

Education-Research-Production Complex as Engineering Training Model System for Human Resources in High-Technology Industries

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Considering present-day conditions the training of human resources for hi-technology industries integrates the following related organizations- university, enterprise-employer, primary and secondary vocational institutions. Due to existing economic and organizational factors many technical universities are unable to provide and modernize their laboratories with expensive or even sophisticated equipment. In view of increasing requirements for modern engineering competencies and corresponding professional abilities and skills, consistent development and improvement, as well as, competence assessment, it is appropriate to coordinate the merging of university- students- graduates- employers into an education-research- production complex. The following article depicts the model system in engineering training in accordance to today's requirements.



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Key words: training research and production complex, graduates' competence, engineering qualification certification, quality management system, independent professional accreditation, standard methodical ware.

The economic and socio-political conditions of today indicate the following effective path development of hi-technology industrial sectors - innovation and production activities to competitive products. Besides procurement, one of the most important factors in effective innovative and everyday production activities is the human resources and qualifications of all-level specialists, i.e. those engineers possessing innovative creativity, skills in research & development (R&D) of new engineering proposals; in other words, this organization can be described in the following cycle: knowledge → idea → engineering design and process engineering → high-qualified product [1-3]. Thus, the target education task is the organization and development of lifelong learning to engage effectively human potential which would

involve integrated education, research and production activities. Human resource training and professional development is one of the prevailing conditions in ensuring successful enterprise performance within the existing hi-technology industry sectors. Engineering training enforcing creativity and practical experience embraces not only the collaboration between enterprise and university (institute), but also an integrated academic-research-training process to develop those competencies of a graduate that would meet current needs and demands of all partners and parties (enterprise-university) involved in this process. The development and shaping of future engineer-graduates should be accomplished throughout his/her studies and education, as well as, professional activities, including pre-university training and instruc-

tional support during his/her professional life at this or that enterprise.

The success criteria in this academic-research-training process are the following: graduate compliance to employer's requirements, their demand and competitive performance in the global job market, education satisfaction, university prestige promotion, all of which enhance education quality that is essential for all involved parties- state, graduate and employer.

It is the university, being capable of promptly and appropriately responding to emerging issues and accommodating educational services in accordance to employer and learner demands, could provide both competitive performance of all participants within this system under conditions of mutual beneficial co-operation and training specialists for enterprise-employer, as well as, one's university.

The most effective tool, according to success criteria (academic-research-training process and competitive performance in the global job market) is to establish an integrated system merging technical university, enterprise-partners and institutions of primary (primary VEI), professional (professional VEI) and secondary vocational education (SVEI) into education-research-innovation corporation, i.e. education-research-production complex (ERPC) [4-5].

The organization structure of such a multi-oriented professional training complex-ERPC is depicted in Fig. 1. The major functional targets of ERPC are the following: collaboration in enterprise HR development, including development of professional competence requirements, design of curricula and academic and their mutual implementation, recruitment and oriented training of future enterprise specialists under contract and employment of graduates to contract.

Each participant within the framework of this complex (ERPC) program in developing professional competencies has his/her assigned role. The education institution embraces the development of socio-personal competencies within pre-university training and orientation programs upon coordinating programs. It is the technical university that trains human resources (HR) for hi-tech enterprises and develops those professional and cultural competencies in accordance to Federal State Education Standards (FSES) and employer's requirements. Besides professional competencies, such skills and personal qualities are shaped, developed and maintained throughout the graduate's professional life as socio-personal responsibility, creativity, corporate culture commitment, moral and ethic principles, teamwork and leadership skills, motivation and ambition endeavors.

The organizational structure of ERPC activities involves the collaboration of the following institutions: university promoter → technical university → Russian Ministry of Education, the latter of which frames applications and furthers the academic process (i.e. programs, curricula) in prevailing professional areas through financing and accepted FSES (Fig. 2).

