

O. Popova

## **THE CONTENT OF STRUCTURAL COMPONENTS OF PROFESSIONAL COMPETENCE OF ENGINEERS**

**Statement of the problem.** Today, the higher technical school of Ukraine is on the way to address improving the quality of training of future specialists in the field of engineering. Scientific and technical progress in information technology, in science and technology allows us to solve engineering problems at a new level.

Therefore, the professional activities of the engineer requires the development of future professionals of new knowledge and skills they could use to solve applied problems.

In addition, modern engineering problems associate with energy, environmental, economic and social processes. Solving problems of this class and their implementation should always be evaluated in terms of security for the safety of the environment, society, cultural heritage of society.

Thus, besides the knowledge and skills is necessary to build a future experts identified personal, professional qualities, which are part of the components of professional competence of engineers.

**Relevance.** Problems in the preparation of future engineers, analyzing the components of professional competence, and their formation is engaged in a number of scientists (O. Romanovsky, O. Ponomarev, O. Kovalenko, W. Petruk, O. Ignatyuk, S. Goncharenko, N. Podbutskaya, T. Butenko). In addition, there are many international standards, which describe the specific professional engineer them professionally important qualities, as well as requirements to be satisfied by an expert in the field of engineering.

However, there are a need systematic approaches and opinions on this issue.

**The purposes of the article** is analyzing and classify the main components of the professional competence structure of an engineer.

**The presentation of the basic material.** Mathematical methods and information technology have reached such a high-power development, that now there's the opportunity to apply them in a variety of disciplines, including sciences and humanities. Description and study of social systems is a rather complicated process. Therefore, the complexity of engineering led to a revision of the requirements to the professional qualities of an engineer, as well as the structure of professional competence.

The concept of professional competence of an engineer is primarily associated with his professional activities, problems that he has to overcome. The complexity of modern problems that must be addressed engineer is associated not only with the complexity of the methods of their solutions, but also greater responsibility to society for the implementation of the results of labor. Therefore, the structural components of the professional competence of an engineer should include not only specialized knowledge, skills and personal qualities, which have an engineer should for the readiness and ability to deal effectively with the task to be responsible for the results of its operations.

Over the past ten years, the problems of professional competence of engineers, as well as an analysis of requirements to the professional qualities have been studied by many scientists such as W. Petruk, A. Protasov, T. Butenko, O. Ignatyuk.

We are of the opinion of A. Protasov, who believes that the engineer's professional competence is a complex structure, based on the cognitive component of education, experience, and also on the ability of engineers to anticipate social consequences of its activities to the public. The scientist allocates six basic components of professional competence are the following:

1. Knowledge and skills related to professional activities;
2. Cognitive component, which includes the ability to acquire new knowledge, develop new technologies, the ability to use information resources and learning;
3. Creative component, which is based on the ability of specialists to find new solutions to professional problems;
4. Communicative component - the possession of native and foreign languages, the use of the conceptual apparatus and vocabulary of basic sciences, the ability to lead a discussion;
5. Social and humanitarian component, which is based on the possession of the means of technical, economic, environmental and predictive analysis of the production to its humanization and rationalization;
6. Personal component that is based on such qualities as responsibility, commitment, determination, insistence [4, 5].

W. Petruk, considering the question of professional competence of future professionals of technical specialties, provides the following professional specialist as significant as responsibility, self-control and professional self-esteem.

We believe that these qualities must be added to the personal component of the above structure of the professional competence of engineers [6, s.186].

In addition to the many scientists, engineers, training issues involved in many international organizations such as: The Engineering Council on behalf of the United Kingdom engineering profession, International Engineering Alliance (Washington Accord, Sydney Accord, Dublin Accord), Assessment of Qualifications and Competencies), that produce the appropriate standards (IEA, Australian Engineering Competency Standards, UK-SPEC) [1, 2, 3].

In contrast to the reasons of scientists, Australian Engineering Competency Standards identifies fourteen key elements of professional competence of an engineer. The most important of them, in our opinion, are the following [2].

The first component includes the availability of engineering knowledge and understanding of the profession in the field of engineering and practical skills in professional activities.

The second component includes the ability to use specialist professional activities in accordance with codes, standards and specifications that comply with environmental aspects.

The next component is based on specialist skills to select and use diagnostic methods and analysis tools for investigating problems as well as the ability to use scientific, technical and engineering principles to solve professional problems.

Professional competence engineer must also include a component that reflects the design activity specialist. This component includes knowledge and skills to design, develop, manufacture, commissioning and maintenance of engineering.

In that standard is also given to the ability to engineer to evaluate the results and implications of engineering. Therefore, future specialist must think about these issues, be able

to determine discrepancies draw conclusions, eliminate errors, to make qualified statements about development.

The standard also states that engineering solutions should not only not harm the environment, health, safety and welfare of society, but also be sensitive to the problems of the public. Therefore, an expert in the field of engineering should implement the results of its activities primarily take into account economic, environmental and social consequences.

Thus, the engineer aims to deliver outcomes that do not compromise the ability of future life to enjoy the same or better environment, health, wellbeing and safety as currently enjoyed. He must:

- inform employers or clients of the likely consequences of proposed activities on the community and the environment;
- promote the involvement of all stakeholders and the community in decisions and processes that may impact upon them and the environment.

