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Towards the Issue of Quality of Engineering Education

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The article considers issues related to the quality assurance of higher engineering education, examines the global experience in this regard and ways to deal with the challenges. It is shown that one of the principal mechanisms to ensure and assess the quality of education is a professional and public accreditation (PPA) of education programmes (EP). The purposes and objectives of the professional and public accreditation, benefits for graduates of accredited programmes in the career development of a professional engineer are described. The practice and outcomes of the activities of the Association for Engineering Education of Russia (AEER) in the accreditation of education programmes in the field of engineering and technology are presented.

Key words: educational trends, professional and public accreditation, university rankings.

Introduction

One of the basic factors of sustainable economic development is significant improvements in staffing the enterprises that are involved in developing and implementing the breakthrough technologies. It is impossible to resolve this task without strengthening the entire system of higher professional education. Therefore, a new approach aimed at solving the most serious problems faced by the mankind in the XXI century is being implemented. The priorities of the sustainable socio-economic development of the society are as follows: improvement of citizens' life quality, economic growth, science, technologies, education, health and culture, ecology and environmental management [1]. A new paradigm of engineering education appears. Its main feature is that education has shifted the focus from knowledge transmission to practice-oriented lifelong education that rests on the fundamental theories. In view of the above, Russian high school is currently facing the task to assure high quality of Russian education and succeed on the global educational market.

Trend and tasks of Higher Professional Education

The following trends can be identified in Russian and foreign systems of higher professional education:

- The breaking down of the national borders: the increase in student and faculty staff mobility, development of international partnerships, participation of the international experts in thesis defense, the growth in import and export of education services and research, emergence of global players on the Russian education market and the risk of "education sovereignty" loss. The only way to survive for the higher professional education is to train graduates for a special niche or sector of economy, i.e. to take on the role of "an agent" of region/sector development.

- Orientation of universities towards the demands of the society and economy: whole scale long-life learning, devaluation of traditional diplomas, emergence of new assessment bodies (independent certification agencies, standards of leading companies (Microsoft certification)), gradual privatization of higher education by business, building of new-type campuses (educational



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transfer centers), focus on team-building and spreading of project universities.

- Changes in educational and scientific content: individual "unattended" education (educational fast-food) based on new approaches (individual study paths, all day long learning – 24/7, simulators and virtual education).

- Changes in the scientific research procedure: projects aimed at preserving scientific schools, self-assembly research teams, development of interdisciplinary research, dissemination of research outcomes (including those in public press), the growing number of scientific inventions for industries, research on the basis of virtual laboratories and cloud technologies.

- Development of new patterns to coordinate society: new approaches to evaluating university and its graduates' performance, student scientific society as a platform for introducing new teaching tools, integration of student and professional associations, education aimed at training teams capable of handling various tasks (the key competency of an educator – ability to make up creative teams for solving various problems).

In line with the above, in order to enhance competitiveness of the country in the context of globalization, the Russian high school should tackle the strategic task – to ensure high quality of Russian education and its recognition on the global market. The latter is impossible to reach without introducing effective quality management systems. In this regard, the tools to evaluate the level of graduates' training are becoming especially important.

The quality of education is ensured by well-designed education programmes, qualitative teaching technologies and resources (including financial ones), the level of interaction with the strategic partners, efficiency of the implemented quality management system, and graduates' training quality. Hence, the education quality assurance patterns developed by universities should correspond to informational resources and facilities, staff,

and certain requirements imposed by the society, personality, and the state.

Analyzing global experience in evaluating university performance, three basic approaches have been identified: reputational, result-oriented, and total. The reputational approach involves experts to evaluate the quality of educational programmes and universities. Result-oriented approach is aimed at evaluating quantitative values of university performance. The total approach rests on the principles of the Total Quality Management, TQM and requirements for the Quality Management Systems imposed by International Organization for Standardization, ISO. The other approaches are, to various extent, a combination of the described methods.

