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Interdisciplinary Project – Basis for Designing Study Programmes

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The specifics of engineering activity lie at the root of projects' implementation. An ability to independently develop and implement projects, as well as to assess their impact and significance is a necessary competence of each graduate. Thus, the core component of training competitive specialists is the introduction of interdisciplinary projects to the learning process. These projects are discussed in the article as a basis for designing of professional study programmes for higher education.

Key words: interdisciplinary project, engineering education, design of study programmes, project- and practice-oriented education.

The topic of interdisciplinarity is not new to the area of engineering education. It has been addressed repeatedly in the development of main professional educational programmes and in execution of fundamental and applied scientific research. The main aim of introducing interdisciplinarity is to obtain a new and novel product as a response to modern challenges of science and society.

The CDIO Initiative raises a question of the need for the formation of educational programmes that include interconnected disciplines, where training intends fostering an ability to create products, processes and systems, communication skills and personal development skills. Students should receive wide experience of conducting design and experimental activities within the training process both in classrooms and in modern training laboratories. Training should be based on exploring engineering activities in line with the model "Conceive – Design – Implement – Operate" real systems, processes and products on international market (CDIO model) [1].

The criteria and procedure of the professional accreditation of educational programmes have been developed by the Association for Engineering Education of Russia (AEER) with an aim to assess the quality of engineering specialists' training in higher education institutions and vocational schools. These criteria state that "the basic knowledge of design in the context of uncertain and controversial requirements, the abstract thinking skills and ability to analyze complex multicomponent problems that do not have a single-valued solution are essential for comprehensive engineering activities"; a student "has to be ready to manage interdisciplinary projects, to have a grip on the principles of management, to conduct efficient communication within society and professional communities. At the same time he/she is required to be able to solve technical tasks with regard to legal and cultural aspects, safety and health precautions, to understand the responsibility for the decisions made" [2].

The foresaid determines the need for new approaches to the development of main professional educational programmes for higher education. The authors disclose interdisciplinary educational projects as one of such approaches. While developing main professional educational programmes the transition from course/ discipline (knowledge-based) organization of educational process to a block-modular, project-based and practice-oriented, person-based, result-oriented organization is

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performed. This transition is ensured by the development of own educational standards at ITMO University (ITMO Educational Standards).

Study programmes of Bachelor level, developed based on the ITMO Educational Standards provide basis for innovative training of globally competitive specialists by creating educational environment that ensures the choice of educational paths and training methods, the access to corporate and personal knowledge databases, including databases formed by students, the choice of training pace, the attraction of a wide range of experts from science, business and industry.
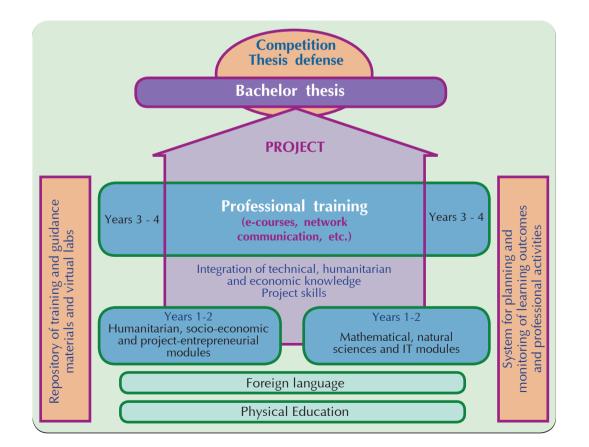
Problem and project training is a conceptual pillar of the training process that can be built upon conducting real projects.

Framework of development concept for Bachelor Educational Standards is presented in the scheme (fig. 1).

The formation of the basic educational block is based on the block-modular principle and includes the following educational modules:

- Humanitarian module, including mandatory disciplines, such as history, philosophy and other disciplines of the humanities focused on the formation of an ability to analyze information and ideas and to formulate problems.
- Socio-economic module focused on the formation of communication skills, economic, legal and juridical competences.
- Project and entrepreneurial module, including disciplines aimed at acquiring knowledge on project management,

Fig. 1. Module and project-oriented training of bachelors based on interdisciplinary projects

management of innovative projects, decision making for practical scientific and technological problems and tasks. This module provides broad and deep training for task-oriented professional activity essential for fostering an ability to understand professional and ethical responsibility.

