

# HUMAN FACTOR IN SOLVING ENGINEERING PROBLEMS OF SAFETY

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The article presents the principles and methods of engineering disciplines of engineering in the process of design and construction of self-propelled work machines, in order to ensure favorable and safe working conditions; based on many years of research in the laboratories of the Department of Security of life and the creation of DSTU discipline "Engineering Ergonomics", based on the priority principles of human factor, showing the methodological and technical development principles of comfortable workplace human-machine operator; it is considered prospects for improving the harmonic connection hardware and the human factor in the self-propelled machines, safety.

Key words: safety, technosphere, human-machine-engineering ergonomics, man-machine, factor.

The development of technology and processes in modern engineering, is known to contribute to the creation of innovative managed human, technical systems, with high specific power output and its socio-economic characteristics. Growing progress includes new production sometimes quite unforeseen harmful and dangerous threats to the life and well-being of people and their environment. According to official statistics, there is a catastrophic international growth in the number of accidents in the technosphere bearing human victims and enormous material damage. According to the analytical data of the UN negative factors health and safety do not contain a downward trend. According to the ILO (International Labour Organisation) officially recorded each year more than 180-200 thousand accidents with severe (ie, lethal) outcome and more than 120 million. Occupational injuries and diseases. The economic damage of these negative phenomena comes to 1.5% of the global national product, the dynamics of these data is clearly upward trend, confirming the relevance of particular security problems in the technosphere.

The aim of our long-term studies of working conditions of the human operator is to find methods of modernization of security engineering, in the progressive creation of new agricultural, construction and other work machines and automated systems. Technological advances in engineering named direction is inevitably linked to a sharp change in the human role in driving. There was a need to consider the scientific and practical problems of design and construction of machinery and technical equipment in accordance with modern scientific achievements of the human factor – a relatively new engineering disciplines - engineering ergonomics. In this case, a systematic approach will radically change the novelty and utility of the new technology, improving not only safety, but also in the growth of social and economic efficiency.

Initially, the practical essence of ergonomics is at its relationship with a man, but a man with a technique that has been repeatedly emphasized by us in our research. The results of our scientific work to create real prerequisites for the search for new methods of worker safety and increasing productivity. This led to the idea of better understanding of the basics of synthesis of engineering, ergonomics, engineering and psychological information. It became clear that the fundamental principle on which depends the solution of the whole complex of important socio-economic problems: human security control equipment, performance of his work, and to create safe working conditions for the health of the labor - is the human factor. So the idea of creating a new scientific direction Engineering – Engineering ergonomics. Analysis of existing knowledge and the search for the principles and methods of applied science sector led the authors to a deep study of the active laws, processes and means of interaction between man, technology and the environment with a view to the application of the design and construction of the "human-machine environment" on the basis of the department "occupational health and the environment" (DSTU), a scientific discipline was called "engineering ergonomics" [1, 4]. Currently this work is actively developing on the continuation of a number of years under the leadership of Head of Department of BZ and AIA DSTU D.Sc. Professor B.Ch. Meskhi (Rector DSTU). The research center is now the goal is to further the study and the search for more effective solutions principles of the foundations of security in the technosphere associated with the human factor.

In modern engineering studies handling machines, called us a very modest place occupied by the development of methods for the safety and reliability of works relating to the registration and accounting of energy of the human body, in the management of technology. For questions about the reliability theory there is an extensive range of literature, including the technical and safety systems controlled by man. Meanwhile, when the price of the reliability and safety of the technical system does not have the essential components, such as the refusal of certain parts of it, such as flying machines, transport systems or the human operator error, the calculation of the safety performance turns into a kind of banal procedure nothing associated with the ultimate goal of designing complex technical systems: ensuring its security.

