requirements to personal skills also well correspond to transferable skills of the EUR-ACE Standards. Further the programme learning outcomes were formulated in order to satisfy the second cycle requirements to learning outcomes of the EUR-ACE Standards.

The table below presents the alignment of requirements of national (FES) and European (EUR-ACE) standards to the programme learning outcomes (PLOs).

Table. Alignment of FES and EUR-ACE requirements to learning outcomes

FES	Professional skills						Personal / transferable skills			
EUR-ACE	Knowledge and understanding		Engineering analysis	Engineering design	Investigations	Engineering practice	Transferable skills			
PLOs	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10

3 THE PROGRAMME EVALUATION AGAINST EUR-ACE STANDARDS

3.1 Evaluation visit organisation

The programme evaluation against the EUR-ACE Standards is one of the most important steps of the project and ENAEE as an accreditation network was assigned to coordinate it.

ENAEE elaborated a template for self-study report to be completed by Russian universities. TPU faculty carried out the self-assessment of its new programme implemented in Power Engineering and submitted the report to an evaluation team prior to the visit. The evaluation team consisted of representatives of ENAEE, SEFI, Russian partner university's faculty and students. The team studied the report and scheduled the visit to TPU.

The evaluation visit lasted two days and was organized in a similar way to accreditation visit including work with programme methodological documents, meetings with faculty, students, graduates and employers.

3.2 Preliminary outcomes of the review

The official report of evaluation team will be presented during the project final conference at BMSTU in 2013, June 4-6, but preliminary conclusion, that the peers arrived to at the end of the visit and announced to the faculty, is compliance of the programme developed to EUR-ACE Standards.

During the visit the evaluation team provided the faculty with following valuable recommendations:

- to make the study plan more explicit in terms of pre- and co-requisites;
- to increase the number of electives available for students;
- to elaborate explicit strategy for assessment of achievement of intended learning outcomes by all students;
- to enhance collaboration with employers and industry representatives at different levels, from the programme till course.

Among advantages of the programme the team emphasised on very good and new laboratory facilities and equipment and high qualification of the faculty in usage of modern specialized software as these issues are important for the particular programme "*Computer Technologies for Design of Thermal and Nuclear Power Plants"*.

As far as a formal requirement for accreditation are graduates completed the programme that wouldn't be available in project duration, the result of evaluation by the ENAEE would be considered as a preliminarily conclusion about compliance of the programme to EUR-ACE Framework Standards and used for the programme improvement.

4 CONCLUSION

The programmes developed within the project are to meet the requirements of the third generation national standards and EUR-ACE Standards for engineering programmes both. The development and implementation of master programmes 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 programmes and their dissemination among a great deal of technical universities of Russia.

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, programme of the conference will cover the issues of Bologna process development and implementation of the EQF in the EHEA countries.

After first graduations from the programmes developed the Russian universities are expected to apply for formal accreditation against the EUR-ACE Standards. The recognition of the programme 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.

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