“INTEGRATED COMPUTER TECHNOLOGIES IN MECHANICAL ENGINEERING” – SYNERGETIC ENGINEERING
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COGNITIVE ASPECTS OF ENSURING THE SAFETY, DEPENDABILITY AND STABILITY OF A DYNAMIC SYSTEM’S FUNCTIONING IN EXTREME CONDITIONS

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A PROBLEM

The relevance of complex dynamic systems **(CDS)** dependability forms a significant increase in the complexity of systems, which leads to an increasing number, significance and consequences of the realization of the risks. The interdisciplinarity of the problem takes place because of the influence on the CDS dependability and safety of a person, society and the environment. It determines the search for new ways, methods and means of risk mitigation to improve the system's dependability considering the cognitive aspects of digitalization. Despite the significant resources in ensuring safety, the negative consequences of human-made disasters are growing.

THE GOAL IS TO EXPLORE THE HUMAN FACTOR INFLUENCE ON THE COMPLEX DYNAMIC SYSTEM DEPENDABILITY UNDER EXTREME CONDITIONS; TO DEVELOP MEANS FOR ESTIMATING AND DECLINING THE HUMAN FACTOR INFLUENCE.

RESEARCH METHODS

THE FIRST METHOD to study CDS is the principles of the theory of CDS viability.

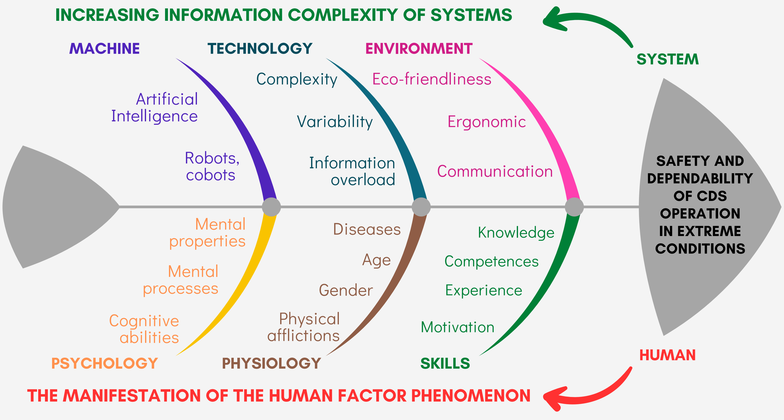
THE SECOND METHOD is several standards ISO 9000, ISO 45001, ISO 31000, and IEC 60300.

THE THIRD METHOD is Scott A. Snook’s “practical drift” theory.

THE FOURTH METHOD is an adapted method of systems analysis based on Ishikawa diagrams.

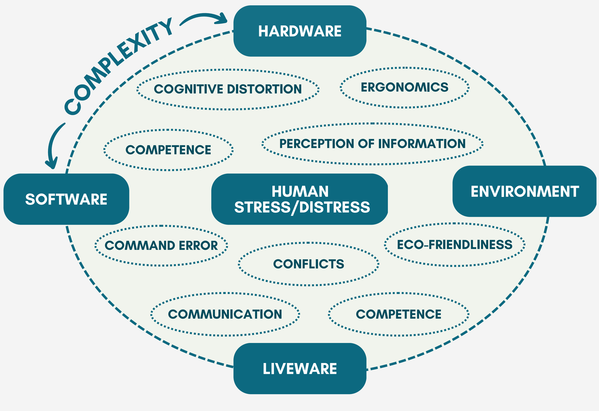
RESULT 1. IDENTIFICATION OF DOMINANT FACTORS INFLUENCING THE CDS RELIABILITY AND SAFETY IN EXTREME CONDITIONS

Analysis of standards ISO 9000, ISO 45001, ISO 31000, and IEC 60300 and statistics of the results of their practical application showed that the safety and reliability of CDS depend on standards, rules, algorithms and programs only theoretically. In reality, the neuroergonomic, psychophysiological and psychological aspects of human perception of information play a significant role. An adapted version of the Ishikawa diagram demonstrates this statement.



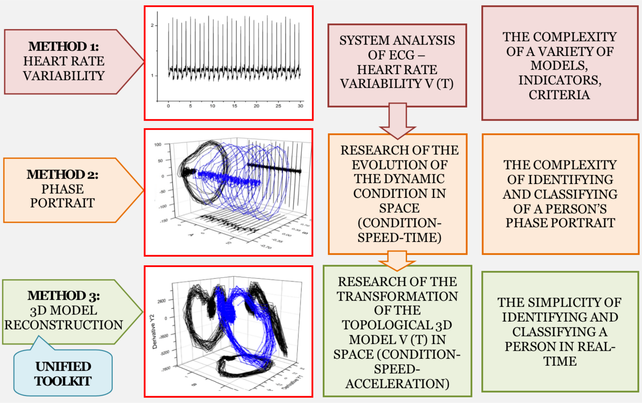
RESULT 2. CDS COGNITIVE MODEL

Functional asymmetry of the cerebral hemispheres leads to latent cognitive problems, which are genetically inherited or acquired during learning and activity. They manifest in the difficult conditions of functioning and cause the manifestation of the “human factor” phenomenon. As a result, there is a violation of the interaction “human – human” and “human – hardware, software, environment” in CDS. A cognitive model of CDS reflects this (transformed SHEL model).



RESULT 3. COGNITIVE GRAPHICS OF THE CDS ELEMENTS FUNCTIONING

Monitoring and forecasting the CDS functioning need to develop interdisciplinary tools for predictive analytics. These include a structural-functional approach to modelling the complex system behaviour and state. We proposed 3D visualisation of information flows in the parametric space of dynamic events. This technology makes it possible to study and model CDS functioning in real time, including the person’s psycho-physiological abilities. The methodology of human factors engineering and the development of a structural-functional approach to modelling make it possible to foresee the problems of CDS physical, functional and information safety, which reduces the risks of cognitive distortions.



RESULT 4. THE STRATEGIES OF RISK MANAGEMENT AND IMPROVING CDS RELIABILITY

Strategy 1. Distribution of random and systematic threats and risks. An elimination of system threats by using standards and creating viable systems based on human factors.
Strategy 2. Interdisciplinary view on the “human factor” problem. In this case, interdisciplinarity means the intersection of such areas in the CDS study as personal capabilities, social capital, etc. This approach gives reducing the human factor impact.
Strategy 3. Training of future CDS developers. A transition to convergent learning and understanding the features of human-machine interaction.