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ANALYSIS OF ENGINEERING PROFESSIONAL ACTIVITY UNDER DEVELOPMENT OF AGRARIAN PRODUCTION COMPLEX

The article presents analysis of the point and the character of engineering activity under innovative development of agrarian production complex. Engineering creative work is considered by means of integrated approach. A creative component of innovative engineering activity has been emphasized.

Key words: engineering, engineering creative work, engineering thinking, creative potential, innovation.

Introduction. Development of agricultural engineering and technologies determines food, economic, environmental and power security of any country. One of the main strategic objectives for Ukraine is to create favourable social and economic conditions for development of Ukrainian agricultural production sector. The key tasks within this field have been defined at the national and local levels [5] and presented in a number of State Policy Documents, such as the Law of Ukraine "On State Support of Ukraine's Agricultural Sector", Support programs for Rural Development (Programme of the Ukrainian Rural Development until 2020, Rural Development Concept Paper), National Project "The grain of Ukraine" and others.

The current social and economic situation in the country requires innovative approaches to development of Ukrainian agriculture. The above mentioned documents formulate the major problems and visions for agrarian policy formulation as well as the key measures for their implementation. Firstly, the measures include practical application of research and technological development, introduction of world integrated agricultural engineering branch and investing in innovation in production of agricultural equipment (modern combine harvesters, tractors) [5]. Secondly, it is necessary to solve such problems as production of renewable materials from agriculture and forestry, their use for energy generation and development of bioenergy production on farms. Thirdly, the support programs envisage creation of a marketing information system to monitor wholesale markets for agricultural products

and application of logistic infrastructure for agricultural product markets. Finally, the strategic steps comprise establishing of partner relationship between agricultural producers, government and researchers in the field of technical and technological development. At regional level collaboration between agricultural producers and scientific institutions in agricultural engineering is being arranged for improvement of existing irrigation systems applying water and power saving technologies [6].

Thus, there is a reasonable long-term prospect that the process of Ukrainian agricultural and rural development will require training and employment of highly skilled specialists, so, engineering does not lose its value. On the contrary, it is assuming ever greater importance recently.

Review of the Literature. Engineering activity is considered to be the complex phenomenon related to general science. There is a vast amount of interdisciplinary studies devoted to it. The philosophical approach to the problem of engineering activity is based on the study of relationship between human and machinery as well as impact, which engineering exerts on society and environment (V. Hororokhov, A. Huning, Ye. Shapovalov and others). Engineering activity is also studied form the point of social and economical reforms (I. Mangutov, A. Pavlova). Social and philosophical sides (by T. Baklanova) as well as sociocultural ones (by A. Sedov) are under consideration too. V. Moliako, S. Rubinstein, M. Yaroshevskiy and other researchers deal with psychological aspect of the issue. They investigate the background of engineering activity and creative process.

A number of studies are devoted to formation and development of engineering during different periods of history. The authors highlight that at the present stage an engineer combines abilities of a scientist, a designer and a manager. That means society does not need just a technical specialist, who is able to solve narrow professional questions. The specialist must be highly qualified. His mission is to join experts from different fields and to provide integrated solution of unconventional tasks connected with environment and social communities.

In this respect ***the aim*** of our work was to widen current knowledge of core activities in engineering and their character. In this context we re-examine the activity

of agricultural engineer. We hope this allows to show contradictions between training requirements to engineering graduates from agrarian universities and their preparedness to embody professional activity under conditions of innovative development of agrarian production

Methods. More recent evidence [2, 8, 12] shows that engineering activity has definite characteristics in the modern period of economical, technical and technological development. The first characteristic is the ability to predict the modification of a new technical object for the time it is being designed, as far as technologies change so quickly and even advanced technique goes out of date too fast. Our conclusions on the item follow what is indicated by L. Hur'e in [2, p. 26-27], where the author named the phenomenon "evolutional systematic design".

The second characteristic is connected with the fact that the objects, which engineers deal with, have become extremely sophisticated. That means it is impossible to foresee all the features and parameters of the objects operation in the "human – technical object – environment – society" system. In this respect it is necessary to support the setup process of the new technical object for the purpose of its proper functioning adjustment.

The third feature shows that nowadays an engineer works under the conditions when the problem of utilization, elimination or recycling (the reuse of production residue) is becoming a separate research subject. This requires the use of materials, which are capable for being recycled.

