System for Quality Assurance of Study Programs in the Area of Engineering Education

Speaker:

Vladimir Mager

Peter the Great St.Petersburg Polytechnic University

Authors:

Alexander V. Rechinskiy,

Liudmila V. Chernenkaya,

Vladimir E. Mager

**Peter the Great St.Petersburg Polytechnic University**

St.Petersburg, Russia

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The world economy is in the phase of the decline of the next Kondratiev's cycle.

It is assumed that the entry into the phase of sustainable growth can be ensured by the development and implementation of the newest breakthrough technologies, and the creation of new products and services on their basis.

Currently, the basis for mastering of the absolute majority of technologies is the level of mastering of information technologies (IT) and cognitive technologies. Data from The Organization for Economic Co-operation and Development (OECD) show the level of IT' mastering in different countries:
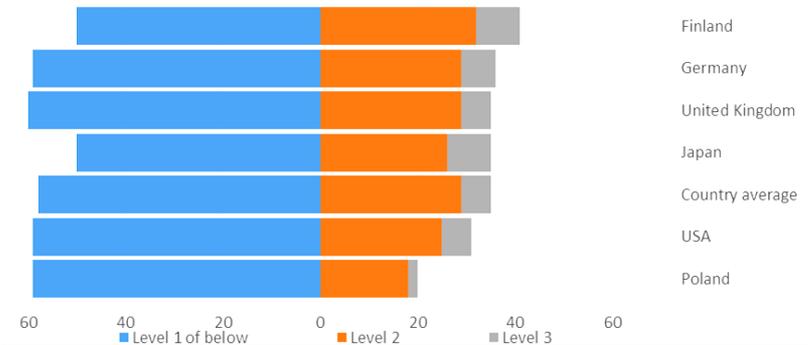
The level of IT acquirement in Russia is quite low and can be characterized by the 55th position of Russia in the World Bank Group's Knowledge Index (KI 6.96)

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To increase the level of IT proficiency of future engineers, it is necessary to introduce modern Study programs (SPs) aimed on training of specialists of engineering profile in accordance with the claimed vacancies at the labor market, and including course units focused on mastering of modern information technologies.

Despite the fact that the basic canons of the information theory (Shannon's formula, Kotelnikov's theorem, and so on) has not been canceled, course units are often aimed only at developing of gadgets, web applications, etc. But in the era of Industry 4.0 it is necessary to study intelligent technologies, professional information and control systems.

Back to CDIO-approach

The development of technological and information space leads to the need to diversify the knowledge of the modern engineer, and include such competencies as mastering of basic knowledge and IT, invention, creativity development; professional skills of teamwork, commercialization of engineering and technical products.

Study programs in the area of engineering education should be focused on technologies which are used in industry, research and development.

Partially the stated task can be solved on the basis of CDIO-approach application, which is used in the practice of foreign personnel training since 2000. This is the concept of practice-oriented engineering education (**CDIO: Create-Design-Implement-Operate**).

Since 2011, the CDIO global initiative has been joined by Russian universities.

The basis of the CDIO approach are 12 CDIO Standards, which set requirements for reforming and evaluating of Study programs, and a list of planned learning outcomes (CDIO Syllabus).

The aim of the initiative is to bring the content of engineering Study programs in line with the level of development of modern technologies and expectations of employers.

Here are the **main points highlighted by us**, which should contribute to the provision of in-demand specialists:

- In order to achieve the learning objectives laid down in the Study program (SP), it is necessary to describe in details the **competencies** acquired by the graduate, **corresponding to the established goals of the program, requirements of Occupational standards and expectations of employers**;

- Material and technical support of the educational process should provide **the possibility of implementing of a practical approach to training**.

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It should be noted the successful experience of the introduction of the course unit "Fundamentals of project activity" for bachelor students at Peter the Great St.Petersburg Polytechnic University (SPbPU).

The purpose of studying this course unit is to form a basic system of knowledge and practical skills in the field of theory and practice of project activities. During studies, students who are able to implement project activities in practice are trained.

Training is project-oriented, the main principle of the course is training through practice.

Quality Assurance of Study programs

Effective training of engineers is impossible without the permanent monitoring of needs of the industrial sector and the adequate response to environmental challenges through changes in curricula and Study programs.

To solve this task, it is necessary to develop a system of information and software provision for assessing of the engineering education quality, providing for the introduction of aggregated indicators that assess the ability of the University to reconfigure its Study programs, assessing of the qualification of a teacher as a knowledge manager.

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The main specificity of the engineering education is the rapid progress of subjects of educational activity, and, as a consequence, the need for high variability of a content of the SP.

The quality of SPs should be assessed by students, teachers, employers, representatives of business communities and other stakeholders. This requires a system approach for on-line quality assessment and improvement of SPs.

The implementation of improvements should reflect the results of activities under well-defined and strictly applied Quality Assurance procedures.

