Тітова О.А. Implementation of design process into engineering education. *Проблеми підготовки фахівців – аграріїв у навчальних закладах вищої та професійної освіти*: збірник наук. працьІІ Міжнар. наук.-метод.конф.26-27 квітн. 2018 р. (ПДАТУ, м. Кам'янець-Подільський). Тернопіль : Крок, 2018. 101-103

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IMPLEMENTATION OF DESIGN PROCESS INTO ENGINEERING EDUCATION

Food security of any country as well as economic, environmental and power one relies significantly on agricultural engineering and technologies. In this respect, one of the main strategic objectives for engineering education is to create favourable conditions for training competent experts. As for Ukraine, it is obvious, that Ukrainian agricultural and rural development will require training and employment of highly skilled engineers. So agricultural engineering is not going to lose its value.

To organize an efficient educational process universities and teachers must realize all the specifics of agricultural engineering. The first characteristic of an engineer's activity is the ability to identify the necessity to improve a technical object for the time it is being designed, since technologies change dramatically fast. Nowadays, advanced agricultural machinery goes out of date almost immediately. The ways how to deal with the situation include wide application of innovative approaches both in engineering teaching and engineering activity as well.

The second specific considers the idea that the objects, which agroengineers deal with, are becoming more and more sophisticated. Thus, it is quite difficult to predict all the features of the objects' operation as well as their influence on the environment (land, water, air, crops, animals, people, etc.). Still an engineer must be able to analyze and foresee every 'sunny-day' and 'rainy-day' scenario in the "human – technical object – environment – society" system when new farm machinery is being set to the function.

The third feature relates the problem of utilization, elimination or recycling of production residue and it is becoming a separate research subject, which requires the production and application of materials capable for recycling.

Since the production is going on to be challenging, an engineer has to be able to react those challenges quickly and efficiently. The question of essential skills is regularly touched at different levels. This year (2018) it caused 'hot discussions' at World Economic Forum in Davos. The 'Top 10 skills' list has been refreshed. Such skills as *Complex Problem Solving, Critical Thinking and Creativity* occupy three leading positions. The experts [1] emphasize that the *Creativity* skill has rocketed from the 10^{th} position up to the 3^{rd}. It can be explained by the fact that all the processes around a human (production, service, education etc.) are becoming more complicated and require non-standard approaches. Moreover, nowadays any data are relatively available, so society needs an expert who is able to create an unconventional solution rather than one who knows just what a searching engine can find easily.

Widely available knowledge has provided the need to foster *Critical Thinking Skills* which enable to analyze, choose and process information effectively.

Complex Problem Solving remains the most needed skill in any sphere. For the educators, this means that the student has to be taught how to deal with the problem at university starting from the first year. That is why problem / project based learning is becoming indispensable.

One of the ways to realize innovations in engineering is a standard process which engineers utilize to arrive at design solutions. It is called 'Evolutional Systematic Design' [2, p. 26-27], 'Engineering Design Process' [3], 'Product Design Process', etc. It is vitally important because design is a direct engineering task. The fact is that all the approaches and methods, which provide the process, have to be learnt by future engineers during first university years. In this respect, the tasks, that engineering students deal with, must have problematic nature. Moreover, the problems must be identified by students and decided using a variety of the innovative methods.

An engineer starts the design process when he can identify a need of the customer who will benefit the solution. The first step is *defining* the problem. At this stage an engineer cooperates with the customer closely. Asking as many questions as possible, the engineer tends to find the root of the problem, define the goals to be achieved and identify the specific 'needs' and 'wants' of the customer. Those needs make up the requirements that the solution must fulfill. The 'wants' form criteria which will measure the success of the solution.

The next step is *researching*. It enables to understand the problem deeply and to confirm that it was defined correctly and the engineer has right goals. Research also includes studying existing solutions and evaluating their advantages and disadvantages.

The following step is *creating* different options that may be used to solve the problem. The main goal is to generate a huge amount of ideas. Any brainstorming technique (Mind Map, SWOT Analysis, SCAMPER or Random Stimulus) is encouraged. At these stage students need to realize that the more options they can produce, the better solution they can provide. All the ideas, even if some look absolutely unreal, are important. Then the criteria, which are defined in advance, are used to make an informed decision (choice of the best solution among created ones).

Modeling continues the process. Engineers usually apply mathematical or computational models, so that it could be possible to perform analysis and predict possible limitations, or disadvantages, or faults. Moreover, 3D computer models can visualize the solution. That is necessary for the other engineers in a team as well as for the investor and the customer.

Finally, the solution / design is *produced* and *tested*. It must meet the design requirements and criteria. This stage is often followed by *improving.* This means that the process may be repeated. Actually, the design process offers just a general outline and the steps are not meant to be strictly followed. The outline is flexible, because the process is non-linear and iterative. So, every step could be repeated or revisited any time [3].

To sum up, it is necessary to highlight that engineering is associated with innovations nowadays. This means an engineer has to own a set of specific skills (Complex Problem Solving, Critical Thinking and Creativity are among the most needed) to provide innovative approaches for nonconventional solutions. The main task of engineering schools is to engage students into innovative problem solving. That will help students obtain skills of problem definition, brainstorming and informed decision making, modeling and realizing the solution.

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