It is obvious that the problems an engineer deals with are closely related to social ones. On the one part, an engineer significantly impacts on society during his work. On the other part, his activity is determined by a number of social factors such as economical, political, ethical and others. Thereby, in the modern period of machinery and information development, on the one hand, engineering work is becoming more full-scale. The subject of engineering research requires complex activity approach as well as integration of different fields of knowledge and various experts around one specified problem area. On the other hand, society and the government are of primary

importance when they support innovation processes in State Policy and bear responsibility for the producing of highly skilled engineers [7].

According to UNESCO Report engineering relates to pure and applied science, creativity and technology [8, c. 65]. At the present stage engineering creativity is becoming significantly important. Scientists study innovation and creative aspects of engineering activity. It is obvious, that engineering is connected with science in both developed industrial and information society and an engineer plays the role of a connector which puts science and technique together. Moreover, an engineer is a subject of scientific and technical creativity. The purpose of that specific activity is creation of novelty on the way from idea to production based on theory and practice.

The problem of creativity in engineering are widely studied, nevertheless, as far as we know, at the present time there is no a single approach to its interpretation. There is a general understanding, that creativity (whatever meaning scientists attach to it) is the ability of combining common or novel things (concepts, methods, devices) in unconventional ways. Many experts [3, 9, 10, 12] now claim that modern production demand engineer with developed skills of creative activity, because most engineering projects have high level of uncertainty and risk. In addition some problems are “overdefined”, and most are “underdefined”.

R. Felder [9] focuses on the fact that new generation of engineers have to combine at least three main abilities. Firstly, it is an ability to use creative approach for problem solving. Secondly, he points out an ability to follow the idea up to the final stage. Finally, an engineer must be able to decide, if the solution is good or not. The fact is that the job of a typical engineer, his practice, in consequence, engineering education deal with the problems which require convergent thinking skills (searching for a single true solution). However, engineers face rather difficult production and technological tasks. In fact an expert with convergent thinking will, probably use conventional approach. When common instructions are useless he will not be able to offer innovative solution. At the same time “the divergent thinker” may produce a number of ideas, which could also be useless if the expert is not able to analyse and assess them.

The author claims, that an engineer has to be ready to professional reality, when some tasks may not have a single solution or at a definite stage some tasks may not have solutions at all. In addition, engineers have to realize, that "problems in life, unlike problems in school, do not come packaged with the precise amount of information needed to solve them". Some problems have more information, than an expert needs, but quite often problems do not have enough information. Thus, most engineering tasks are "open-ended", that means, they do not have a single true solution. There are also situations when a solution that at first seems to be absurd then becomes the best. To be wrong, therefore, does not mean fail [9].

T. Peters wonders, "how creative engineers think" [10] and analyses the creative problem solving of outstanding engineers. The author comes to the conclusion that the attempts to go outside conventional engineering paradigms in researches and observations, the tries to revise current approaches and practice finally led to novel design ideas.

The creative component may be traced from the point when engineering arises. This fact is proved by the word "engineer" origin. It comes from medieval Latin "ingeniare" and in later use from "ingenero" which both mean "contrive, devise". That allows us to conclude that an engineer is a person who invents, designs, builds, or maintains. It is skillful contriver or originator of something whose thinking goes off the beaten path.

A number of studies [1, 3, 9] have found that engineering thinking is specific professional thinking. It is aimed at designing, production and maintenance of high-performance, safe and aesthetically acceptable machinery. In addition engineering thinking is responsible for the development and introduction of novel technologies. Improvement of product quality and safety as well as production organization is also an area of engineering thinking application.

Technical, technological, natural-scientific and engineering knowledge form rational, theoretical and methodological base of engineering thinking. Moreover engineering thinking includes creative, sensory, emotional and axiological elements, memory, imagination, fantasy and professional self-consciousness. More recent

evidence shows that social and humanitarian knowledge acquire greater importance , in contrast with the past.

Initial work in this field focused primarily on engineering creativity as the driver of innovation, social and economic development. The generally accepted use of the term “engineering creativity” refers to an activity which does not follow the rules, algorithms or instructions. Engineering creativity is exhibited in *rationalization* and *inventive acts*. Other kinds of technical creativity are *design* and *designing.* Throughout this paper we use the term “*design”* to refer to the action of conceiving of and producing equipment, systems, and facilities. “*Designing*” is acting in a scientific and technical calculating the parameters of a future technical object. A general purpose of designing is producing technical ideas, evaluation of advantages and disadvantages resulting in an optimal concept. Designing includes producing of working drawings (preliminary design and production project), principal technical documentation for production of a physical product.

