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Goryachkin and His Idea in the Agricultural mechanics: Human - Machine - Environment

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Abstract. The famous scientist, academician V.P. Gorjachkin (1868–1935), the founder of agricultural machinery industry in Russia, posed and developed a global problem “Human - Machine - Environment” in his works. In Russia of scientific and technological revolution, this problem is developed on the basis of four general scientific directions: biomechanics of working processes, mechanics of machines, theory of machine control, and theory of technological processes.

Keywords: applied mechanics, agricultural machines, theory of mechanisms, living movers.

1. Introduction

A specific property of most agricultural machines, including modern ones, is the fact that a human operator is needed to control these machines. Starting from his very early works in agricultural mechanics and theory of agricultural machinery, Goryachkin explored working movements of a human operator in search for optimal forms of these movements, which would minimize the burden on arms and legs of an operator. When solving these issues, it was necessary to find appropriate relationships between operator’s movements and the physiology of the human being. Application of the methods of classical mechanics in agricultural engineering and biology. He developed the theory, scientific basis for the design of all types of agricultural machinery. He explained the General principles of their test. Goryachkin was a talented mathematician and mechanic. He saw in each machine its mechanical nature.

2. Base section

When trying to formulate the ideas posed and developed by V.P.Goryachkin in his works in terms of modern concepts, the set of these ideas can be determined as a global problem: Human - Machine - Environment.

A specific property of most agricultural machines, including modern ones, is the fact that a human operator is needed to control these machines. Many manual tools are applied up to present, especially in gardening, horticulture, vineyard processing, and cultivation of speciality crops. Starting from his very early works in agricultural mechanics and theory

of agricultural machinery, Goryachkin explored working movements of a human operator in search for optimal forms of these movements, which would minimize the burden on arms and legs of an operator. He examined also some aspects of comfortability, convenience in the machine control, and questions connected with service zones, as these are called nowadays.

While solving these questions, a problem arose how to determine inter-relationships between required operator movements and human physiology. And Goryachkin introduced the course called Theory of Live Engines into the curriculum on agricultural mechanics. The course was given by academician A.V. Leontovich, the outstanding physiologist. He considered some questions of human physiology, which are developed now as biomechanics of working movements of humans and animals. Leontovich set forth also the physiology of humans and animals paying special attention on the role of muscles of the nervous system and brain in generating and controlling working movements. Further, energy characteristics and adaptive properties of live engines were considered to determine their ability to adjust to different working conditions, in particular, to find out an effect of the position of an operator relative to the machine (upstanding or sitting positions, moving nearby the machine, etc.).

Goryachkin not only created a new branch of the applied mechanics but also formulated an original Human - Machine - Environment concept. The second item of the problem, Machine, was considered by Goryachkin in different aspects; however, studying the issues of mechanics of machines was the main aspect.

In the 1930s, V.P. Goryachkin was eagerly engaged in studying the theory of manual tools. He carried out his explorations together with the Central Institute of Labor, involving his apprentices in the work. For example, I.I. Artobolevski determined mechanical parameters of hammers, mattocks, spades, scythes: their masses, barycenters, moments of inertia, centers of oscillation, etc. Simultaneously, more complicated tasks were solved, for example, how the position of a barycenter of a human operator affected operator's movements. These tasks were solved using the simplest, although unique at that time, experimental installations. All these works were based on remarkable results obtained by Goryachkin in the kinematics and dynamics of manual tools, the theory of impact processes produced by these tools, etc.

The organization of works on standardization of tractor plows was carried out at that period of time too. Vasilii Prokhorovich requested his friend, professor N.I. Mertsalov, who was reading courses of the theory of mechanisms and machines and the kinematics of spatial mechanisms at the Moscow Agricultural Institute (since 1921) to carry out the study of kinematics and kinetostatics of elevating mechanisms in tractor plows. N.D. Luchinskii, who became an Academician of VASKhNIL (All-Union Academy of agricultural Sciences) afterwards, and I.I. Artobolevski, a future Academician of the Academy of Sciences of the USSR, were also involved in these works. N.D. Luchinskii defended his graduation project called American Thresher, in which the problem how an operator could control a

machine using handles was considered. The same problem of the relations between a human operator and a machine arose when designing new reaping machines (these questions were examined by professor P.I. Borodin and I.I. Artobolevski under the guidance of V.P. Goryachkin).

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The common thread running through all his works was an idea that mechanics of agricultural machinery could not be considered without taking into account the technological process. In this context, there appeared his papers devoted to cutting and reversing furrow-slices, works on the theory of cutting herbs and grasses, crushing agri-products, etc., connected with specific technological processes involving the environment that was processed using a tool or a machine.

3. Conclusions

The necessity of considering the theory of agricultural machinery in terms of the Human - Machine - Environment system, an extremely profound conception of Goryachkin, has become widely recognized today in the current theory of machinery. Indeed, all the three factors are taken into account when designing separate automatic machines and systems of automatic machines (automated sequence machine systems), machine tools, and other programme-controlled machines, as well as industrial robots and walking machines.

Academician Goryachkin's heritage, although connected with the past doctrines on mechanisms and machines, gave birth to sprouts, which resulted in an unprecedented, wide-scale development of the theory and practice of the agricultural mechanics. New, highly-productive and effective machines and systems of machines were designed as a result of his teaching, those machines that are aimed at the solution of problems of the development of the national economy.

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