Agency, Ministry, professional institutions, and enterprise associations, in accordance to the demands of this or that enterprise, frame its own specialist application and are involved in the finance and resources provision of the education-research process, which, in its turn, is mutually organized both by the technical university and enterprise-partner, as well as, organizing further training and education.

In its turn, the technical university frames graduate application, postgraduate feed-back, further training, refresher training, and professional engineering development

Fig. 1. ERPC organizational structure

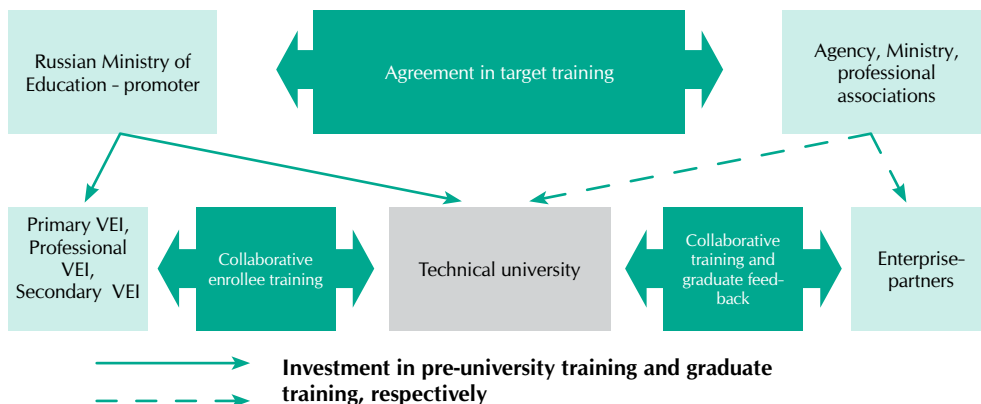
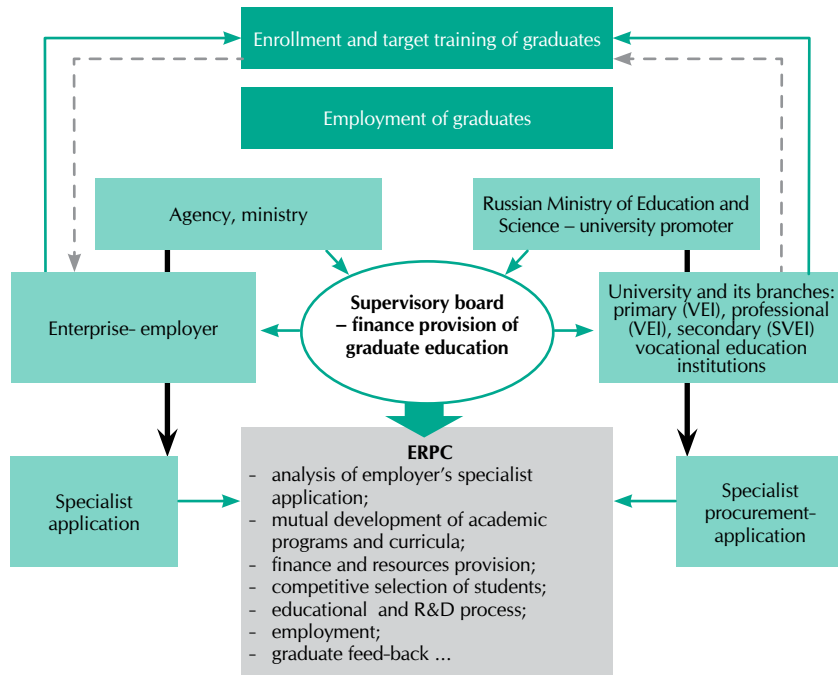


Fig. 2. Integrated communication diagram within education-research -production complex



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certification in collaboration with primary (VEI), professional (VEI), secondary (SVEI) vocational education institutions and enterprise-partners.