In order to solve the major problems of safety necessary to create methods for determining the energy of human - operator, followed by calculation of reliability mechanical "man-machine systems' reliability and the level of man as a complex system. With the goal. solve these problems we have been combined into a single system based on three areas containing the knowledge necessary for human security, manage complex technical means. These skills include: a) the theoretical foundations of workplace safety rights in the technical system; b) the reliability of these systems of control and c) engineering and ergonomic principles of "human-machine systems" (SCHM), of course, in the initial stage of creating art - in the design stage. The "man-machine system" is considered conditionally simplified form that allows for the solution of important engineering design security tasks. Finding a solution to this problem by itself require complex synthesis characteristics psychophysiology human operator, with one hand, and the design and operating practices - other. Here is brief information about the basics of three areas mentioned above, providing security systems - "Man appliances."

a) The safety and performance of workplace human operator self-propelled machines. Operator self-propelled machines - is a constant, individual workplace expert equipped with controls and monitoring by means of display, equipment, providing an optimal environment of convenience and safety. The working machines (agricultural, construction and other uses) the operator's seat area is "docking" of man and machine. Many scientific and technical sources, the availability of technical means of human interaction with technology qualify as aid, however, if we consider SCHM as a system in which man is the main link, these funds can not be attributed to the category of auxiliary. These funds are an integral part of the "system", without which it is impossible to control, because it becomes a threat to human health and safety. Hence the need for an evidence-based account of the parameters and possibilities of the human factor. One of the difficult problems of the human factor are its individual performance, which are naturally different for each person, to operate the machine. In this regard, the designer needs to provide all the complex machine control system a technique that allows the machine operator to quickly adapt to their anthropometric data and ease of management. To do this, the designer must have much more information on the "human factor" operator to create art than that is contained in a purely engineering problems maker machines. In order to expand the spectrum of scientific and technological improvement of working conditions of the operator, the authors have developed and offered engineering, ergonomics and psychological, and in subsequent years, engineering and ecological principles to improve management operators of self-propelled machines. The research results were published in the media, both for specialists engineering and design trends, and in the textbooks for the students of technical colleges the corresponding profile [1, 2, 4].

b) Reliability of control technology. In the design process, solving the problem of the proper use of human capabilities and the division of labor between man and machine, it should pay attention to the high reliability of the operator and thus ensure the reliability of the whole system, ie, The main task here is to minimize the possibility of human error operator. Reliability operator is characterized by indicators infallibility, availability, recoverability and timeliness of decision-making.

Designers do not yet have quantitative data on human reliability. In order to solve an extremely difficult task, increasing the operator error-free, you should consider: 1) the main function, anthropometric and energy potential of the human operator; 2) the characteristics of the human operator associated with the views of its activities and influence of adverse environmental factors.

In the first case it is necessary to take into account that the main functional and anthropometric data of the person established quite accurately. Much of the difficulty of determining the energy of the body of the operator, whose possibilities have not been studied, although this obviously has a direct

connection with the reliability of the work SCHM. Attempts have been made to develop a conditional model of energy the body is very helpful in the development of science SCHM, but they have a presumptive form for today based on some of the available parameters of the systems of lethal devices and machines. Therefore, these data can not be fully utilized in the development of self-propelled vehicles, since it does not allow to make a sufficient understanding of the impact of the energy load on the reliability of the action, such as an agricultural machine mechanic.

c) Engineering and ergonomic principles in the design stage "of the man-machine". Under the engineering and ergonomic design (EPI) refers to a set of engineering design work, which defines the basic characteristics of the machinery, as well as complemented by the ergonomics and the environment. Efficacy is evaluated not only from the technical and economic, but also from a social point of view, taking into account the measures aimed at maintaining the health and comprehensive development of a human operator or another agricultural machine.

Power line units of the "man-machine-environment" in the design of all types of working machines also has no theoretical basis. As is known, the design of the workplace of the operator should be aware that people reduce their functionality with the growth of energy load on his body (this is in excess of such an important factor as the preservation of health and the health of the operator). Sure, there is the energy load limit human operator control functions. Increasing this limit will result in the failure of functions, reducing the quality of work, productivity; increase the degree of risk of damage to human health and the design of the machine. However, the methods of recording and evaluation of energy consumption of the body of the operator of the machine and their influence on the system developed enough. Lack of appropriate ergonomic requirements and constraints results in an underestimation of the designer to involuntary compatibility operator, machinery and environment. These examples reflect the general situation with all kinds of compatibility SCHM and confirm the need for further study of scientific substantiation of these characteristics.

