

Preparation of Technical University Students for Professional Design

Raisa Moradovna Petruneva and Valentina Dmitrievna Vasilyeva

Volgograd State Technical University, Volgograd, Russia

Abstract: The article is devoted to the issues of theoretic and process support needed to form project culture of the future engineers in conditions of modern higher school with the use of socio-humanitarian expert appraisal of engineering and design solutions in the process of instructional design. Proposed technology of completing instructional engineering projects side by side with traditional stages which reflect the structure of real engineering projects isomorphically includes socio-humanitarian expert appraisal of engineering solutions. Implementation of proposed instructional technology allows to train today's bachelors and masters for humanitarian-oriented professional activity of machinery and technologies' designer.

Key words: Engineering design activity • Project culture of an engineer • Instructional engineering design • engineering design solution • Socio-humanitarian expert appraisal

INTRODUCTION

During last decade our society faced the problems connected with negative influence of the products of engineering activity on man's health and environment. Today progressive and safe development of society depends on how engineering design activity corresponds to criteria of social and ecological appropriateness, structural and ethical compatibility of machinery and technologies with human values' system [1-5]. This leads to the necessity of inculcation of project culture in future engineers (still at the stage of their training), adequate to modern socio-cultural situation and providing humanitarian orientation in their professional design activity.

If we consider project culture of an engineer as obligatory result of his professional training and his professional and personal feature we can imagine the contents of project culture as combination of the following groups of competences: [6] professional knowledge in the sphere of machinery and technologies and other adjacent sciences, which must be applied in the process of engineering design; functional skills and abilities of designing based on modern ways and means of designing; creative ability of an engineer to generate creative solutions to engineering design tasks, to use

innovative approaches in practical designing; moral-axiological which includes recognition of social significance and the role of project culture in professional activity, being highly motivated for its successful realization; readiness to forecast and assess oncoming social and humanitarian consequences of realized project solutions in different levels, bear moral and other responsibility for the effects of implementation of new machinery and technologies design's results.

To solve the task of reformation of engineering education including its humanitarization, a number of international projects has been already initiated (World initiative CDIO) [7]. An important step in direction to modernization of engineering education is joining of the Association of engineering education of Russia (AEER) to APEC Engineer Register as associative member of Washington agreement. This allowed to assign Russian specialists in technical sphere and technologies of the APEC with engineer rank. In accordance with APEC Engineer Manual the rank "APEC engineer" is granted to those engineers who successfully passed all examination tests and correspond to a specific set of criteria, including the Code of professional ethics of engineer in accordance with which APEC engineer has to "be responsible for fulfillment of his commitments, realization of his ideas and effects of his engineering activity" [8].

Proposed interpretation of project culture of an engineer also fully corresponds to ideology of International Engineering Alliance (IEA) [9] which declares, as the most important attributes of complex engineering activity (especially in the part of axiological mind-sets of specialist-designer), such competencies as ability “to make contextually reasoned complex solutions taking into consideration social, cultural, law aspects and the health and safety rules and bear responsibility for the consequences of professional activity; follow the principles of professional ethics and the standards and rules of performing complex engineering activity” [10].

Thus, it not by chance that today all interested organizations are striving to learn about the most successful and interesting practices of engineers’ training.

Modern engineer must act in the conditions of non-full or insufficient project data, in restrictions determined by socio-humanitarian consequences of his technical solutions. And taking into consideration the fact that now technical universities have only 4 years to train a specialist (so called applied Bachelor’s degree) a question is raised how to infuse future specialist, within very short term, with all mentioned in the APEC Code of engineering ethics characteristics on high or even satisfactory level. In order to do that special conditions must be formed - pedagogical preconditions for formation of moral and axiological competences in the process of studying activity.

To obtain valuable experience of practical solution of tasks and in the same time understanding their socio-humanitarian essence, to form project culture of future engineering is possible only in the process of practical use of obtained socio-humanitarian knowledge in instructional quasi-professional activity. In this regard such a kind of studies as instructional engineering design (which in fact is an integrating foundation of the instructional quasi-professional activity) has great potential.

Best practices of leading universities of the world which offer educational programs in the sphere of machinery and technologies [7, 11] demonstrate that engineering design is a key discipline in the university's curriculum and an important stage of training a specialist. Though there is great diversity in applied programs of engineering training, instructional engineering design can be described as a self-organized independent work performed by students which must be carried out under supervision of a coordinator or a Project manager. Practice

of a number of North-American universities (MIT, Olin College and others) shows that even the 1 project can be done by several student research groups.

In Russia independent working out by a student of instructional engineering project is most often individual work. Such a project done under supervision of a teacher can not get a young specialist higher than beginners' qualification level, because at the beginning of his engineering career he is not entitled to make final technical decisions because he is guided by a more experienced “colleague”. In order to integrate the obtained knowledge, instructional engineering tasks and real engineering projects students’ independent instructional activity in the process of fulfillment of instructional engineering projects must be updated and been considered at a new angle.