- Foreign module aimed at the formation of communication skills in both oral and written communication in foreign language for solving tasks of interpersonal and intercultural cooperation.
- Module of natural sciences, IT and math, that provides fundamental training and creates basis for training graduates with required professional competences, including those aimed at application of information technologies and professional packages. The main objective of this module is to foster practical skills of applying mathematical and physical phenomena in professional activity, as well as while studying major-specific disciplines and executing projects.
- General professional module that includes health and safety courses, as well as disciplines aimed at formation and development of general professional competences.

Fundamental training on math and natural sciences, as well as integration of technical and humanitarian knowledge for realization of socially important projects is conducted during 1st and 2nd years of bachelor programmes. The study process includes modules and disciplines on development of professionally-oriented programmes, such as "Introduction to Project-based Activity", "Introduction to Engineering", and programmes of academic and social adaptation – "Adaptation to learning", "Practical psychology of a student", etc.

Besides the usual curriculum students can participate in summer and winter language and theme schools, seminars and workshops on personal development and socialization of students.

During the 3rd and 4th years of bachelor programmes training is based on an active introduction of problem-based and project-

based learning, studying principles of managing innovative projects and main stages of products' and processes' life cycles, as well as team-work skills and elements of entrepreneurship. Students conduct interdisciplinary problem-oriented scientific research (design) projects within study process by participating in research activity of their departments or research educational centers.

The curriculum includes modules of students' professional training for innovative and entrepreneurial activities, such as "Project Management", "Management of Innovations", "Engineering Entrepreneurship" and other that foster research and entrepreneurial skills and leadership. Through the project work students contribute materials for their future bachelor thesis. At the end of the project period a competition of students' projects is held; winning projects are proposed to be implemented and their creators are recommended for the enrolment to master programmes.
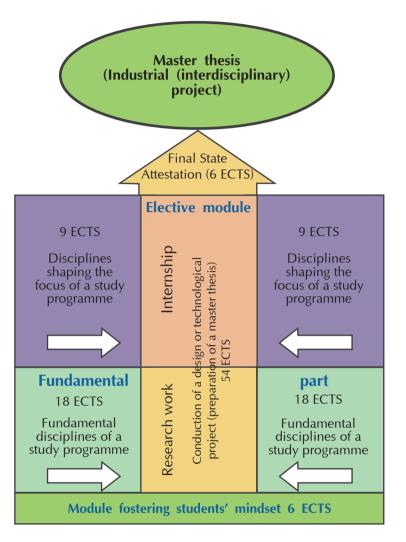
Framework of development concept for Master Educational Standards is presented in the scheme (fig. 2).

Master programme curriculum includes the following modules supporting interdisciplinary projects: module fostering students' mindset (6 ECTS), general professional module (18 ECTS), professional module (18 ECTS), and elective module (18 ECTS). The rest of the curriculum (60 ECTS) is devoted to the conduction and the defense of an interdisciplinary project in the process of internship, research work and final state attestation.

This approach to bachelor and master programmes curriculum design corresponds to the international CDIO Standards with regard to studying products' lifecycle stages, increasing the percent of practical studies, acquiring design and implementation expertise.

A system of joint project work and problem-based learning is supported by e-learning and distant learning technologies, which assure students' immediate access

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Fig. 2. Framework of development concept for Master Educational Standards

study programmes can be executed in a network form. At this, particular disciplines can be studied at leading Russian or foreign universities based on academic mobility of students in line with the agreements for network study programmes. The contents, volume and study periods of partner universities' programmes indicated in such agreements.

Thus, the main specifics of the development of bachelor and master programmes (in the framework of interdisciplinary projects realization) are as follows:

■ Consideration of educational standards (Federal State Educational Standards, university and international standards) and Professional Standards;
■ Theses, course projects and self-study tasks should be tightly connected to real projects executed by scientific and industrial organizations;
■ Students acquire up-to-date knowledge and abilities, foster personal skills (also by gaining responsibility for their results) by conducting independent search for project solutions and receiving expert evaluation from teachers, employers and theirs fellows.

to the required databases that might be needed within the process of project work. In order to work in real time conditions and to acquire new knowledge on project theme students need to have access to a well-structured and constantly updated electronic database. Such database should also be filled by students themselves. The university's system of distant learning provides students with access to a database of university's e-courses, as well as courses of other partner universities, including foreign ones.

According to the chosen learning path a student can choose courses that he/she has

interest in. The control of learning outcomes is conducted through a system of planning and monitoring of learning outcomes and professional achievements, which allows developing students' soft skills and their motivation, as well as managing their study process. Students can receive credits for any discipline or course that can be accessed. Personal results of every student's staged training are recorded in the learning outcomes database.

With an aim to enhance the quality of students' training, their competitiveness and motivation, and programmes resourcing

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