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System Dynamics Based Simulation Approach on Corrective Maintenance Cost of Aviation Equipments

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Abstract

This paper first analyzes the causality of the maintenance and support (M&S) cost's generation; then draws the stock and flow diagram, establishes the correlation equation of stock, flow, instrumental variables, constants and determines their initial value; on the basis of the model reasonable, analyzes the model's calculation results, observes the change of the model results by adjusting model's parameters to determine the optimal strategy, provides decision support for decision-makers. Emphatically analyzes the influence of parts' failure rate and preventive maintenance rate on maintenance costs during the equipment's life circle. The analysis results have verified this paper's simulation method's practicality.

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1. Introduction

The RDTE cost and maintenance costs of aviation equipment are extremely high in the new era; the equipment's maintenance costs of US navy reached more than 200 billion US dollars every year. Since 1980s, the maintenance cost of aviation equipment was close to the sum of their research development charges and procurement costs, accounted for 14.2% of defense spending. Therefore, the studies of the principle of maintenance support cost's generation and development and the effective methods to decrease and control the maintenance support cost are important method to control the cost in equipment's whole life circle.

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The existed analysis of maintenance cost often considered the whole average of the maintenance support cost in a certain long time episode, so the cost's composition was relatively fixed, and the connection between maintenance factors would be ignored in the simplified analysis. If we quantify the connection between maintenance factors, we can comprehensively describe the equipment's maintenance process and its transient behavior by analyzing the interaction and constraints between these factors. Then we can interpret the generation of maintenance support cost, sequentially we can give the maintenance support system's analysis, design and improvement a right direction from the perspective of cost.

This research aimed to decrease the cost, took aviation equipment's corrective maintenance process as main research object, used system dynamic principal to analyze the dynamic characteristics of it, built a general model to describe it, the simulated it with computer. Provided an effective method to calculate, analyze and control the maintenance support cost.

2. Corrective Maintenance of Aircraft and Influence Factors about Cost

2.1. Corrective Maintenance of Aircraft

Corrective maintenance is also called repair or trouble clear mend. It is a repair activity to make the malfunctioned or broken equipment to recover to required technical state. It includes one or all of the following activities: malfunction location, malfunction isolation, decomposition, replace, re-install, adjustment, verification and fix the damaged parts. From this we can see the corrective maintenance's influence factors are from multiaspect. Firstly, the reliability of the equipment, it determines equipment's malfunction time in a certain time which has direct relation with the maintenance cost. Secondly, the testability, it determines the time spent on detecting, locating the malfunction, which directly influences working-hours. Another factor is reparability. When the equipment or part of it has good reparability, maintenance personnel can fix the malfunction in a short time with less tool, maybe less material. Therefore, the above factors must be considered.

Furthermore, the case intensity and operating environment also are factors that cause the aircraft fault. The longer time aircraft flies, the more fault will come out. When the fly environment is sever, such as low temperature, high temperature, high elevation, high humidity and so on environment problems, these will influences the fault rate. Therefore, these factors must be considered, too.

2.2. Corrective Maintenance cost's influence factors

Because different repair consumes its relevant resource, there may be lots difference between them. If we want to estimate the maintenance cost precisely, firstly, we need to know the specific model's maintenance activities which can be looked up in the maintenance scheme. When we use system dynamic methods to estimate the new researched equipment, we can take the similar one's main Aircraft's composition is complicated, thousands of components. We can't do all the simulation of each component. It's an impossible work, as a matter of fact, system dynamic method doesn't suggest to build models for every detail. Modeler can interact with experts, maintenance workers, maintenance recorders and finance staffs to determine the major components and build their models. The others' cost can be simplify or convert into these ones. We can do further simulation when subdivision is necessary.

Figure 1 shows a simple example for the problem of corrective maintenance. In this example, we assume that the corrective maintenance cost includes the corrective maintenance cost of repairable items with limited life, the corrective maintenance cost of repairable items with unlimited life, and the cost of repairable items. Figure 1 shows the composition of the cost and its effect factors. Figure 2 shows the causal loop diagram drawn by the software of Vensim.

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