Today the order of performing instructional inter-disciplinary project at Russian technical universities at the end of each year and before graduation stimulates a real process of engineering design of technical objects. As a rule it suggests a number of project operations to be done by students - from getting preliminary task to design a technical facility to the defense of the project. The key stage of design process is a stage of analysis and selection of a new solution to the project. Obligatory element of this stage is pro-active analysis and forecasting risks/dangers for a man and mankind, related with production, operation and disposal of designed technical object. Such forecasting is impossible without attraction of poly-disciplinary knowledge. This was well-known at the beginning of XX century, when they did know yet that mankind is standing at the threshold of scientific and technical revolution and information era, by a famous Russian engineer and philosopher P. Engelmeier [1]. He believed that an engineer in order to understand the essence of his invention needs to look at his "child" from eagle’s fly height, to brainstorm adjacent disciplines. Because of restricted character of his education any specialist can not make unbiased conclusion by himself (on his own) about results of his creative work and assess them adequately.

This situation can be solved by engagement of the experts from other (non-engineering) spheres of activity into the process of engineering design at the stage of analysis and selection of design solution. Adding elements of grouped poly-disciplinary expert work to the practice of implementation of instructional engineering projects allows to change the quality of projects greatly, for student it will be possible to obtain new expertise and

actuate already obtained professional knowledge and skills in practice, to engage creativity in search for project solution, as well as to apply his own inter-personal features, to form ability to forecast the influence of the results of project implementation on the global and local processes in nature, society, life of every person. This fully corresponds to requirements of IEA Graduate Attributes and Professional Competences in accordance with which an engineer must be able to act not only individually but in the team as well, be ready to manage inter-disciplinary projects applying principles of modern management and communicating efficiently on all professional levels [10].

In reality this work in the form of expert council (consensus) can be organized in the process of realization of the project in the following way: [12]

Student-designer gets a task for designing work and develop input data in order to choose the way how to reach the goal formulated in the project. Using his knowledge in the sphere of socio-humanitarian sciences and personal experience, designer forms hypothesis about which social and humanitarian consequences will take place after realization of proposed by him technical solution of the problem. On this base he forms a list of alternatives which must be studied. In order to do that, after agreement with his consultant (adviser) on the project, he forms a group of experts. Every expert has to study one alternative in detail and give his own scientifically grounded resolution. The group of experts consists of the similar student-designers. Every of them can be an one-problem expert for his mates. Proposed project solution is discussed by experts' council. The moderator is the teacher because he has enough knowledge and experience for it. Experts' council decides to which social and humanitarian consequences of different scale the realization of the proposed technical solution will lead and either will recommend it for further implementation or declare that other technical solution of the problem must be looked for.

In general expert appraisal of engineering design solutions, as a instructional technology, must be based on the following principles: collective discussion of the results of implementation of new technical solution; pedagogical follow-up (teacher-consultant acts as a moderator of discussion process); poly-discipline character (while discussing project every of its participators must act as an expert in some engineering area); all participators take part in the activity on free-will

basis (the author of instructional engineering project invites fellow-students as he wishes and with their consent); problem character of discussion (moderator sets specific questions before experts to which they must answer in full); freedom of expression of thoughts (the most extravagant versions can be discussed because the improbable today will become quite probable tomorrow; scientific reasoning and giving proofs (every expert must give his summary mentioning scientific or other sources which prove his opinion; necessity to arrive to common agreement (discussion will last until all experts and moderator has arrived to common opinion - either about rejection of the proposed solution or recommendation to implement it); drawing protocol is an obligatory procedure of the expert appraisal; discrete character and extension of the procedure in time (discussion can be held at several meetings depending on the complexity of the problem in question).

Such method of preparation of instructional engineering projects at present time is not viewed by us as utopia because for implementation of such technology objective conditions exist. Firstly, the society has already realized the necessity of creation of safe industrial projects (machinery and technologies). Secondly, in some countries state institutions have been operating which perform complex, including socio-humanitarian expert appraisal of technical facilities (in the USA, Germany). We hope that in nearest future all objects of innovation engineering design activity will pass such expert appraisal, partially or completely.

Criteria of completeness of project culture can be as follows:

- Fullness and wideness of the coverage of engineering design problem, innovations in applied technical approaches and solutions, finding out the effects which result from the realization of project solution (including socio-humanitarian ones), forecasting of technogenic situation as a result of project implementation. Evaluation must be done only by experts - public defense of instructional engineering project in front of certification commission of specialists representing the company-customer, scientists on this profile and humanitarians, public representatives (for example, of Public Chamber, professional unions, social movements and organizations, representatives of religious associations etc.).

Modeling in the process of socio-humanitarian expert appraisal of new engineering design solutions, inclusion it into contents of instructional activity will be in our opinion the key link which will connect socio-humanitarian and professional knowledge of future engineers into integral construct, will give students precious experience of immersion into quasi-professional situation which facilitates reinforcement of moral foundations for making technical solutions and performing civil acts. The main accent in this process is not on the contents of studies but on the result of educational activity - what was finally implemented by the student. Participation in quasi-professional expert appraisal will allow the student-designer to more fully understand essence of his activity, experts will be able to explore new areas of knowledge, adjacent to their future profession and all participators in the expert council will obtain experience of man-oriented engineering design activity. Use of the results of the study in preparation of future specialists of engineering profile will allow to reduce technogenic and socio-humanitarian risks which result from implementation of engineering projects, both locally and globally.

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