

Contribution of Industry and Professional Community to the Development of Continuing Engineering Education

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INTRODUCTION

Changing socio-economic context, industry transformation and rapid technology development result in the increasing role of continuing engineering education. Life-long learning is becoming a key competence for social and economic sustainability.

Engineering profession puts a great impact on economic growth. The important role in development of engineering community in Russia play higher education institutions (HEI) that offer engineering educational programmes. Literature studies and personal experience in the field make evident a mismatch between academic requirements and competencies needed in the workplace [1-3]. One of the reasons of this mismatch is a weak interaction between academic and industrial systems. The analysis of the current engineering educational context in the Russian Federation showed that the main stakeholders of education such as employers, professional bodies and communities don't demonstrate an active engagement in educational process.

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Tomsk Polytechnic University (TPU), one of the leading engineering HEI in Russia, has been successfully developing the continuing engineering education system including bachelor and master degree programmes, PhD programmes and continuing professional development (CPD) programmes in engineering and technology. This requires the engagement of industry in university activities, including the development of strategic partnership.

1 UNIVERSITY-INDUSTRY PARTNERSHIP

1.1 Principles of strategic partnership

University-industry partnership is an important factor of university development and its competitiveness in local and global market. Graduate employability and employer reputation are crucial considerations by the evaluation of education institutions and educational programmes (see e.g. QS University Ranking methodology [4], Criteria for accreditation of educational programmes in engineering and technology implemented by the Association for Engineering Education of Russia (AEER) [5], etc.).

Tomsk Polytechnic University develops strategic partnership with industry based on a number of principles including:

1. Complexity (there are several modes of cooperation with one strategic partner).
2. Partnership with industry leaders (TPU activity aims at cooperation with leading organizations and enterprises).
3. Effectiveness (monitoring of contract performance, personal responsibility for the fulfillment of treaty obligations).
4. Common goals and objectives (mutually beneficial cooperation targeting achievement of industry and university goals and objectives).

1.2 Modes of university-industry cooperation

TPU activities in the field of R&D, investigation and education suggest strong collaboration with employers. The main modes of university-industry partnership include but are not limited to:

- programme accreditation by the Association for Engineering Education of Russia and international accreditation bodies, e.g. ABET, ASIIN, etc.;
- design of educational programmes in accordance with professional standards developed by employers, professional bodies and industry associations together with educational institutions;
- employer involvement in design, delivery, evaluation and updating of educational programmes;
- vocational training and hands-on experience for students and faculty members;
- engagement of industry representatives and employers in activities that enhance the competitiveness of TPU students and graduates (Career Days, employer presentations, workshops, conferences, forums),
- graduate employability,
- delivery of CPD programmes for engineers and engineering technicians,

- founding of integrated structures, etc.

The main modes of TPU-industry cooperation are discussed below.

2 DEVELOPMENT OF COMPETITIVE EDUCATIONAL PROGRAMMES IN ENGINEERING AND TECHNOLOGY

Design, delivery, monitoring and evaluation of TPU educational programmes is influenced by industry and professional community. According to the TPU educational standard [6], educational programmes offered at the university should be designed and delivered in compliance with Russian professional standards, AEER accreditation criteria, as well as international standards of engineering education such as EUR-ACE Framework Standards and Guidelines [7], IEA Graduate Attributes and Professional Competencies [8] and CDIO Standards and Syllabus [9]. Educational programmes are developed based on industry demand in graduate competencies; the intended learning outcomes are discussed and approved by potential employers.

Besides, industry representatives are involved in programme delivery, namely they can be engaged in educational process as faculty members, and they offer bases for practical on-the-job training. Industry representatives are also included in examination board and can assess graduate's achievements taking into account current needs of labour market.

Strong collaboration with industry and following national and international professional standards and accreditation criteria developed and approved by professional communities result in high graduate employment rates. In 2016 the demand for TPU graduates came to 180% of output.

3 VOCATIONAL TRAINING AND HANDS-ON EXPERIENCE FOR FACULTY MEMBERS

Following the CDIO Standards [9], engineering faculty members should be competent in product, process, and system building skills which are developed best in contexts of professional engineering practice. Continuing professional faculty development including gaining hands-on experience and improvement of his/her qualification by participation in R&D and engineering projects are important considerations by accreditation of engineering educational programmes [5]. The actions that enhance faculty engineering skills include professional training in industry, research and education projects in collaboration with industry colleagues, etc.

In 2015 a new form of professional training in industry was piloted for TPU faculty, namely a team project-based industry training. Three teams were built, each of them included representatives of engineering departments, as well as the departments of Economics and Management. The teams took part in training programmes at Tomsk enterprises. Each team had to solve a particular engineering problem taking into account economic, social, legal and other considerations. As a result the faculty members got acquainted with current industry demands, developed engineering and interpersonal skills including ability to work in cross-disciplinary team and communicate effectively with professional community. They also prepared cases and real-life engineering problems for educational process and modified their courses in accordance with current industry needs.

4 COMPLEX OF TRAINING PROGRAMMES FOR INDUSTRY PARTNERS

Focused on life-long learning, TPU implements a monitoring system of partner's staffing needs. Degree and CPD programmes are developed based on industry demand and taking into account current competence and skills needs.

The complex of CPD programmes offered at TPU includes over 250 professional development programmes and about 50 retraining programmes for industry staff in relevant and modern engineering fields.

The benefits of professional development programmes offered at TPU include but are not limited to:

- Quality of education: the training programmes are designed and delivered in accordance with best practices in engineering education; all programmes are reviewed by the trained experts before they are launched; the training programmes are revised regular based on evaluation results and feedback gained from programme graduates.
- Unique facilities and resources: modern equipment, labs and centers authorized by international organizations are available for students, e.g. Training Center TPU & Softline authorized by Microsoft, Authorized Training Center SolidWorks Tomsk, the Petroleum Learning Centre (a joint project of TPU and Heriot-Watt University), etc.
- Modern educational technologies and teaching methods, including e-learning, context learning, problem-based and project-based learning, etc.
- Individual approach: if required programme content and structure are adopted based on student's needs; deferent options of programme delivery are offered, including in-class activities, on-the-job practice, blended and e-learning.
- Highly-qualified faculty: all faculty members take regular training courses, including training programmes in contexts of professional engineering practice; certificated experts and professional engineers are also engaged as lecturers.

5 CONCLUSIONS

Being the main stakeholders of engineering education, industry and professional community put a great impact on its development, namely they define graduate attributes and competencies relevant in labour market. Graduate employability and employer reputation are crucial considerations by the evaluation of education institutions and programmes. Universities should develop strategic partnership with industry in different modes, including R&D, investigations, innovations, and education to be competitive in local and global market. Tomsk Polytechnic University demonstrates a successful practice of university-industry cooperation that results in high graduate employment rates, competitive educational programmes, professional training courses in industry for TPU faculty members, the complex of training programmes offered at TPU for industry partners. Continuing engineering education aligned with industry demands is an essential factor for economic growth and industry development.

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