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SYSTEM APPROACH TO DESIGN OF CIVIL ENGINEERING UNDERGRADUATE PROGRAM

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Abstract: The article considers the system approach to design of Civil Engineering Undergraduate Program. At the present stage of society development, the object of engineer's professional activities has changed from a separate technical unit to a complex human-machine system. The connection between technical parameters of engineering objects and socio-psychological characteristics of their users is manifested in socio-technical approach to engineering system design. The authors assume that integrating psychological and pedagogical modules with engineering training in the first cycle of higher education contributes to this approach. At the same time, the content of such modules must have certain specifics. The module "Psychology and Pedagogy of Higher Education" includes project-based activities, such as system design of the educational process through its modeling. The main goal of learning is the creation of an interdisciplinary system of socially oriented information, serving as a tool for the implementation of engineering activities.

There is no doubt that a key task of a technical university lecturer is to develop students' engineering thinking, which is an integral attribute of professional activities of an engineer.

The work of an engineer as a category demands rethinking and clarification. It usually involves creation of artificial technical systems on the basis of complex application of integrated scientific knowledge. The present

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stage of development of engineering is based on the system approach to technical tasks solution taking into account the convergence of human knowledge to the sphere of scientific and technical progress.

By the beginning of the 20th century, the profession of an engineer had involved implementation of the whole complex of different types of professional activities: design, construction, technology, invention, etc. By the end of the 20th century, it had become obvious that both the object of engineer's professional activities was no longer a separate technical device, but a complex human-machine system. Thus the work of an engineer has become considerably complicated and the list of functions performed by engineers has extended. For example, today there is a pressing need for technical experts who can run the manufacturing process and, at the same time be able to organize and manage the project, and create an effective team for project implementation. The work of an engineer is increasingly influenced by a human factor. The connection between technical parameters of engineering objects and socio-psychological characteristics of their users is reflected in socio-technical approach to engineering system design.

Psychological and pedagogical modules are added timely to the undergraduate engineering programs. This is confirmed by positive response of higher educational institutions faculty. However, not all teachers are aware of the methodological role of these courses. While searching for solutions to complex engineering tasks one can apply methods or fundamental knowledge from the general psychology and didactics. Some tasks require a combination of approaches, principles and ideas of different sciences which can not be related to each other. For example, the course "Psychology and Pedagogy of Higher Education" can help to overcome dissociation of separate sciences, to give justification of coordination and interconnection of scientific research principles and to emphasize the unity of methodological bases of various areas of human knowledge.

The content of the course must have certain specifics, which deserve particular methodological analysis. It is obvious that system approach shows the interdisciplinary nature of engineering activities and teaches how to think widely and systemically. One of the effective methods is to teach students the system design of the educational process through its modeling, i.e. design activity. Such an approach allows students "to experience" the internal logic of the training process, to develop all-educational skills, to understand the mechanism of information implementation in the existing individual knowledge system and to realize interdisciplinary nature and systematic character of the information mastered in the course of training. The knowledge of methods of pedagogical systems design will help future technical professionals to organize the process of staff training competently if needed, and give a powerful stimulus for further self-education that will eventually promote personal development.

It is known that the structure of any initial pedagogical system can be presented in the form of "the interconnected set of invariant elements" [1] including: the course objective, teaching content, teaching methods and tools, a student and a teacher. It is necessary to emphasize that due to the systematic

character of these elements they are not only interconnected but also interdependent. The course objective is primary in relation to other components and its influence and impact on other elements of the system is obvious.

What is the objective of the course "Psychology and Pedagogy of Higher Education"? Each teacher will answer this question individually taking into account the understanding of the tasks. The appropriate formulation of the course objective substantially contributes to the effectiveness of the process.

In our opinion, one of the strategic objectives of learning is creation of an interdisciplinary system of socially oriented information acting as a tool of engineering activities. Interdisciplinary knowledge is successfully integrated with technical training when a student performs gnostic, design, problem-solving, communicative, socio-psychological and administrative kinds of activities. Through modeling and design of the pedagogical process, students successfully perform these kinds of activities.

