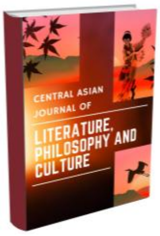

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Article

Aspects of Cognitive Theory of Formation and Development of Engineering Knowledge

Sayfullaev Samarbek Dilshod o'g'li[*1]

1. Tashkent State Transport University Department of "Social Sciences", independent researcher
* Correspondence: SayfullaevSamarbek11@gmail.com

Abstract: This article examines the interdisciplinary connections between engineering, exact, natural, and human sciences, and the epistemological aspects of the formation of engineering knowledge based on dialectical laws. In the process of analyzing the topic, in particular, the views of European scientists K.R. Popper, Prigozhin, Jose, M. Heidegger, J. Ellul and Russian scientists T.V. Fedyukina, I.K. Kornilov on engineering were analyzed.

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1. Introduction

In the development of humanity, "Engineer" has gone through a long historical stage. The term "engineer" was originally applied to persons who solved military tasks or state problems [1]. These tasks included land measurement, study, construction of roads and water structures, and determination of their location points. Engineers mainly had to know geometry, the art of geodesy, and architecture. The engineer had to be able to manage engineering work, the labor process, and the workforce, draw the planned object on paper, perform calculations, and carry out land surveys using measuring instruments. To avoid disagreements with employees, he also needed legal knowledge [2].

Currently, the number, quality, and complexity of technical equipment have increased by a million times. Modern engineers cannot become engineers without studying special technical sciences such as mathematics, physics, chemistry, as well as theoretical mechanics, materials science, material strength, drawing, and modern non-classical scientific and technical sciences. Today, economic and social sciences have become an integral part of engineering activities [3].

2. Materials and Methods

In a developed society, millions of people are involved in the processes of technical and technological activity. Science and technology have given humanity a sense of dominion over the world. However, the earth has become too small to accommodate all products and waste created by man without harming nature and human health. Therefore, a modern engineer must think about the social consequences of their activities and be responsible for them to their children and all of humanity. After all, the responsibility of engineering is increasing over time [4].

Thanks to engineering activities, many things have been created, and they are inseparable from our modern life. All engineering achievements created from ancient times to the present day are aimed at solving problems in human life. In the process of solving such problems, technical ideas arose. They rose to the level of concrete inventions through the active use of creative, including artistic, imagination [5].

The main objects of modern engineering activity are still various technical devices and industrial technologies. Traditional types of engineering activities include invention, design, engineering research, production technology and its organization, operation and evaluation of equipment, and disposal of obsolete or damaged equipment [6]. Recently, in engineering activities, such areas as the solution of environmental problems of production, use, and disposal of technical products are becoming increasingly relevant. A modern specialist should also understand issues related to the economic indicators of production [7].

3. Results and Discussion

Issues of engineering creativity also occupy an important place in engineering activity. According to T.V. Fedyukina, the goals of studying engineering creativity are:

1) Development of skills in posing and solving engineering problems;
2) Development of skills in searching for new, more effective constructive and technical solutions;
3) Mastering methods of scientific and engineering creativity;
4) Identification and development of students' creative abilities;
5) Study of modern methods of scientific and technical research (interdisciplinary approach) [8].

It is impossible to imagine a modern engineer without talent, deep and comprehensive knowledge, breadth of thinking, and the ability to overcome its inertia. Today's era absolutely does not accept an engineer without modern knowledge [9].

Although engineering has played a decisive role in human progress, it has not developed uniformly. Hundreds of thousands of years have passed since humanity created the first signs of technological progress. This process began with the use of "ready-made" natural resources and continued to improve them. In the world around us, we can classify objects into classes: 1. Lifeless nature. 2. Living nature. 3. New-thinking beings are people. Engineering activity is the main means of human influence on inanimate and living nature, as well as a means of human interaction with nature [10]. These connections and interactions are divided into four system groups:

1) Engineering - labor;
2) Human - engineering;
3) Engineering - nature;
4) Engineering – society [11].

The history of humanity depends on the achievements of individual countries in one or another technical field. New knowledge, technical solutions, and inventions enter the world through the individual and are the product of their creative activity. Engineers who have reached great heights in understanding and transforming the technosphere will remain in the memory of generations. The development of engineering has been the cause of intense human race from ancient times to the present day [12].

The most important problem of engineer training is the ability of engineers to independently set new tasks. It also includes the search for new constructive and technical solutions at the level of inventions and modernity, ensuring the improvement of product quality, achieving the level of world standards, comprehensive intensification of production, and saving all types of resources.

