Chapter 56

Diagnosis and Evaluation:
A Psycho-Emotional State of the Operators of Socio-Technical Systems

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ABSTRACT

The accident free work of complex systems depends of the compatibility of their components. When it comes to socio-technical, this means the compatibility of the human factor with the environment and equipment, organized through a specific interface. At the same time, there is a certain contradiction: the modeling and design of equipment and interface is based on a classical mathematical apparatus, whereas its use for understanding human activity is confronted with the non-formalizability of many aspects of perception and decision-making. Elimination of this contradiction on the basis of the modeling apparatus, equally suitable for modeling all components of socio-technical systems, will open the way to improving the compatibility of components and reducing the accident rate. Therefore, the development of such a mathematical apparatus is an important problem. In this chapter is presented the modelling instrument, which is adequate to the composite open systems properties – axiomatic wave model, theory of self-organization, practical examples.

BACKGROUND

The methods of aviation human-machine-environment systems (HME-systems) designing are based on the principles of the humanitarian approach. For illustration, let's use the SHELL model (Figure 1) (Edwards, 1972; Hawkins, 1980; ICAO Circular 216-AN31, 1989).

The use of the humanitarian approach was made possible through the advancement of electronic methods of displaying data and was implemented in "glass cabins", the devices of which make it possible to present information in a convenient for perception form. However, the systems designed on this basis, are not free of the flaws. According to (ICAO Circular No. 234-AN / 142, 1992, p.13-24), obtained on the basis of the analysis of operating experience of Boeing 747-400, MD11, A 320 aircraft, there are:

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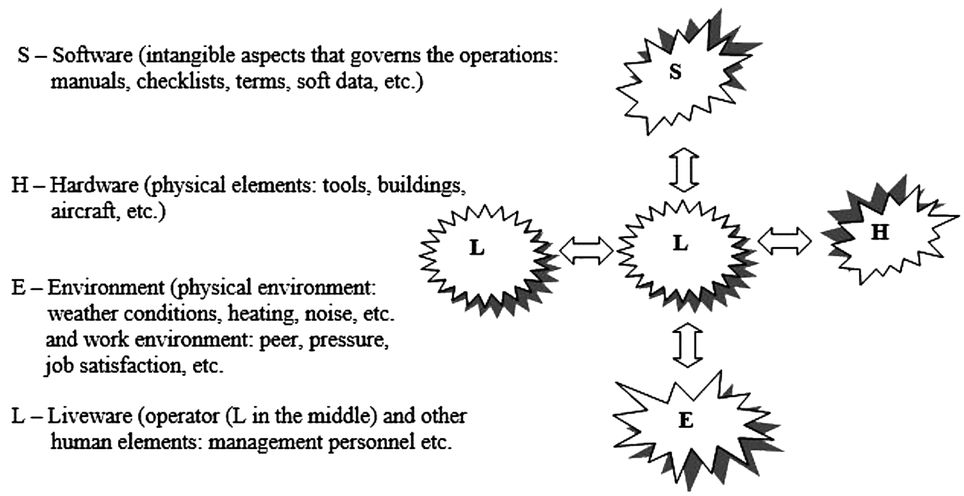
- Loss of knowledge of the situation by the operator;
- Loss of understanding of the control system working;
- Excessive trust, or, conversely, fear of a control system;
- Loss of professional skills, changing motivations, changing functions within the crew or shifting;
- Vulnerability to heavy and systematic errors;
- Increase of work tension in extreme situations;
- The need to change the methods of selection and training of operators and the same.

Figure 1. SHELL-model of the HME-system



These and other flaws were examined on the base of experience of airlines in different countries before and after the publication of this circular (Baum., Dahlin, 2007, Desai, 2016, Janic, 2000, Latorella, Prabhu, 2000, etc.). Various aspects of the interaction between the components of the SHELL-model have been detailed, and improvements have been proposed, some of which are described in other chapters of this book.

In practice, this led to the improvement of methods for designing sociotechnical aviation systems (Baxter, Sommerville, 2011, Cherns, 1976, Clegg, 2000, Mumford, 2006, etc.), but can we assume that the problem of system components compatibility was solved?

On the one hand, accident statistics (Leychenko, Malishevskiy, Mikhalic, 2006) indicate that their relative number tends to decrease - for the leading airlines and countries where international air travel safety standards are strictly observed and personnel is highly qualified. On the other hand, the proportion of the human factor in the causes of accidents is still close to 80%, and this shows that human interaction with other components of SHELL leaves much to be desired.

Hence it can be concluded that the reasons for the incompatibility of the components of human machine systems are determined not by the shortcomings of specific methods of their design, but by the conceptual inadequacy of the modern research apparatus based on the methods of psychology (Heider, 1958, Burlachuk, 1979, Zavalova, Lomov, Ponomarenko, 1986, etc.) and mathematics (Gong., Zhang,

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