

## **DEVELOPMENT OF THE THEORY OF MATHEMATICAL MODELING AND ITS APPLICATION IN EDUCATION AND INDUSTRY**

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### **RESULTS OF SIMULATION MODELING AND RECOMMENDATIONS FOR IMPROVING THE ORGANIZATION OF COMBAT WORK IN AUTOMATED CONTROL SYSTEMS OF TACTICAL MANAGEMENT LINK**

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As a result of the analysis of the specifics of the combat crew (CC) activity in the automated control systems of tactical management link (ACS TML), changes in the role and place of operators in the control loop, trends in the complexity of combat processes, determining the impact of performance indicators on the effectiveness of operations. The capabilities of the control system revealed that the operator of promising ACS TML remains its main element that carries out goal-setting and coordinating functions [1]. The organization of combat work significantly affects the quality of solving combat command tasks and the effectiveness of the functioning of automated control systems (ACS) as a whole.

Due to the lack of operational and logically related methods for substantiating the characteristics of the activities of BR operators in solving combat control tasks, as well as the lack of due regard for engineering and psychological factors in assessing the quality of activities, a large number of erroneous decisions and actions appear. These shortcomings underestimate the level of combat effectiveness being implemented.

The performed system analysis showed the relevance and necessity of improving the scientific and methodological apparatus for substantiating and evaluating the rational way of organizing the activities of the CC ACS TML in order to improve the quality of solving management problems [2]. The advanced scientific and methodological apparatus is based on the use of CASE-technologies, methods of multi-approach simulation, as well as optimization of activity algorithms. Using the method of sequential accounting of factors in assessing the quality of activities, planning experiments with a small number of factors taken into account made it possible to carry out comprehensive preparation of the source data. On this basis, a new approach has been developed to build the entire logical and mathematical sequence of evaluating and substantiating the rational structure of the organization of combat work, taking into account the composition of the most important groups of factors through management efficiency [3].

The purpose of this research is to develop recommendations based on the conducted simulation to improve the organization of combat work in the ACS TML.

**Material and methods.** The research used CASE-technologies, methods of multi-approach simulation and optimization of activity algorithms.

**Finding and their discussion.** An analysis of the trends in the processes of combat work, as applied to the ACS TML, shows that as the ACS improves, the composition of the tasks has changed insignificantly, but their complexity is increasing. The way they are resolved is changing in the direction of increasing the degree of automation. With an increase in the degree of automation, the activity of the CC in the solution of control problems undergoes significant changes, i.e. its role and place in ACS is changing. The operator is exempted from a number of functions of internal management and maintenance of ACS, a number of functions is reduced in its volume. At the same time, the volume and significance of the functions of external management and especially the use of the complex in terms of making decisions on the use of subordinate units and means, i.e. the role of the ACS operator is constantly growing.

The analysis of the development of ACS TML indicates that the main trends in organizing the activities of operators in solving combat control tasks at ACS are: a decrease in the type of automated workplace (AWP) with a transition to unified workplaces, a reduction in the total number of information display devices and controls on the workstation. Reduction in the total number of full CC with a significant redistribution of the required category of specialists.

Taking into account the indicated tendencies, in order to determine the effectiveness of control, studies were conducted on the dependence of the effectiveness of the organization of CC activities on the ACS TML, which comprehensively takes into account the most significant factors in solving combat command tasks and the density of the air strike. Control efficiency in the existing system decreases significantly with increasing density of the air enemy's strike. This is caused by an increase in the solution time and the probability of missing tasks at high densities. The deterioration of these indicators is caused by overload of the operators of the CC, a long time for them to receive information, and the participation of several persons in the solution of certain problems of the CC. The need for dynamic redistribution of functions between operators in order to leave the commander only those tasks that are creative in nature and associated with the disclosure of the enemy's plan is revealed. The studies showed that the level of operational redundancy of the algorithms for entering commands and orders from the AWP and the number of commands and reports of semantic concepts provided in the information field for entering the existing ACS TML is overestimated. Given the uniformity of the used controls on the workstation, we can talk about the same level of overestimation of the temporal characteristics of the

implementation of algorithms by operators. In many respects, these characteristics are explained by the fact that CC operators perform their functions in the automated mode of ACS operation as a measuring and correcting body.

The analysis of the obtained dependencies made it possible to identify and analyze the influence of the studied factors on the quality of operators' activity. It is shown that through the use of algorithms for setting the target orientation of the activities of combat control operators and an algorithm for ordering tactical episodes, the average time spent on fulfilling the control tasks is reduced. In addition, due to the reduction in the information search time for «conflict situations», an increase in the probability of correct and timely processing of activity algorithms for the whole range of tasks was recorded.

Estimates of the execution time of the algorithm for streamlining management tasks in accordance with the objectives of the operators confirm the possibility of fulfilling their functional duties in real time even with the maximum filling capacity of the information model.

In order to improve the quality of operators' activities on a promising AWP, taking into account the peculiarities of their activities, it is necessary to develop structural and logical schemes of activity algorithms and reflect them in the operational documentation and relevant instructions.

**Conclusion.** The use of the multichannel information model developed by the authors allows increasing the time for completing thought processes by reducing the sensory-perceptual component of activity. A sharp increase in the speech-cognitive component throughout the entire range of tasks allows operators to use the creative component in the decision-making process.

Due to this, the probability of a correct and timely solution to the whole complex of management tasks increases, and the losses of priority «conflict situations» worked out by operators are significantly reduced. Calculations using the simulation method have shown that the implementation of these recommendations simultaneously with the improvement of information models will increase control efficiency.

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