Professional and public accreditation of education programmes: goals and objectives

Let us take a closer look at the reputational approach. Being one of the most widely applied in educational community, this approach is primarily based on the procedure of accreditation of training process, in general, and education programmes, in particular.

Accreditation is a system of education quality assessment which allows considering the interests of all stakeholders. It combines both public and state forms of monitoring.

The main goals of accreditation are as follows:

- to ensure advance in higher education quality;
- to ensure efficient evaluation of educational service quality, in general, and education programmes, in particular;
- to foster development of educational establishments and enhancement of education programmes via continuous self-examination and planning;
- to guarantee the society that the educational establishment or a certain education programme has adequate learning outcomes and the ways to achieve them;

- to support in developing and enhancing educational establishments and implemented education programmes;
- to protect educational establishments from the interference into the teaching process and infringement of academic freedom.

In higher education, there are various types of both state (performed by the authorized governmental bodies) and public accreditation. It is worth noting that professional and public accreditation is increasingly popular in evaluating quality of education programmes offered by universities. This type of accreditation is of particular interest. It is proved by the fact that within the framework of the Bologna Declaration the development of professional and public (non-state) accreditation is one of the key issues [2].

Professional and public accreditation of education programmes is basically defined as a procedure aimed at evaluating the quality of a university performance in implementing certain education programmes. It is designed to define a university status to show the public that university has met and is maintaining high level of standards set by professional communities (associations), experts-volunteers, specialists, representatives of various industries (employers) and peer universities [3]. As a rule, a certain education programme undergoes accreditation.

Thus, professional and public accreditation of education programmes is a non-governmental system of education programme quality assessment and incredibly important facet of high-quality specialists' training. Such accreditation is considered an effective tool to assure all stakeholders of an education programme (school leavers and their parents, students, employers, authorities, the public in general) that it meets high standards of educational quality, i.e. is in line with their requirements and expectations.

Accreditation of education programmes allows universities timely respond to the changes in business and labor market and foster development and enhancement of

training process in accordance with the requirements of the public via the system of quality assessment criteria.

Precisely, the network interaction model between universities and enterprises has been actively introduced into the training process over the past years. The network interaction, being a flexible form of integration processes that may occur in education system, provides much wider access to the most up-to-date learning tools and technologies, allows piloting new forms of teaching and content including e-learning and distance education [4]. Additionally, the network interaction model inevitably leads to facilitating indirect contacts: on the one hand, the number of contacts and interactions is increasing, therefore, the results are becoming more qualitative and efficient [5]. On the other hand, the question arises: what are the criteria to evaluate the efficiency of this model? What is the way to assess the quality of specialists' training within a certain discipline and the entire education programme provided electronically? Many scholars and faculty members pose these questions, which, definitely, should be reflected in the criteria of education programme quality assessment.

Attending an accredited programme in the field of engineering and technology can mean for a graduate the first step into the corresponding professional community with a further possibility to obtain appropriate professional licensure in the field and apply for the international professional registration:

- International Professional Engineers Register.
- APEC Engineer Register.
- International Engineering Technologists Register.
- International Engineering Technicians Register.

In Russia, the system of professional certification of engineers is only beginning to take root. In western countries, the certificate of the international professional registration is absolutely essential for career growth both in the industrial and academic sectors. Additionally, being recognized as

a specialist in a certain field, an employee can count on additional bonuses (social and educational, insurance). Such specialists are in great demand, as highly-qualified and skilled engineers significantly influence the company performance, i.e. winning various contracts (contracts on supply of the equipment, technology development, etc.).

Obtaining an accredited degree is absolutely beneficial for students, as well. In some countries, students who attend an accredited programme are the only one who eligible for federal financial aid. These facts prove the validity and market weight of the accredited programmes [3].