The enterprise, based on its needs and demands in HR and development prospects of the enterprise itself, plans its strategic and HR policy, frames its specialist application in collaboration with the Agency, Ministry, professional institutions annually, as well as, the finance provision. In this case, the functions of the enterprise include internship (on-the-job training), involvement in R&D, management, and project activities, and development of its own HR.

The University, i.e. technical university, in collaboration with primary (VEI), professional (VEI), secondary (SVEI) vocational education institutions executes integrated orientation and academic programs, as well as, graduate peer training with industrial enterprises. In addition, the technical university coordinates the activities of the ERPC.

Finance coordination of ERPC activities is the exclusive prerogative of the Supervisory board, which includes representatives from Russian Ministry of Education and Science, agencies, ministries, professional institutions, enterprise (employer) associations.

Coordinated activities of ERPC involve the following:

- analysis of employer's applications;

- mutual development and design of curricula and training programs;
- training resources provision;
- competitive selection of students;
- education-research process;
- employment;
- graduate feed-back (further training, refresher training, and professional engineering development certification and others).

The role and function of the technical university within the framework of ERPC significantly increases i.e. the university graduates into a «supplier of no-address» graduates into a multi-profile education-research- innovation center. The perspective results are the emerging new-generation engineers, capable of determining potential challenges, developing and implementing sophisticated technological findings. It is these engineers who are of great demand in hi-tech enterprises nowadays.

As an innovative-research center (ERPC) the technical university with its enterprise partners develop and incorporate the students' creative skills in designing and implementing this or that product and transforming advanced engineering proposals into in-demand items.

The fundamental principles of this collaboration include the following:

- **Complexity** – engineering training in collaboration with all interested partners-

state, university, enterprise-employer and students.

In-demand – graduate training, complying with the demands of the state, enterprise-employer, society and labor market.

Responsibility – the university is responsible for graduate-engineer training quality.

Permanency – further qualitative training is accomplished throughout the professional life of the graduate as further training, refresher training, and professional engineering development certification.

Balance of interests – mutual interests and commitments of all concerned parties-state, university, enterprise-employer and students.

At the same time the coordination and management functions of the technical university within ERPC changes significantly. It becomes the central institutional body in this complex management system of ERPC, involving not only methodological provision,

qualitative education management (accreditation, licensing), but also non-government «tools» to guarantee and provide qualitative education-research activities such as quality management system, self-governed social-professional accreditation mechanism for curricula and post-graduate engineering qualification certification (Fig. 3).

In-university quality management system (QMS) and its certification, providing a stable effective improvement mechanism for university technical activities, is one of the world-wide tools in education quality guarantee. Self-governed professional accreditation of academic programs guarantees qualitative learning «technology» for all participants of the education activities-graduates, employers, university and its staff. The orientation in training in-demand competitive specialists for enterprises and hi-tech industries should involve the enterprise (employer) itself in the education-research process, due to its production feasibility, sophisticated equipment and technolo-

