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## Professional Training of Bachelors in Mechanical Engineering, Based on Networking Resources

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### Abstract

Mechanical engineering is the main industrial sector, which has effect on development of other economic sectors and reflects the level of research and technology state and defense capacity of the country. Main purpose of higher educational institutions is management of personality professional training according to interests, abilities and socio-economic needs of society. Relevant objective of economy development, based on knowledge, is organization of close interaction between educational institutions and partners in the area of education. Based on Russian and foreign experience, a pedagogical model of professional training of bachelors in mechanical engineering on the basis of networking, which facilitates the demand for graduates in labor market was designed.

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### 1. Introduction

Analysis of psychological, pedagogical and philosophical publications, and the educational practice, as well as of employers' requirements, points to an important component in the training of bachelors in mechanical engineering, enhancing their value as graduates with the key and subprofessional competencies.

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Analysis of employers' requirements, made to engineering universities graduates allowed forming a list of required qualities and competencies, developed during professional training, and which mechanical engineering bachelor graduates are in deficit of.

The main significant lacking qualities and competencies mechanical engineering bachelors considering the requirements of employing companies are knowledge of modern Russian and foreign equipment; skills of modern technologies; use of legal norms, regulating rights and freedom of citizens; ability to think logically and literally, to design; knowledge of regulatory documents, basics of standardization and management methods; to exercise and be guided by the rights and duties during development of social projects; ability to perform production and engineering calculations; knowledge of corporate culture basics, ability for teamwork; personal and social responsibility (Lizunkov & Sushko, 2014), (Loschilova, 2015).

## 2. Subject and methods of research

There is no unified approach to definition of "professional training of mechanical engineering bachelors" in the pedagogy, and it is considered from different aspects both as a stage of personality's professional development, assuming a training process in educational organization; and training as the process of forming preparedness for future tasks completion; as a result of mastering the amount of systemized scientific knowledge and skills, required for completion of set objectives (Lizunkov & Sushko, 2014).

Having based our research on the ideas of the systems, personality-based, activity-based and competency-based approaches, we defined professional training of mechanical engineering bachelors as an integrated dynamic process of developing general cultural and professional competencies of students, based on networking resources, and providing their preparedness for organizational and managerial, research and designing activities, which meet the requirements of social partners in the labor market, and which has a dialectical nature, characterized by orientation to creative self-fulfillment (Loschilova, 2014), (Zamyatina, et al., 2015). Content of professional training of mechanical engineering bachelors is reflected in the Federal state educational standard (FSES, 2009) for higher professional education for the training profile 150700 Mechanical Engineering, in the curriculum, programs of courses, practical training and internships. The training process of mechanical engineering bachelors provides learning of the following cycles: humanities, social and economic; mathematical and natural sciences; professional and the following disciplines: physical education, practical training and internship; and final state certification.

Professional training of mechanical engineering bachelors currently not only requires significant changes of purpose, objectives, content and organizational forms of learning process, but activation of relations of educational organizations with the external environment, based on cooperation with social partners.

The research demonstrated that today the necessity appeared for changing the mechanisms of integration of members of educational, research and production activities.

Revealing of networking potential to a full extent is facilitated by study of foreign experience (Germany, Denmark and the United Kingdom), for which the significant influence of social partners on policy and content of student training is characteristic.

Very high index of young people's employment is noted in Germany that is caused by contemporary social and economic policy of the state, aimed at development and support of small and medium-size enterprises (Vul'fon & Mal'kova, 1996). As Drewek (1994) states, a special role is given to professional education modernization by specialists of various professions.

Wide network of continuous engineering education and continuing professional development was created for employees of various enterprises and companies. The methods of student encouragement, development of self-evaluation and motivation began to apply during the training process. According to Thiess and Gropler (1998), much attention during training was given to development of skills to maintain business relationships with social partners. For provision of youth employment, the state stimulates cooperation of enterprises and companies with educational institutions, which allows combining theoretical training of students with the content of engineering activity that is combination of training with production activity (Voskresenskaya, 2001).

The main role of social partners (trade unions and employers) is expressed in provision of consultations, organization and control of professional education.

In Denmark the component of national policy at labor market is cooperation among social partners, which part consists in development of legislation for labor market (Thiess & Gropler, 1998).