In the course of professional and public accreditation, universities are given the recommendations on improving their education programmes. The recommendations are given by the experts who have gained vast experience in evaluating various educational establishments and obtained deep knowledge in education quality assurance [3]. This enables universities to enhance their competitiveness, thus, the competitiveness of their graduates both on the national and international markets of intellectual labor.

Another important objective of any national professional and public accreditation is to maintain recognition of the programme quality at the international level. To achieve this objective, it is required to harmonize national accreditation policy with the similar foreign ones including international associations and agencies in the corresponding field.

All the above-mentioned factors significantly help professional and public accreditation contribute to assuring high standards of education quality.

AEER Accreditation

One of the main activities of Association of Engineering Education of Russia (the Association, AEER) is professional and public accreditation of engineering programmes. The Association has developed and advanced the professional and public accreditation of education programmes since 2002 [6]. According to the Federal Law "About

Education in the Russian Federation", AEER is entrusted to conduct professional and public accreditation of various education programmes in the field of engineering and technology. In compliance with this law, such accreditation demonstrates to the public that students graduated from an accredited university are properly educated according to the standards of educational quality agreed upon by professional experts, labor market specialists, and representatives of the corresponding industrial sector [7].

Compliance with the AEER criteria would guarantee the quality and continuous advancement of education programmes offered by universities. AEER accreditation criteria and procedure have been developed with regard to the Bologna Declaration for bachelor's, specialist's and master's degree programmes (the first and the second cycles) [7]. When developing the accreditation criteria, the association considers the world's best practices in engineering education quality assessment. The programmes accredited by AEER are registered in the Association, ENAEE (European Network for Accreditation of Engineering Education), submitted to the Federal Education and Science Supervision Service, covered by the mass media and appeared on the sites of AEER and ENAEE.

The criteria are set for learning outcomes evaluation. The learning outcomes imply a combination of competencies, knowledge, skills, abilities, methodological culture acquired by students upon completion of the education programme. They are designed in line with the requirements set for graduates by the professional community. An education programme can be accredited only if it meets all the above-mentioned criteria.

It an educational programme is successfully accredited, both bachelor's and master's degree programmes are signed 2 certificates (AEER certificate and the EUR-ACE Label certificate). Specialist's degree programmes may be awarded 3 certificates: AEER certificate, the EUR-ACE Label certificate, and the Washington Accord certificate.

AEER is the only association in the Russian Federation, which is entrusted to award education programmes a common quality label "EUR-ACE label" (bachelor's degree, master's degree), as well as to sign certificates of compliance to the requirement of the Washington Accord (Specialist's degree). The above-mentioned certificates are regarded as international ones and are recognized in the signatory countries of ENAEE and the Washington Accord.

During the period from 2003 to 2016, AEER accreditation center [8] accredited more than 400 education programmes offered both by Russian and foreign universities (fig. 1). The representatives of the Ministry of Education and Science of the RF, international accreditation agencies and professional communities were always involved into the accreditation process. More than 350 education programmes were awarded EUR-ACE label (fig. 2).

The education programmes accredited by AEER accreditation center are offered by the leading Russian universities which take the top spots in the national university ranking. The data on most of accredited programmes are available in the annual reference book "Best Educational Programs of Innovative Russia". The graduates of the accredited

programmes are in a high demand among employers and usually move up quickly the career ladder.

For further development and advancement of multi-level systems of education quality assurance, in 2014 the accreditation center of AEER designed and implemented the criteria to accredit vocational programmes in the field of engineering and technology. The accreditation criteria and procedure are set in compliance with the international standards [7]. The accreditation was piloted in Tomsk Polytechnic Vocational School, Tomsk Vocational School of Information Technologies and Sary Oskol Technological Institute n.a. A.A. Ugarov (branch) National University of Science and Technology "MISIS".