Next component of professional engineering competence is demonstration ethical reflection. The engineer have to:

- demonstrate an understanding of the ethical issues associated with area of operation;
- demonstrate an understanding of how these issues are managed collectively by the organization, project or team;
- demonstrate an ability to identify ethical issues when they arise, and to act appropriately.

Significant place in the structure of professional competence engineer is given experience and skills necessary to manage the process of solving professional problems. The engineer have to:

- use basic engineering science to achieve a sustainable solution;
- recognize the limits of personal and team knowledge, skills and competence;
- recognize wide-ranging, possibly ill-defined risk factors;
- utilize strategies to manage client relationships;
- apply the benefits of continuous technical change;
- cultivate an attitude of engineering innovation and creativity;
- secure the necessary intellectual property rights;
- demonstrate a clear understanding of the interrelationships between all parties to an engineering activity.

Therefore, analyzing research papers in the area of professional competence of an engineer, and developed international standards, we have identified the following key components of professional competence. We believe that the engineer's professional competence can be represented in the form of three interrelated structural components (theoretical, practical and personal.)

The theoretical component of the professional competence of an engineer is a set of professional skills necessary for the engineer of his success. These include:

1. Knowledge of mathematics, science and technology in line with a major engineering;
2. Applied knowledge of processes, systems, methods used to solve complex engineering problems;
3. Knowledge that are associated with the organization of work.

In addition to the theoretical component of the professional competence of an engineer an important place in its structure is a practical component that is associated with the skills and abilities to perform professional engineering work.

The basic skills and abilities, which an engineer should have, should be attributed as follows:

1. The ability to search for the problem of the study;
2. Ability to analyze an engineering problem;
3. Ability to justify the selection of analytical methods;
4. Ability to draw conclusions consistent with the objectives;
5. Ability to use modern information technologies in the field of engineering;
6. Skills to carry out forecasting and modeling of complex processes;
7. Skills to evaluate performance under conditions of uncertainty.

Modern engineering problems are so complex that they are very difficult to deal with one person. Therefore, over the majority of practical engineering problems the whole team is working.

Speaking of the team, it is important to note that each member should be able to organize the work of other professionals, to be a member of the team, to take his place and carry out his duties. Leadership qualities are high among the professionally significant qualities of an engineer [7]. The specialist must possess management principles. He must be able to apply them in their work, be able to manage projects.

For effective team work is essential that every engineer had the communication skills, and abilities [8]. The specialist should be able to communicate in a team of colleagues to prove their point of view, to discuss methods of solving problems. In addition, it is important not only to be able to solve the problem, but also to prepare documentation, reports, to make an effective presentation development, to give and receive clear instructions at every stage of the solution. Thus, communication and management skills should be incorporated into the structure of the practical component of professional competence in mathematical modeling.

Important role in achieving quality results are relations in the team of specialists. Possession of engineer's ethical principles, professional ethics, as well as qualities such as mutual respect and tolerance increase the efficiency of a team of specialists. We consider it necessary to include these features in the structure of the personal component of professional competence of an engineer.

Most attention is paid to international standards of safety performance of the implementation of an engineer. Therefore, the engineer must be inherent in such important personal qualities of both humanity and responsibility. When choosing an applied problem solving engineer must, above all, to take into account security issues and the development of future results of operations for the population (environmental, cultural, legal and social aspects).

In order to become a high-level specialist a person should aim to improve his knowledge and skills during the whole life. Therefore, the engineer must be capable of independent and lifelong learning. The more that technology in the field of engineering is constantly improved and the complexity of applications is constantly growing. Thus, the structure of the personal component must also include the person's ability for self-learning and self-development, self-reliance.

**Conclusion:** After analyzing the work of scientists and the development of international standards for the training of engineers should be allocated to these components: theoretical, practical and personal. For the theoretical component should include expertise in engineering, mathematics, and methods for solving applied problems.

Under the practical component we understand the ability to apply analytical and information technologies, skills and experience of systems analysis, communication and leadership skills.

The personal component involves the possession of professional ethics as an engineer, as well as the presence of such qualities as responsibility, tolerance, independence, humanity, ability for self-learning and self-improvement throughout their lives.

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О.В. Попова

### **ЗМІСТ СТРУКТУРНИХ КОМПОНЕНТІВ ПРОФЕСІЙНОЇ КОМПЕТЕНТНОСТІ ІНЖЕНЕРІВ**

У статті проаналізовано зміст основних компонентів професійної компетентності інженера відповідно до його професійної діяльності. Також проаналізовано праці науковців та міжнародні стандарти щодо структури професійної компетентності інженера. Виявлено найбільш важливі професійні якості, що характерні для майбутніх інженерів.

*Ключові слова:* компетентність, професійна компетентність, інженер, професійна компетентність інженера.

Е.В. Попова

### **СОДЕРЖАНИЕ СТРУКТУРНЫХ КОМПОНЕНТОВ ПРОФЕССИОНАЛЬНОЙ КОМПЕТЕНТНОСТИ ИНЖЕНЕРОВ**

В статье проанализировано содержание основных компонентов профессиональной компетентности инженера в соответствии с его профессиональной деятельностью. Также проанализированы научные труды и международные стандарты профессиональной компетентности инженера. Выявлены наиболее важные профессиональные качества, характерные для будущих инженеров.

*Ключевые слова:* компетентность, профессиональная компетентность, инженер, профессиональная компетентность инженера.

*Стаття надійшла до редакційної колегії 26.05.2012*