Fig. 3. Structure of ERPC management system complex

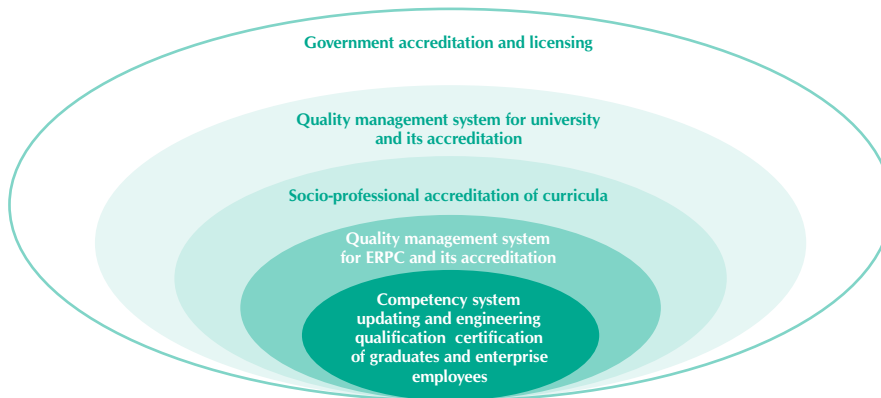
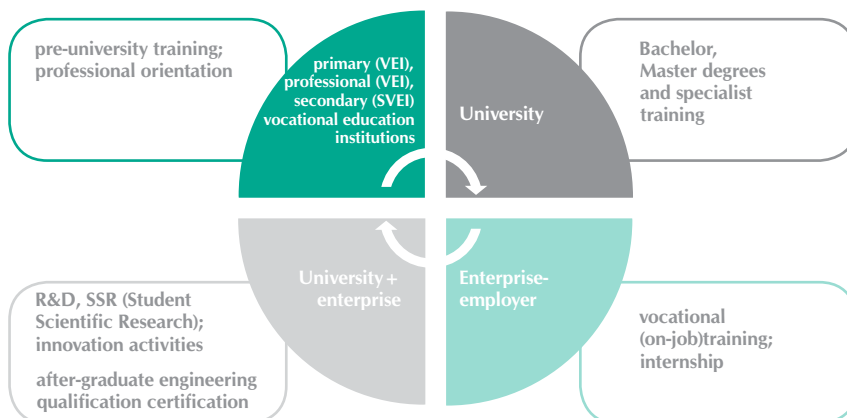


Fig. 4. Distribution of functions within ERPC



gies. Effective collaboration factors are both cooperation within common requirements (mutual development and implementation of curricula and training programs) and inter-relations with primary (VEI), professional (VEI), secondary (SVEI) vocational education institutions (organization and management activities within in-university QMS) involving the following scheme: «suppliers» – enrollees and «consumers» – employers (Fig.4).

Integrated QMS for ERPC and its certification ensures the proficiency and performance of training and education (T&E) activities under conditions of collaborated research and development (R&D), production, potential HR organization of enterprise-partner.

This integrated QMS should ensure the quality of engineering training in the education- research process, considering the enterprise-employer requirements.

All factors, especially graduate feedback required in working experience for further training and professional engineering development, are determined by ERPC strategies.

All activity types within ERPC are embraced in regulatory and procedural documents. This portfolio includes basic documents and three standard groups, as well as, requirements to the activity procedures and results of ERPC, documented requirements compliance, methods of matching and evaluation methods of efficiency and monitoring (Fig. 5).

The first group of documents set requirements to graduate competencies, methods of shaping competencies, functions of its members, resource distribution, and responsibility and authorized rights within ERPC.

The major documents of the second group- methods of requirements compli-

ance that regulate the educational and R&D processes, methods of mid-term and final certification, development of so-called « learner and graduate competency portrayal», in-demand analysis, employment and competitiveness, as well as, graduate career forecasting.

The third group of documents includes assessment methods of efficiency and results of ERPC. The management targets of all ERPC members in accomplishing intended graduate training results embraces the following set of competencies: pre-university training in accordance to university requirements, , resource provision, instruction quality, staff competency management, quality curricula level, «technology-tools» shaping graduate competencies, infrastructure, learning environment, information support (Fig. 6).

The management targets within ERPC- key system elements in developing professional, personal and social competencies of the graduates (Fig.7).

- These management targets include:
- pre-university training in accordance to university requirements and their profession orientation;
 - graduate training under conditions of integrated learning process and student research;
 - training of highly-qualified staff in post-graduate and doctoral internships;
 - further education training, advanced learning , refresher training;
 - facility management, infrastructure management and management of education environment;
 - economic-planning and finance;
 - international collaboration in education and research, internships, international exchange of students and teachers;
 - information support, publishing activities and library services;
 - graduate feed-back, engineering qualification certification.