The selection of the learning content is aligned with the course objectives. The sources of information for the selection of the learning content are:

– choosing one or several theoretical approaches to selection of the content (the theory of didactic materialism, didactic formalism, didactic utilitarianism, etc.);

– analysis of the professional activities;

– identification of the structure of professional skills to ensure effective implementation of professional functions;

– identification of the theoretical knowledge system providing fundamental and methodological training and practical knowledge, which make up the information basis of professional skills [2].

The choice of learning content is influenced significantly by teaching methods and tools, which are in turn substantially influenced by engineering content due to systematical character of the process. The variety and specifics of methods and tutorials applied in technical university are necessitated by:

– the need to develop engineering thinking;

– the creation of prerequisites for students' continuous self-development;

– increase in labor market competitiveness.

Informational and algorithmic methods of teaching that are acceptable only in the initial stages do not fit for the purposes mentioned. Problem-based training, cooperative learning, project-based teaching, use of information technologies in training, etc. are the priority pedagogical technologies which are adequate to learning objectives.

Despite some inertness of the higher education system (in our opinion, this cannot be regarded as unambiguously negative phenomenon) manifested in traditional character of the educational process, there are new innovative approaches to meet the modern requirements. In particular, there is a positive experience of using a combination of classes in engineering courses. A combination of lectures and practical classes, lectures and seminars, laboratory and interdisciplinary classes increases the efficiency of the educational process through students' individual work, general development and their creative potential improvement. These forms most fully satisfy the pressing need

for effective use of the professionally centered interdisciplinary information system that is one of the main conditions of effective engineering training.

As far as the change of one component in the system generates changes of its other components and of the system in general, the result substantially depends on the success of stage-by-stage implementation of design activities aimed at teaching the designing process.

In our opinion, the technology of educational program in project design includes three main stages [3]:

1) the first (strategic) stage involves the designing strategy for creation and implementation of the project through consecutive procedures aimed at:

– the preliminary formulation of strategic objectives, concept and mission of the educational system taking into account complex educational system diagnostics and assessment of its innovative potential;

– analysis of the educational field and identification of the key problems;

– assessment and distribution of available resources;

– finding ways of solving problems;

– definition, study and defense of prime projects;

– choosing the final strategy;

2) the second (organizational) stage includes:

– development of a business plan with detailed analysis of the situation, technological, organizational and financial plan of action, marketing actions, possible risks in the project implementation, etc.;

– organisation of design;

– social design given the consequences of the project implementation and its public importance at macro-, meso- and micro levels;

3) the third (adaptation) stage involves:

– specification of methods used in the course of pedagogical design;

– identification of the actions for the pedagogical project implementation;

– development of an algorithm of practical actions to introduce the project in teaching practice;

– development of measures for effectiveness of solutions and quality assessment.

Thus, training of engineering students in the educational process system design using design methods is one of the essential conditions of engineering training for effective professional performance.

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Системное конструирование подготовки бакалавров по направлению «Строительство»

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Ключевые слова: инженерное мышление; междисциплинарные знания; профессиональная деятельность инженера; системное конструирование учебного процесса.

Аннотация: Рассмотрены вопросы системного конструирования процесса подготовки бакалавров по направлению «Строительство». На современном этапе развития общества существенно изменился объект профессиональной деятельности инженера, в роли которого вместо отдельного технического устройства стала выступать сложная человекомашинная система. Связь между техническими параметрами инженерных объектов и социально-психологическими характеристиками пользователя нашла отражение в социотехническом подходе к проектированию инженерных систем. Включение в учебные планы бакалавров по направлению «Строительство» психолого-педагогических дисциплин способствует реалиизации данного подхода. При этом внутренняя организация знаний в дисциплинах такого рода должна обладать определенной спецификой. Одним из эффективных приемов выступает обучение студентов в рамках дисциплины «Психология и педагогика высшей школы» системному конструированию учебного процесса на основе его моделирования, то есть проектной деятельности. Основной целью обучения при этом является формирование междисциплинарной системы социально ориентированной информации, выступающей в роли инструмента осуществления инженерных видов деятельности.
