The Study on Evaluation Index System of Air-Defense & Anti-Missile Command Model Based on Capability

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Abstract. Whether the design of the Air-Defense & Anti-Missile command model is reasonable determines the success of the future combat system. The capability-based model evaluation method is an effective way to solve the problem, and the construction of the index system is the key to the evaluation. This paper studies the construction of the evaluation index system of the model based on the capability perspective. It establishes the corresponding model capability system through the analysis of the tasks system of the model based on the comprehensive micro mechanism. In order to ensure the integrity of the model evaluation, it uses the flexible index system design principles to achieve the transformation of the capability system to the indicator system to build an evaluation indicator model.

1. Introduction

With the development of a new generation of weapons, and in order to adapt to the new combat styles, it is urgent to carry out the research of a new generation of Air-Defense & Anti-Missile command models. The model involves a large number of equipment types, the rules of the operational rules are complex. And the air attack objects have strong unknowns and dynamics, the scale and intensity of the operations are difficult to predict. The application of operational resources has nonlinear and dynamic programming [1-2]. The above characteristics determine that the model evaluation is a difficult problem that combines multi-scale, multi-parameter, qualitative and quantitative, while the current model evaluation focuses on the test of the function realization of the model, and the research on the index system and evaluation method that are close to the operational requirements. Establishing a scientific and reasonable evaluation index system is the key [3], the research on whether the model is close to the operational requirements, whether it meets the rules of the operational rules and whether it conforms to the operational logic [4]. At present, some scholars have achieved certain results in the research of index system [5], but the research on the evaluation index system of the model is almost blank.

2. Analysis of Models

2.1. Description of the command system

Since the model is embedded in the command system, it is necessary to study and discuss the composition and structure of the command system [7]. It can be divided into three levels: firepower level, tactical level and regional level, and the tasks are different, but basically have four functions of information, calculation, logic and inspection. The calculation function is the core part, and the
decision making is the focus of research. It can also be divided into three stages: pre-war, mid-war and post-war. The real-time decision-making stage is the key to the research, including: air situation analysis, target comprehensive identification, threat assessment sequencing, and interception feasible. Sexual analysis, target identification, launch decision, etc.

2.2. The command process description
The command process provides the decision-makers with real-time decision-making information under the support of the command system. The tactical-level command process is the focus of research, mainly consisting of eight sub-processes: track target selection; target recognition; interception suitability judgment; threat assessment; interception ordering; target allocation; launch decision; evaluation of killing effect.

2.3. Characteristics of the model capabilities
The model is mainly based on the operational regulations, operational rules and operational logic, through the input of the airborne information obtained by the sensor and the real-time status of the weapon and ammunition resources, the target threat degree is calculated and analyzed, given the multiple constraints. The comprehensive data information assists the commander to make the target firepower distribution decision, so that a series of analysis, judgment, evaluation and solution processes for obtaining the maximum operational benefit in the high-real-time combat confrontation, the basic characteristics of the model can be studied from the equipment, the composition, the operational basis, the situation analysis, the ergonomic design and the inter-model interconnection. The basic characteristics of the capability are as shows: orientation, emerging, complexity, evolution, hierarchy, knowledge.

3. Model capability system design

3.1. Description of model capabilities
Model capability can usually be analyzed from both ontology and cognitive theory. Ontology emphasizes the connotation of model ability. Cognitive theory needs to consider combat practice. The description of model capability is more objective and comprehensive, . And it can be divided into pragmatic analysis, semantic analysis and grammar analysis. The specific definitions are as follows:
Semantic analysis: It mainly analyzes the capability hierarchy based on the basic characteristics of the model capabilities;
Pragmatic analysis: The task system is analyzed mainly on the premise of describing the mission objectives of the mode;
Grammatical analysis: Describe the content and connection of pragmatic and semantic according to certain normative standards, and obtain the corresponding the model capability system.