Fig. 5. Structure of regulatory and procedural documents for ERPC activities

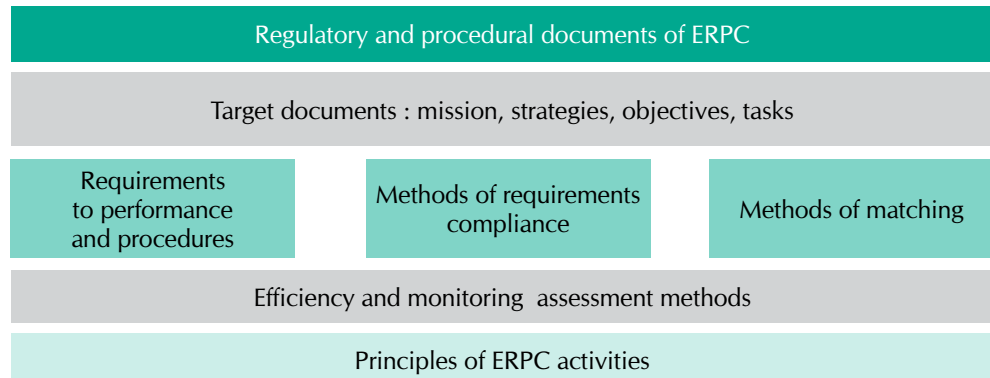


Fig. 6. Transformation from learning quality to education quality

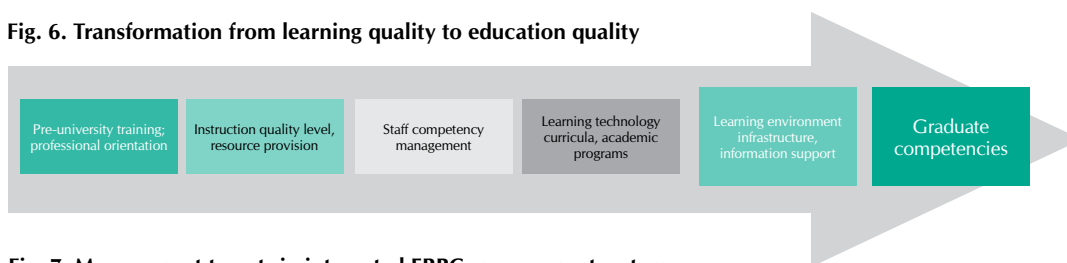
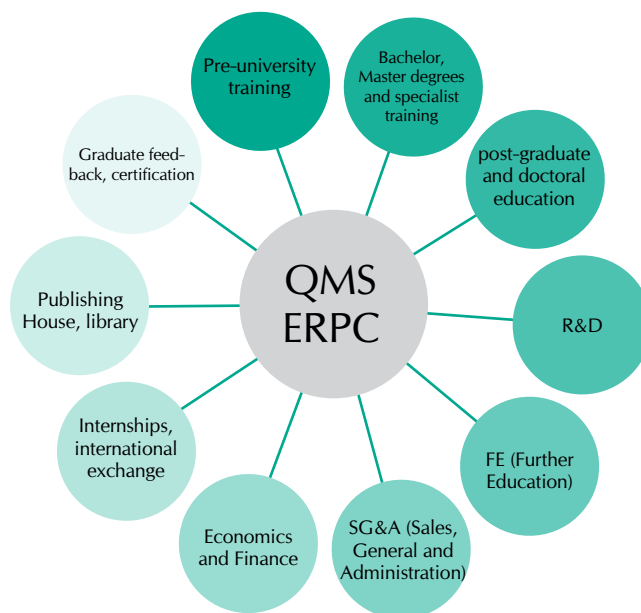


Fig. 7. Management targets in integrated ERPC management system



Monitoring system and efficiency evaluation and further development and implementation of management decisions are those factors providing effective ERPC activities.

The above-mentioned ERPC, including regulatory and procedural documents and interaction principles, could be recommended as a universal integrated model system of employers, research and innovation activities.

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