In the United Kingdom there is a special organization of educational process, which is a complex of measures, assuming participation of public, private and volunteer sector organizations, and various partner agreements among institutions. The Sector Skills Councils play the central role in the system of professional education of the United Kingdom, acting as the bodies of social partners interaction, combining interests of industry and education and developing national standards for professions (Drewek, 1994). Within framework of networking among educational institutions, the following cooperation types exist in the UK: consortiums of general education schools (interschool associations); consortiums of schools and colleges; and consortiums of further education colleges (Drewek, 1994), (Parkyn, 1973).

Study of foreign experience allowed stating that a major result of transformation in the Russian engineering universities is creation or significant development of innovative infrastructure by means of various network structures: innovative-engineering centers, technology transfer centers, business incubators, design and engineering bureaus, pilot-scale productions, science parks, research and production complexes, clusters, competence centers, bringing together the high-technology enterprises, research and design organizations, professional education institutions and representing a specific interest for experience transfer during professional training of mechanical engineering bachelors .

The main method of networking interaction of educational organizations and social partners is the social dialogue, which the parties start to reach consensus on the issues of mutual interest (Chuchalin, et al., 2014; Tashchian, 2013).

Analysis of psychological and pedagogical literature, and of foreign experience allowed determining the following capabilities of networking of educational organizations and social partners in production, academic and methodological, research areas of professional activity as the principal, and which were considered during development of professional training model for mechanical engineering bachelors: organization of engineering and industrial internship, graduates employment at the labor market; participation of social partners in development of educational programs, organization of professional skill competitions; provision of access to resources, development of common projects, grants and business incubators (Minin & Lizunkov, 2014; Oleynikova, 2005; Chuchalin, et al., 2014).

While developing the pedagogical model of professional training for mechanical engineering bachelors, based on networking resources, we relied upon that educational process in engineering university assumes accounting of competencies deficit, identified during inquiry of employers, active interaction of participants with external environment, the integration of networking resources of educational organizations and social partners, and cooperation of the participants.

The following stages of professional training are given in the pedagogical model of professional training of mechanical engineering bachelors, based on networking resources: orientation (1st-2nd years of training), activity-based (2nd-3rd years of training), and reflexive (3rd-4th years of training).

We will describe in detail the stages of professional training of mechanical engineering bachelors in the field 15.03.01 Mechanical Engineering, the profile Technology, Equipment and Automation of Machine-Building Enterprises.

Purpose of orientation stage (1st-2nd years of training) is professional self-identification of students and justified choice of profession. Initial level of student preparedness for professional activity was determined at this stage; monitoring of the level of awareness of engineering field choice was done. The result of orientation stage was the developed motives and interest to future profession; understanding of professional activity importance in provision of educational process quality; acquaintance and establishing contacts with social partners, and participation in various events.

Activity-based stage (2nd-3rd years of training) assumed development of experience in professional activity. Development of skills took place during engineering and industrial internship at partner enterprises through participation in creative production activity, professional skill competitions and exhibitions. The result of activity-based stage was acquisition of skills to apply and adapt obtained knowledge by students in the context of future professional activity, and professional competencies development.

The reflexive stage (3rd-4<sup>th</sup> years of training) included determining of the level of student preparedness for professional activity, self-evaluation and expert evaluation of professional activity, analysis and self-analysis of the results. The result of reflexive stage was motivation to perform professional activity; ability to reflect, generalize and translate the experience; ability for evaluation and self-evaluation, given in Table 1.

Table 1. Description of professional training stages for mechanical engineering bachelors.