3.2. Construction of model capability system
The comprehensive micro-analysis mechanism includes two parts: “integrated-analysis” and “micro-analysis”. The integrated-analysis uses modular thinking to describe the model decomposition, and establishes a corresponding comprehensive framework by clarifying the connections between modules. The micro-analysis is on the basis of integrated-analysis, and the research on module behavior and relationship with each other is carried out, so as to achieve a comprehensive examination from the whole to the part and part to the whole. And the construction of the capability system stems from the decomposition of the combat mission, and the research on the model capability system for the requirements collection and analysis of the model, mainly the capability mapping relationship between the model and the task. The analysis is based on the uncertainty and non-quantitative features of the model task, it needs to be decomposed in layers to obtain the associated sub-task. The bottommost task is called activity, mainly is a description of the task execution node. The task is divided into sub-tasks,
and then the sub-task execution nodes are analyzed in detail to obtain the corresponding model activities and comprehensive analysis. Finally, the identity and similarity degree are checked.

In the demand analysis stage, the capability system describes the "potential" ability of the model to deal with the corresponding tasks, which essentially reflects the mission requirements. Therefore, the model has the ability to perform the corresponding defense. The assurance of combat missions is derived from the analysis of the sub-tasks of the model, and the capability elements are also the refinement of the basic capabilities of the model. In the same way, the sub-task continues to decompose to obtain a series of activities. The required capability atom is determined by analyzing the corresponding execution nodes and the relationship between the nodes. It is the most basic capability of the model to complete the task. The capability system mapping relationship mainly refers to the analysis of the capabilities and task sets related to the model based on the mathematical mapping relationship to establish a mutual mapping relationship. It can be seen that the comprehensive micro-analysis mechanism can effectively link the macro level and the micro level, and establish a capability system based on the above analysis. The specific steps are as shows:

**Step1:** Determine the model task according to the corresponding stage of the process;

**Step2:** Decompose the model task based on the task analysis to obtain the model sub-task set;

**Step3:** According to the sub-task set, combined with the analysis of the model, determine the capability elements needed to complete the sub-task, and analyze and simplify it;

**Step4:** Determine the mapping relationship between capability elements and model capabilities based on a comprehensive analysis;

**Step5:** Obtaining the model initial activity set by analyzing the sub-task execution node;

**Step6:** According to the model activity set, combined with the analysis of the model, determine the capability atoms needed to successfully perform the node activity;

**Step7:** Determining the relationship between the capability atom and the capability element based on the analysis of the demand support relationship;

**Step8:** Determining the capability system of the model based on the mapping relationship established above, the specific steps are shown in Figure 1.

![Figure 1 The model capability system construction process](image-url)
4. Model capacity index establishment

4.1. Design based on capability assessment index system

Since the new generation of the model is still in the development stage, this paper mainly studies the capability evaluation index of the model from the demand collection and analysis stage. Therefore, the main factors for analyzing the capability of the model should be from the model. In essence, the overall understanding is to examine whether the model requirements design meets the actual operational needs. And we can mainly analyze the influencing factors of model ability from the following aspects:

Task change factors: The air situation situation of the operations is dynamic, and the tasks that need to be processed have greater uncertainty and randomness. Therefore, the model needs to have effective response to mission changes;

Equipment components: The development of a new generation of the model is to solve the problem of “generational advantage” between the current weaponry and command models;

Combat style change factors: The combat style is closely related to the model task, and the task itself is dynamically changed. Therefore, the model needs to be appropriately adjusted according to the task or the style of the war to ensure the effective performance of the capability;

Rule criteria change factors: Rule rules determine the task processing methods, which often have a substantial impact on the model capabilities;

Situation changes and task overload factors: Situation changes mainly refer to air conditions and personnel changes. Task overload refers to the impact of the model on the ability of the model when it cannot handle sudden tasks.

Fig. 2 Conversion of the system to the capability indicator system
4.2. Identify the Headings
The transformation from the realization of the capability system to the capability indicator system is mainly based on the established model capability system and its priority relationship. This is the core link of the capability evaluation index model for constructing the model, as shown in Figure 2.

4.3. Capability Indicator System
The demand matching ability is mainly a comprehensive reflection of the mission requirements of the air defense and antimissile command and control model. According to the current new generation of air defense and antimissile command and control model research design concept, in order to effectively deal with the complex and volatile air condition environment, the model needs to be intelligently designed. Considering the commander's own subjective initiative, it is also necessary to design the human-computer interaction of the model. Therefore, it is necessary to fully reflect the above requirements in the process of model capability system analysis, and based on the analysis of the model task system. Further refinement to obtain the overall demand matching capability system, and finally to achieve the transformation of the capability system to the capability index system based on the relevant principles of flexible indicator system design, so as to obtain the corresponding demand matching capability index system.