In agreement with other authors, we highlight integrative character of innovative engineering. Conventional engineering activities include designing, technological, managerial and research work. O. Ihnatiuk [3] comes to the conclusion that such activities as informational and analytical, informational and technical, diagnostic, marketing, promoter, service and quality management relate to innovative engineering activities. A number of authors bracket innovative engineering activities with conventional ones.

In her analysis H. Hlotova [1] reaches the conclusion that innovative engineering activity has some distinctive features. The features are intensive creativity, integration of engineering activities, market requirements focus and growing demand for effective communication between professionals.

Nowadays a Ukrainian agricultural engineer has to strive for overcoming the current critical situation in agrarian production. Many researchers believe that an agricultural engineer must have a number of core competencies. Firstly, the competences include logical approach, global flexible system thinking and wide world view. Secondly, among the key competences scientists affirm an ability to

analyse important social situations, skills of creative problem solving, abilities to search for original solutions for routine problems and unconventional engineering tasks in the field of agrarian production. Thirdly, several studies outline such competences as the skills of application of system-analysis technique and mathematical simulation for production processes in agriculture, an ability to forecast course and development of processes and phenomenon. And finally, the competences include the skills to develop social and economic projects with a glance of resource-saving and influence on environment as well as adherence to principles in plant and animal health.

At the end of the 20th century it was obvious that providing new ideas creativity was the driver of innovation. At the same time foreign teachers stated the fact that "engineering schools do not adequately prepare students for creative endeavors or for the realities of modern industry" [11]. At this point the educational system in the EU, the USA, Canada, Australia, etc. has been intentionally reformed for the purpose of that gap overcoming. An increasing number of studies have found that creativity is successfully taught from kindergarten to graduate school. Regular curriculum at European or American university includes courses on creative problem-solving methods and methods of scientific and technical creativity [1, 12].

Results. At the present time an international professional qualification for engineers in the EU is provided by standards of engineering education and training. The core competencies include communicativeness, responsibility, reflection, cooperative ability, professional self-sufficiency, self-development ability, initiative, great professional activity, etc. Another fact draws our attention: creative self-sufficiency is the basic competency among the key ones [3, c. 14].

Training requirements to the graduates of agrarian universities in mechanical engineering are stated in the educational standard. The requirements are connected with the tasks which the future specialist has to be able to solve. The tasks are grouped according to levels of complexity. There are three groups of tasks. They are stereotype, diagnostic and heuristic. We have analysed the requirements according to the groups of the tasks. The Bachelor's degree provides skills for design,

organizational management, executive and technical functions. The set of analyses showed that in the majority of cases EEng has to be ready to deal with stereotype and diagnostic tasks. Master degree standard includes more heuristic tasks.

In this respect we can conclude that Ukrainian standard of engineering education and training includes such a core requirement as high level of professional training (fundamental and practical). However, this requirement provides skills for effective performance professional responsibilities related mostly to typical problems in agricultural production.

Employment requirements for an agricultural engineer have also been studied. The analysis showed that employers' expectations about their engineering staff in agribusiness include the ability to solve unconventional economic, production and managerial tasks under specific conditions when, on the one hand, the resources are limited and, on the other hand, the whole agricultural production branch needs optimization.

In agreement with V. Manko [4], we demonstrate that at the definite point in time the educational standard played its positive part. It became the base for selection of learning content and graduate programs development. The main weaknesses of the standard are its declarative nature, nonconstructivity and complicated examination. This means the standard is not functional in full. It resulted a situation when knowledge and basic skills answering the group of heuristic tasks are not built into current curricula.

Conclusions. The trend of mechanization and automation in agriculture remains, so, an engineer is still of primary importance in agricultural production. In contrast with the past professional activity of a future engineer is directed to development of new competitive technical objects. Another important task is to solve social problems within the scope of "human – technical object – environment – society" system. Thereby engineering acquires innovative nature today. Engineering education is realized under quickly changing conditions. Taken together, these findings highlight the fact that universities have to train creative engineers to be able to solve standard and unconventional technical problems effectively.

Further studies will focus on substantiation of pedagogical system for teaching and learning pointed at purposeful developing of the creative potential of future engineers.