Name and purpose of stage	Content-related component			Result component
1	2			3
Orientation (1st-2nd years of training) Purpose: Get students acquainted with training process, find out the motives	Define the initial level of students preparedness for professional activity, monitoring of student awareness about personnel requirements in the economy, level of awareness of engineering activity choice, identification of difficulties, motivation for studying, planning of educational process, creation of conditions for professional self-identification by means of various events			Awareness of the essence of training, formed motives and interest to professional activity,
Technological component (forms and methods of interaction with social partners)				
To form the stimuli to engineering profession, understanding of the essence and importance of professional activity.	Production activity	Academic and methodological activity	Research activity	Understanding of professional activity importance in provision of educational process, Acquaintance and establishing contacts with potential employers.
	Career guidance for students in educational organizations; Practice-oriented courses for schoolchildren; Participation in profile education of schoolchildren; Involvement of specialists to development and organization of optional courses; Organization of field trips, workshops, creativity competitions, academic practical training	Following the trajectory of student self-determination; Orientation of educational process in higher institutions to professional career development; Provision of access for students to databases and library	Consulting for main academic profiles; Organization of workshops, seminars and webinars. Cooperative development of topics for yearly papers and projects	
Activity-based (2nd-3rd years of training) Purpose: development of professional activity experience	Development of skills during engineering and industrial internship at the enterprises through participation in creative production activity and professional skill competition.			Skill to apply and adapt the obtained knowledge in the context of future professional activity, development of competencies, ability for self-esteem, cooperation with employers.
Technological component (forms and methods of interaction with social partners)				
	Production activity	Academic and methodological activity	Research activity	
	Organization of professional skill competition; practical training; Involvement of	Cooperative organization of educational process; development and revision of program and academic	Development of researches, research and production association for laboratories creation; Organization of fairs of	

	engineering staff to designing activity of students; Opportunity of employer-sponsored training in educational institutions	documentation; Organization of joint applied science conferences, workshops within conference week program	vacancies and university places; Joint applications to competitions, grants and patents
1		2	3
Reflexive (3rd-4th years of training) Purpose: evaluation of level of student preparedness for professional activity	Evaluation of various achievements of students, related to professional activity; questionnaires of employers about graduates level of training; assistance together with social partners in employment and self-employment, internship, professional re-training via self-evaluation, expert evaluation of professional activity of future engineers, analysis and self-reflection of its results		Motivation to perform professional activity; ability to reflect, generalize and translate experience; ability for evaluation and self-evaluation.
Technological component (forms and methods of interaction with social partners)			
	Production activity	Academic and methodological activity	Research activity
	Organization and support of practical training; Cooperative control of quality and requirements to competencies development; Mentorship; Provision of opportunity for employer-sponsored training in educational institutions; Cooperative organization of graduates employment; Selection of the relevant job from vacancy bank; First workplace provision based on quota; Support of graduates adaptation to labor market; Professional retraining; Monitoring	Organization of topical workshops and round tables together with employers; Implementation of distance learning and active forms of learning in educational process; Representatives in certification committees, committees for consideration of collective disputes	Involvement of experts from major enterprises to information activity; Development of researches

Results of mechanical engineering bachelors training for professional activity were taken into account during production, academic and methodological, and research activities include the following:

- Understanding of essence and importance of professional activity by students
- Demonstration and application of knowledge of legal and social aspects of engineering activity at the enterprise
  - Individual work and teamwork; personal responsibility and managerial skills
  - Development and preparation of design and technological documentation, statement of the results of complex engineering activity, according to regulatory documents
  - Preliminary feasibility study for substantiation of design solutions
  - Participation in innovative projects and patent researches

### 3. Survey results analysis

Analysis of foreign publications allows stating that for Germany, Denmark and the UK a significant influence of social partners on policy and content of student training is typical; networking is a component of the governmental policy in the area of professional education and assumes such forms of interaction as: cooperation of enterprises and educational institutions, consortiums, Sector Skills Councils, etc.

Application of the networking resources potential during professional training of mechanical engineering bachelors facilitates activation of work on attracting talented young people; cooperative analysis of skills requirement to identify the non-conformity between employers' demands and quality of graduates training for labor market; opportunity for employer-sponsored training under contracts; introduction of distance learning elements in the instruction practice; use of materials and equipment (equipment and teaching aids); involvement in the actual innovative activity; information exchange of best experience in solving relevant problems in providing the personnel and researches for economy modernization; improvement of employment system, and expansion of educational programs list.

### 4. Conclusion

Considering all of the above, we note that as a result of implementation of the specified opportunities for networking of educational organizations and social partners, the following is done: effective training of engineering personnel potential; cooperative results in research, engineering and innovative activities.

Implementation of the pedagogical model of future engineers professional training, based on networking, is tested on the basis of Yurga Institute of Technology (affiliate), National Research Tomsk Polytechnic University (UIT TPU), and allowed provision of network resources integration in production, academic and research activities, as well as creating a common information and learning space, organizing the process of personal and professional development of students that facilitates the preparedness of students for professional activity.

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