University Ratings

Despite all the drawbacks of the university ratings (the examples are illustrated in the article by S.V. Ablamejko [9]), they provide not only subjective evaluation resulted from the current university reputation, but also a number of basic characteristics, such as highly-qualified faculty, qualitative training, up-to-date facilities and other parameters, i.e. the level of university performance, as a whole (though not always precise information). It is also believed that ratings

Fig. 1. The number of programmes accredited by AEER

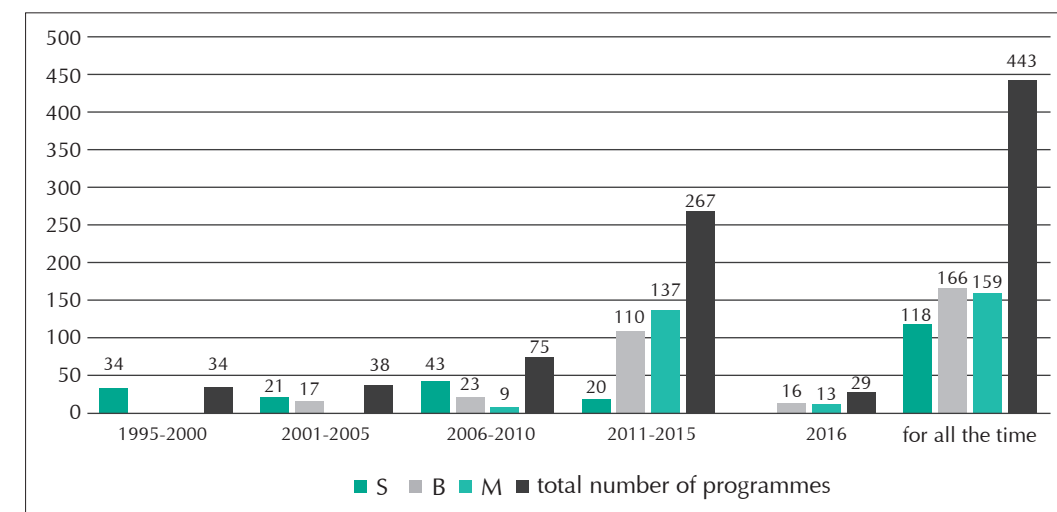
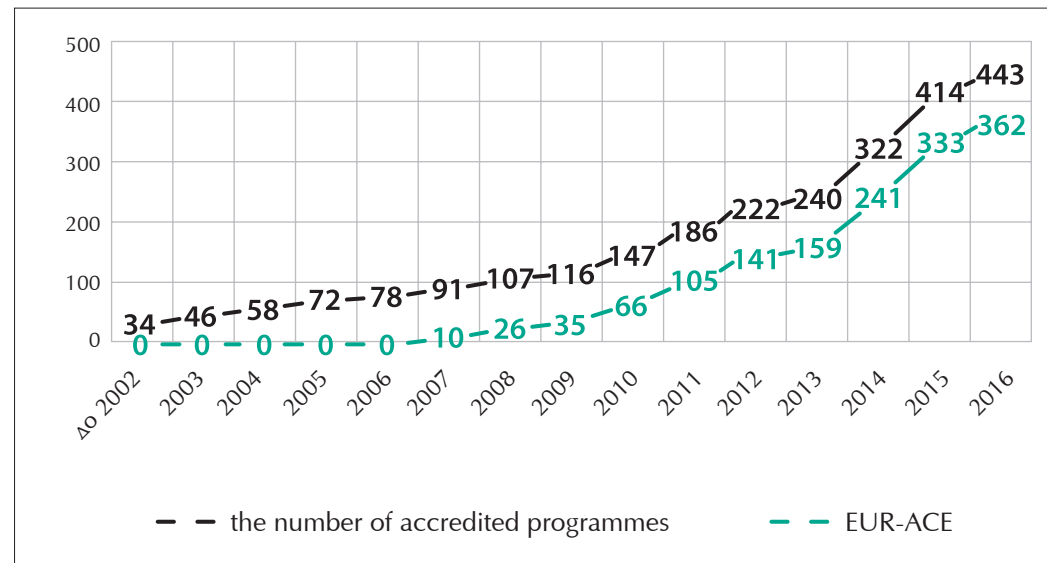


Fig. 2. The number of programmes awarded EUR-ACE label



contribute to enhancing education quality due to sharpening competition on the educational service market.