The operational adaptability is a measure of the ability of the model to deal with internal and external changes and uncertain factors when dealing with air defense and antimissile command and control combat missions. The operational adaptability often needs to be analyzed from the whole process of the model processing task, according to the front air defense and antimissile The task analysis of the command and control model and the description of the basic characteristics of the capability can be refined into task adaptation ability, combat regulation adaptability, rule criterion adaptability, combat logic adaptability, time adaptability, personnel adaptability and environmental adaptability.

Model tolerance capability refers to the air defense and antimissile command and control model to make appropriate adjustments to the model itself in order to successfully complete the task. It often refers to the ability of the model to withstand the limited changes of the outside world and itself, that is, the air defense and antimissile command and control model is not required. According to the analysis of the model task system and the basic characteristics of its capabilities, the corresponding evaluation index system is designed, which mainly includes four aspects: task tolerance capability, operational component tolerance capability, rule criteria tolerance capability and operational logic tolerance capability.

5. Conclusion
In view of the shortcomings of the traditional air defense and anti-missile command and control model evaluation model, this paper conducts an in-depth study on its evaluation index system from the perspective of capability and gives the comprehensive ability to improve the ability of matching demand matching, operational adaptability and model tolerance. Evaluation of the indicator system. At present, the research on the air defense and antimissile command and control model based on the capability perspective has just started. The index system needs to be continuously improved in the subsequent research.
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References
[1] David S Alberts, R E Haves. Power to the Edge: Command Control in the Information Age[M]. Information Age Transformation Series, CCRP Publications, 2003
[2] David S Alberts. The Agility Advantage: A Survival Guide for Complex Enterprises and Endeavors[M]. Information Age Transformation Series, CCRP Publications, 2011
[3] Zheng Maoran, Yu Jiang, Chen Hongshan et al. Construction of evaluation index system for relay protection based on KPI[J] Journal of Shandong University (Engineering Science), 2017, 47(6): 13-19
[4] Li Jun Research on the evaluation method of capacity-based command and control system architecture [D] Nanjing: Nanjing University, 2017: 23-40
[5] Li Linlin, Lu Yunfei, Zhang Zhuang et al. Construction and modeling of indicator system based on information superiority [J] Systems Engineering and Electronics, 2017, 40(3): 577-583
[6] Wang Yong Research on Key Technologies of C4ISR System Facing Information Advantage [D] Xi'an: Northwestern Polytechnical University, 2007: 74-83
[7] Yan Shouchun Ground-to-air missile firing command and control model [M] Beijing: National Defense Industry Press, 2009: 1-90
[8] Liu Bin, HILL David John, Zhang Changfan, SUN Zhijie Stabilization of Discrete-Time Dynamical Systems Under Event-Triggered Impulsive Control with and Without Time-Delays[J] Journal of Systems Science & Complexity, 2018(1)
[9] Yushi Lan, Kebo Deng, Shaojie Mao. Adaptive evolvement of information age C-4ISR structure[J] Journal of Systems Engineering and Electronics, 2015(2)
[10] Refiner K Huber, James Moffat, David S Alberts. Achieving Agile C2 by Adopting Higher Levels of C2 Maturity" 17th ICCRTS, 2012, Paper Number:021
[11] Shen Zhaoqi Research on weapon system capability measurement method for VFT [D] Changsha: National University of Defense Technology, 2014: 4-34
[12] General Staff Department Chinese People's Liberation Army Military Language [M] Beijing: Military Science Press, 1997: 1-50
[13] Zhuang Wanyu, Ling Dan, Zhao Wei, et al. Research on the weight of agility evaluation index[J]. Journal of University of Electronic Science and Technology of China 2006,35(6):985-988
[14] Xie Mingxia, WANG Jiayao, YANG Aiming. DPSIR Model-Based Evaluation Index System for Geographic National Conditions[J] Wuhan University Journal of Natural Sciences, 2017(5)
[15] Li Song, Liu Jinsbusi, Zhang Jincheng, et al. Research on Modeling of Distributed Air Defense C3I Model[J] Systems Engineering and Electronics, 2003, 25(11): 1421-1423
[16] Lin Chi, Li Song Agility evaluation of air defense and antimissile accusation system based on subjective and objective comprehensive empowerment [J]. Journal of Air Force Engineering University (Natural Science Edition), 2018, 19(4): 31-37