Innovative engineering is aimed at developing independent engineering creativity skills in the process of forming knowledge and skills. As the English philosopher C. R. Popper noted: “Practice is not the enemy of theoretical knowledge, but its most important stimulus.” [13].

The main task of an engineer is to use various types of knowledge to achieve a specific practical goal. Creating various technical devices, machines, or technologies and organizing their production is also one of the engineer's responsibilities. An engineer participates with scientific knowledge in the process of creating a technical object. In this process, the conceptual and logical level of engineering thinking plays an important role. According to I.K. Kornilov, engineering thinking manifests itself in the form of a specific spiritual and mental activity, reflecting a certain aspect of social activity related to technologies and technical knowledge in the design and creation of human-machine production systems. The result of engineering activity is an engineering solution in the form of a project, drawing, standard, norm, order, instruction, assignment, etc.

It is known that the creative works of people known for their outstanding achievements are studied and summarized. The results of such studies show that there are many common aspects of the thinking process in various types of creative activity.

Knowledge of the laws of formation and organization of creative thinking is useful for any person, especially an engineer.

The highest level of engineering creativity consists in identifying and forming the regularities of the structure and development of technology and their conscious use in the search for more effective and rational design and technological solutions.

The science of the laws of technology has gone through its stages of formation. The first stage, of course, is associated with the formation and substantiation of hypotheses about the regularities of the structure and development of technology. Today, there are still no sufficiently substantiated, universally recognized individual laws of technology, and there is no complete closed system of them in hypotheses. The creation of such a system and the substantiation of individual regularities is one of the most important modern directions of fundamental research related to technical knowledge and the general theory of design. This direction awaits its dedicated researchers.

However, unlike recently, today there are already theoretical and methodological developments on the regularities of technology, which are of great interest for practical use in engineering creativity.

Technical laws can also be more precise, multifaceted, and often applied in local engineering creativity. Firstly, based on the laws of technology, the most effective methodology and methods of engineering creativity can be developed. Secondly, the connection of principles and regularities to a certain class of engineering creativity allows us to determine the most correct structural features, appearance, and features of engineering creativity in subsequent generations.

The development of engineering activity led to its stratification. Initially, inventive and design activities, and later engineering design work, were formed as separate areas. According to P.K. Engelmeyer, invention, like engineering activity in general, is considered “creative and guiding activity.” According to P.K. Engelmeyer, the process of invention, from the first flash of an idea to its final implementation in practice, is carried out in the following stages: the birth of the idea, the development and implementation of a plan or scheme. In the first stage, first of all, the terms of the assignment are implemented, and a clear idea is formed in the form of an intention or plan. In the second stage, it is necessary to eliminate all the uncertainties and speculation of the idea, to draw up a plan or scheme of the invention. Then it will be divided into as many parts as there are in the invention. In the third stage, details are needed to create a prototype, and they show the implementation of the idea. Also, in the third stage, routes can be divided. In this case, everything is already prepared, and the designer is involved [14].

The history of engineering is closely connected with the history of technology. The history of technology is the science that studies the general laws of the development of productive forces in different periods of the development of human society. Or more precisely, the history of technology is the science that studies the relationship between the means of labor in the social production system and the forms and methods of labor, especially in relation to the object (subject) of labor. From the point of view of natural sciences, the history of technology shows that humanity is increasingly mastering the laws of nature and using matter and natural energy more effectively and diversely. From a social point of view, the history of technology illuminates the driving forces of society, the social conditions for the development of technology, and the specific role of the creators of technology.

The world surrounding man consists of nature, society, and technology. The laws of dialectics apply equally to natural, social, and technical phenomena. Dialectics (from the Greek “dialektike” - the art of conversation, discussion) is the science of the development of being, its progress, self-awareness in action, and the most general laws of nature, society, and thought. The most important categories of dialectics include such phenomena as cause and effect, possibility and reality, chance and necessity, particularity and generality, content and form. At the same time, there are also fundamental laws of dialectics, such as the unity and struggle of opposites, the transition of quantitative changes to qualitative ones, and the negation of negation. In particular, the law of negation of negation is directly related to the processes associated with the development of invention [15].

4. Conclusion

In conclusion, along with the biological relationship of man to nature, he develops a specific type of material connection with nature - the labor process. The level of development of tools and means of labor determines the nature of these relations. The concept of “production” reflects the essence of the efficiency of human labor activity. In the process of labor, things are created that can satisfy human needs. However, simultaneously with the production of material goods necessary for life, people also form social production relations that arise in the process of their labor. The nature of these relations is determined not by the will and consciousness of people, but by the achieved level of development of their productive material forces and needs. Consequently, the concept of “production” also expresses the social nature of labor activity, its implementation within the framework of material social relations.

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