How often universities apply for accreditation and whether there is any dependence between the number of accredited programmes offered by university and its spot in the national ratings? To answer these questions, let us analyze the following examples.

All universities can be divided into three groups:

1. "Elite" universities basically need no approval of education quality; however, they take top spots in the national university ratings and have good reputation in the international university educational community.

Such universities include Lomonosov Moscow State University, National Research Nuclear University MEPhI, Bauman Moscow State Technical University, and Saint-Petersburg University.

2. The universities which are striving to become leading ones in the academic community, they accredit education programmes on a regular basis, participate

in various national university ratings and federal programmes (project 5-100, "Staff for Regions", "Universities as Centers for Innovations", etc.).

This group involves National Research Tomsk Polytechnic University, National University of Science and Technology NUST MISiS, Higher School of Economics. Based on the comparison of the number of accredited programmes offered by these universities, let us analyze the proportion of the accredited programmes relating to the position of the university in various university ratings (Table 1).

3. Finally, universities which demonstrate no interest in university ratings and do not participate in the governmental programmes.

As it is obvious, the table demonstrates no direct dependence of the university position in the national ratings on the number of accredited programmes. However, this issue requires more rigorous examination as it is quite complicated to undoubtedly identify the influence of this factor on the university rating. The accreditation of education programmes is an absolutely

Table 1. Relation of the number of accredited programmes to the university position in the national and international ratings

Universities from project "5-100"	National university rating (Interfax), 2016	Rating agency "Expert RA", 2016	QS World University Rankings, 2016	BRICS Rankings, 2016	EECA University Rankings, 2016	The proportion of accredited programmes (approximately, data are taken from open sources)
Higher School of Economics	6	6	411-420	62	35	0.55
National University of Science and Technology NUST MISiS	14	18	601-650	87	63	0.7
Saint Petersburg Electro-technical University "LETI"	22	36	not available	121-130	110-120	0.57
Tomsk State University	9-10	13	377	43	20	0.06
Tomsk Polytechnic University	9-10	8	400	64	45	0.63
ITMO University	12	19	not available	101-110	81	0.07

important facet of university life, especially of those universities which are interested in enrolling foreign students and offering joint programmes or double degree ones.

Additionally, global ratings evaluate university as a whole and, as a rule, they do not reveal the quality of certain education programmes (bachelor's, master's, and post-graduate programmes), as well as one can hardly learn from these ratings how actively a university implements new teaching technologies, for example, distance education. However, it is these issues that are of great interest for a potential enroller or employer. Therefore, the ratings based on certain university activities or programmes are becoming more and more popular.

Conclusion

In the context of global competitiveness, the quality of education becomes an essential factor that enables a certain person or the entire society to achieve and maintain the leading positions on the global market. The world and its values are in constant change, which means that education should also change (though not so rapidly) in order to meet the requirements and expectations of students who are definitely want to be in demand in the modern world.

The professional and public accreditation allows university authorities timely to respond to the ever-changing requirements of business and labor market. The accreditation criteria developed to assess the quality of education programmes stimulate development and advancement of education systems in line with the demands of society.

The basic benefits for the students attending accredited programmes were outlined.

Thus, in line with the above and in order to contribute to further enhancement of education quality, it is required:

- to continue accredit education programmes by international and domestic professional and public accreditation centers, including AEER;
- to make agreements between leading industrial corporations and accreditation agencies of Russia;
- to consider the results of professional and public accreditation of education programmes in the national university ratings;
- to involve as more as possible stakeholders in dealing with the issues of engineering education quality enhancement.

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