Improvements should affect both the content of the SP and the methods used, and the promotion of SPs in the market by improving their quality, transparency and comparability.

All of the above imposes **obligations on the supervisors of SPs**, unusual for teachers in Russia:

1) the supervisor of the SP is charged with the **responsibility of ensuring of its competitiveness**, through which the involvement of students (the main source of investments) is carried out;

2) the supervisor of the SP is obliged to **provide the necessary resources** for the entire process of organization and implementation of the SP;

3) the supervisor of the SP is **responsible for the quality** of both the true process of providing of educational services and the quality of learning outcomes.

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The organization of teaching requires consideration of external and internal factors. In the context of higher education, **the external environment** has a number of specific features.

The influence of the external environment I_{ext} can be characterized by a tuple of variable factors:

$$I_{ext} = \left\langle Leg_{Educ}(t), \operatorname{Re}q_{employ}(t), STP(t), M_{labour}(t), INF(t), Comp(t) \right\rangle,$$

where Leg_{Educ} are changing requirements of legislation in the area of education;

Req_{employ} are constantly changing requests of employers;

STP is scientific and technological progress;

M_{labour} are changing conditions on the labor market, availability of vacancies;

INF is public awareness, including stakeholders represented by potential students and their parents;

$Comp$ is competition in the market of educational services.

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A distinctive feature of higher education in comparing with the General education, is its non-mandatory nature. Therefore, the supervisor of the SP cannot expect to a constant influx of applicants, and must organize marketing research to attract students.

As a significant change, the development of Occupational standards should be considered.

Also, taking into account the long duration of the education process, it is necessary to plan that during the training working conditions and technological equipment can go far ahead in comparing to the conditions, which were in force at the beginning of training. This factor is crucial in the concept of the on-line Quality Assurance of SP, based on the prompt feedback from employers and graduates of the SP.

The **internal environment** also has a direct impact on the process of the SP implementing. Its influence I_{int} can also be represented as a tuple of variable factors:

$$I_{int} = \langle Manag(t), \mathrm{Re}\,sour(t), PTS(t), Fin(t), Doc(t), QA(t) \rangle,$$

where *Manag* is the approved complex of interactions of the supervisor of the SP and the management of the University; *Resour* is the system for provision of necessary resources; *PTS* is the system of selection, recruitment and payment of Professors, Teachers and Support personnel; *Fin* is the financial system of ensuring the payback of the SP; *Doc* is the system for documentation and reporting according to the SP; *QA* is the Quality Assurance system of the SP.

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Algorithm of actions in the Quality Assurance system:
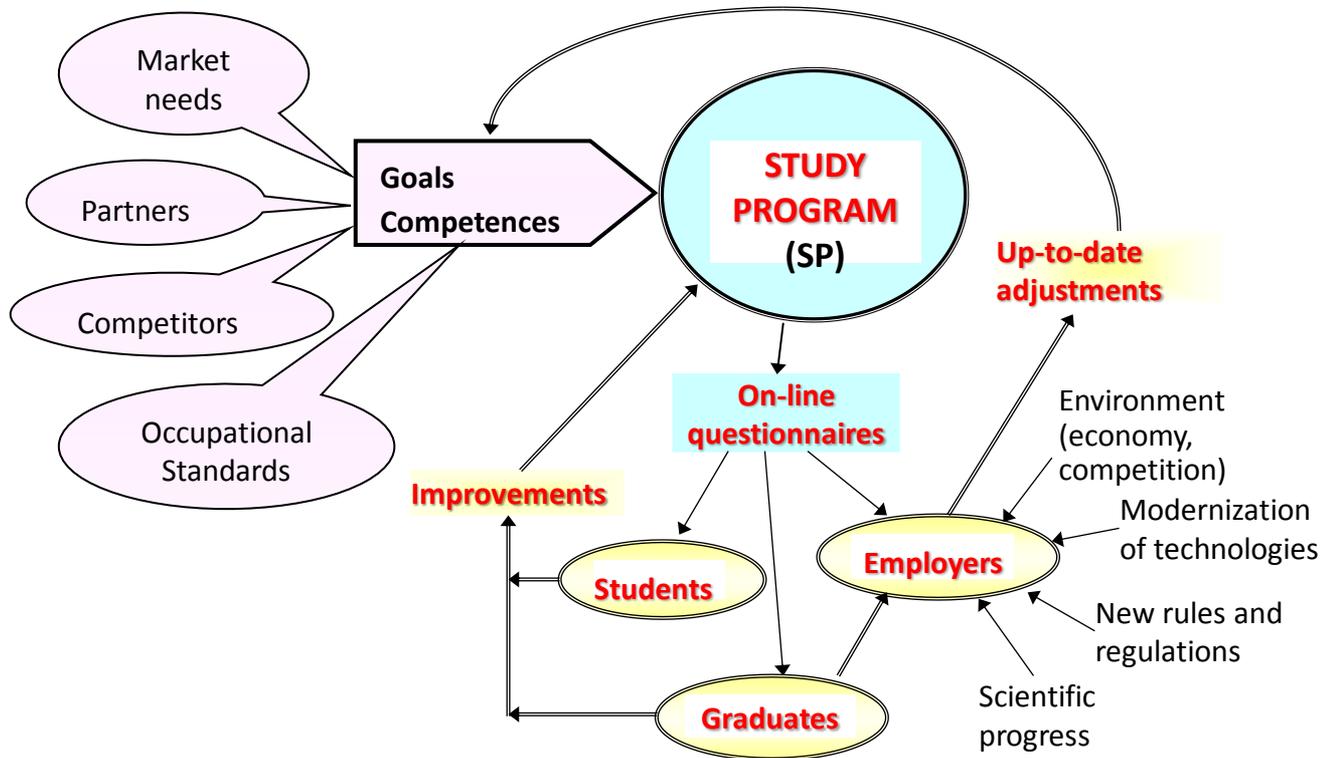
Milestones of the algorithm:

1) determination of market demands for SP;

2) marketing of educational services and fixing of competitive advantages of the offered SP;

3) formation of goals and competencies of graduates on the basis of Occupational standards;

4) planning;

5) implementation;

6) receiving and analysis of results of the feedback from trainees and employers;

7) updating (if necessary) objectives and contents of the SP;

8) deciding whether to continue, or to update, or to eliminate the SP.

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Use of the Quality Assurance of SPs

For the first time, the proposed model was tested in **preparation for the International professional-public accreditation of the SPs** at SPbPU in 2014.

In 2019, the developed methods were also used in preparation for professional-public accreditation carries out by the Association for Engineering Education of Russia (the official member of the European Network for Accreditation of Engineering Education), with obtaining of **the Certificate, which confirms that the SP satisfies the criteria for Master degree programmes specified in the EUR-ACE® Framework Standards** for the Accreditation of Engineering Programmes, and for the stated period of accreditation the **SP is designated as a "European-Accredited Engineering Master Degree Programme".**

European Accreditation of Engineering Programmes
EUR-ACE® Master

This is to certify that the engineering degree programme

System Analysis and Optimization of Information Systems and Technologies

provided by

Saint-Petersburg State Politechnic University

accredited by

the Association for Engineering Education of Russia

on 27 December 2019   until 27 December 2024

satisfies the criteria for Master degree programmes specified in the EUR-ACE® Framework Standards for the Accreditation of Engineering Programmes, and therefore for the above period of accreditation is designated as a

EUROPEAN-ACCREDITED ENGINEERING MASTER DEGREE PROGRAMME.

certificate

For the European Network for Accreditation of Engineering Education (ENAEE)

For the Association for Engineering Education of Russia (AEER)

The President
Prof. Dr. Bernard Remand

The president
Prof. Yuri Pokholkov, Sc.D.

Brussels, 27 December 2019   Moscow, 27 December 2019

RU-000457

A graduate of this programme may define him/herself "EUR-ACE® Bachelor/Master" as appropriate.

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Certificates of professional-public accreditation of SPs are taken into account during conducting of the State accreditation, and in the distribution of admission control figures for Universities.

The indicator, characterizing the presence of professional-public accreditation, is included as an additive component in calculating of the potential of an educational organization

(according to the methodology of the Ministry of Science and Higher Education of Russian Federation, approved by the Order of April, 1, 2015 No. 340 "On approval of the Procedure for the competition for the distribution of control numbers of admission by professions, specialties and areas of training and (or) enlarged groups of professions, specialties and areas of training for training in educational programs of secondary professional and higher education at the expense of the Federal budget appropriations").

In preparation for the International professional-public accreditation the software for the on-line documentation of the Quality Assurance of SPs in a web application accessible through a web browser had been used.

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Interface of the system for on-line documentation of the Quality Assurance of SPs is shown here:

The folder contains the information about the educational process for the achievement of the established learning outcomes.

The peculiarity of the Quality assurance system is the **permanent feedback from employers, graduates and students** of the SP, carried out with the help of the software for remote questioning on the basis of developed questionnaires.

The presence of the feedback allows to close the cycle of continuous revision and enhancing of the SP quality, taking into account the current changes in external environmental factors.

Implementation of the Quality assurance of the SP allows:

- **to justify the quality of training outcomes** that meet the needs of stakeholders,

- **to improve the quality of the SP** on an ongoing basis,

- **to increase the "transparency"** of the SP, which should lead to increasing of the confidence of consumers and, ultimately, **increase the competitiveness of the SP**.

Thank you for attention!

Speaker's contacts:

Vladimir Mager

Peter the Great St.Petersburg Polytechnic University

St.Petersburg, Russia
mv@qmd.spbstu.ru