What do you need to address design issues of workplaces and the entire system "man-machine" in the new scientific and technological level?

The designer must have (except for state standards and specifications) sufficient range of data, the parameters defining a balanced combination of human capabilities, modern machinery and environment protection. This information must be strictly science-based. You can get them only through careful study "of the man-machine-environment" with the obligatory participation of engineers, specialists in ergonomics, engineering psychology and physiology of labor, mathematicians.

Unlike our foreign colleagues, greatly advanced in the analysis of biological systems management (J. Milsum and his team of scientists (USA)). We were able to get away from the union, but rather the concept of optimal mix, reaching a particular quality, with the concept of adaptation, that is, the ability of the system "to reduce the entropy of" adapting to environmental conditions.

In practical terms, the scientists managed to DSTU make a real contribution, not only in utility, but also the novelty of creating engineering and ergonomic tools. At the present time, taking into account the significant growth of catastrophes of modern technology related to the human factor, the authors are working on upgrading security doctrine, including research into the causes of accidents in the philosophy of science professionals and psychological understanding of man has a huge impact on the growth of accidents in the technosphere [1, 2, 4]. In further his research in the field of security in the broadest sense, we believe that human life, the life of society can realize the resolution of the basic contradiction of the time only by increasing people's spirituality, their spiritual culture, to the level of awareness of the need for a rigid focus on constructive, in respect of environment, lifestyle [4, 5].

In this regard, at the forefront of security issues and on its basis, the modernization of society in favor of perfection human factor determining global opportunity to create not only the technosphere, but also electron-intelligent future of society. It is for this reason, to achieve a high degree of perfection of a fundamentally new information in the above technologies related to the priority of human security and society, according to the authors should dominate new methods of human forms of life, establishing a connection between man, not only with the material world around him, but also the ideological content that allows meaningful to transform reality. This concept laid the basis for further development of our work on security, in particular the technosphere [1, 2, 4].

Special attention in the modern engineering deserves further development of knowledge about the priorities of the human factor in the cost-effectiveness of technical means. Methods of engineering

psychology and ergonomics, providing human factors in the design of machines, are becoming more common in all areas of engineering. Engineering - ergonomic design (IEP) of equipment, and especially jobs human operator, not only led to a marked improvement in safety, but also a significant increase in economic benefits, who found an important place in our studies [4]. The development of the IEP, the authors focus on creating high-performance, and favorable conditions for the health of people working on machines in agriculture, construction and management by any means of transport. [4]. However, the problems associated with the human factor, not all studied and most important task of the development of indicators of human security and economic efficiency of technical means is the further development of engineering techniques and new tools of modern science associated with anthroposphere and change the culture of thinking and outlook of modern society.

### *References*

1. Meskhi B.Ch. Engineered ergonomics agricultural machinery and equipment "Safety". Rostov-on-Don, 2011.
2. Meskhi B.Ch. Health and Safety in the design of agricultural machinery and equipment. Rostov-on-Don, 2011.
3. Meskhi B.Ch. Methodical instructions to implement the section "Safety and environmental project" graduation project for students of specialty 190603 "Service of transport and technological machines and equipment (road)" [electronic resource] / DSTU (ucheb.metod.posobie) B.Ch. Meskhi, AE Astvatsaturov and others. Rostov-on-Don, 2013.
4. Astvatsaturov A.E. Fundamentals of Engineering ergonomics RSU, Rostov-on-Don, 1991.
5. Astvatsaturov A.E. Engineering Ergonomics machines RSU. Rostov-on-Don, 1987; Analysis of Global Security; Globalistics 2009 / MSU. University [Electr. Source] M in 2009; Start protection against environmental disasters; Saarbrucken (Germania), 2013.
6. Ergonomics in Japan / Osim Masamitsu // Ergonomics 1982. Vol. 25. № 6.

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