The Exploration of Aerospace Engineering Project Management Method Based on System

Introduction

As an important part of national security strategy and comprehensive planning, the development of aerospace has become a symbol of national science and technology capacity. With the development of China's space industry, the complexity of aerospace engineering project development is gradually increasing, besides, the number and the scale of the aerospace projects are increasing day by day. Aerospace engineering development involves not only scientific and technical research but also complex project management in multiple fields and systems, which requires scientific and effective management methods. System engineering is just to organize and manage the planning, research, design, manufacture, test, and application of aerospace systems by applying the theories of operations research, information theory, and cybernetics and using information technology as tools. The application of system engineering has made an important contribution to the development of the aerospace field [1].

1. Background

Starting from the system concept, system engineering is a general term for the integrated organization, management, technology, and method that obtains the best of the whole system by the optimization method. According to Qian Xuesen, system engineering is a scientific method for planning, researching, designing, manufacturing, testing, and application in the organization and management of "systems", and it is a scientific method of universal significance to all "systems" [2]. The application of system engineering in aerospace engineering project management needs to combine the characteristics of the aerospace engineering project itself. The aerospace engineering project owns its unique operation mode and the following characteristics:

• There are many systems involved and a wide range of cooperation. Aerospace engineering projects involve the spacecraft system, the vehicle system, the aerospace engineering launching sites, the space measurement & control networks, etc. A single system also involves

different subsystems. For example, the vehicle system includes multiple subsystems such as structure, thermal protection, control, and measurement system. Therefore, aerospace engineering project development is cross-disciplinary, cross-organizational, and cross-industry, which requires very high integrated management capability.

- It is technically difficult and knowledge-intensive. Space projects are often faced with unprecedented technical difficulties. Scientific problems are coupled with engineering technology. To use the most cutting-edge research results in the field, a large number of ground experiments, simulations, and calculations need to be carried out, and a large number of researchers need to invest.
- The constraints are strict. Aerospace engineering involves a wide range of fields and has a great social impact. The project team needs to work under the guidance of organizational strategic objectives. The requirements of development progress and cost are gradually increasing. Besides, the vehicle's operating environment is extremely harsh and requires high reliability and safety. Therefore, it is necessary to comprehensively coordinate the relationship between schedule, cost, and quality.

2. Practice of system engineering in aerospace project management

The contents of system engineering are very abundant, especially aerospace system engineering including the activities of the whole life cycle from planning, design, manufacturing, delivery, service, and decommissioning [3]. After the long-term exploration and practice, China's aerospace project management has obtained eight management elements: system planning, technical status, cost and

schedule, product assurance, risk, material and comprehensive support, document and communication, and human resource management [4].



Figure 1. Phase division of a NASA flight project System.

To adopt system engineering, the life cycle and phase division of the project must be determined first [5]. Fig.1 shows the phase division of NASA's flight project. The stage division of a certain type of aerospace engineering project in China includes demand analysis, project demonstration, scheme, initial sample, sample, finalization and batch production stage.

System engineering is a synthesis of the technical and management processes. American system engineering expert A.·D.·Hall thinks that system engineering is a three-dimensional spatial structure composed of time, logic and knowledge dimension. System engineering also develops tasks from disassembling to integration in the time dimension in sequence, as shown in Fig.2 [6].



Figure 2. Decomposition integration process and development program.

In the process of aerospace engineering development, that is, task disassembling and integration, it is necessary to consider the implementation of the project from two dimensions. The first is the system composition, which is the physical structure of deliverable products, and generally consists of the top system and subsystems; The second is the activities of supporting system development, including design, analysis, production, test, etc [7]. These two dimensions are coupled with each other, and the systems and activities involved in these two dimensions need to be fully considered when developing work breakdown structure (WBS). Because of the large scale and vast units involved in aerospace engineering development projects, the WBS is much more complex than ordinary projects. Generally, the top layer of WBS of the aerospace engineering development project is the overall project, and the next layer is the sub-system. Both the whole system and the sub-system have design, production, experiment and other work, and then each work is decomposed into work units layer. Generally speaking, the work unit is a specific job, such as a single device, a test, etc., and the work unit can continue to be disassembled into inseparable work packages, and the corresponding responsible person is specified.

System engineering takes large and complex systems as the research object, and designs, develops, manages and controls them centered on the target. The overall design of China's aerospace industry has been continuously strengthened in the development practice, and plays a leading role in the whole development process, which makes the top system and sub-systems, sub-systems and sub-systems can effectively coordinate and cooperate with each other, which shows a strong space system development capability.

3. Difficulties and suggestions of aerospace engineering project management in china

3.1. Difficulties and problems in management

With the increasing complexity of aerospace research and development tasks, some management difficulties have emerged, which are mainly reflected in the following five aspects:

- The guidance and pertinence of planning in schedule management are insufficient. At present, the planning aims at user demand and organization strategy, and the work content of project development is decomposed into subsystems from top to bottom, and each subsystem is subdivided layer by layer to form a planning network diagram. In this process, on the one hand, the estimation of duration is unreasonable; on the other hand, the formulation of the plan only considers the logical relationship between tasks, but does not consider the constraint relationship of resources, which leads to big deviations between the plan and the actual progress [8].
- The progress management lacks an effective monitoring system. At present, the progress monitoring of aerospace projects is mainly based on the product development management platform in the system. However, due to the resource constraints and temporary problems in the development process, the actual progress will be out of line with the plan of the original management platform, and managers can only manually detect and adjust the plan, which will inevitably lead to some omissions.
- Professional interfaces are not uniform, and aerospace engineering development requires multi-disciplinary personnel to participate. However, there is no uniform standard for input and output files at present, and each major often needs to spend more time processing upstream and downstream data and files before carrying out its own professional analysis and calculation work.
- Lack of knowledge management tools, explicit and invisible knowledge such as specific work to be carried out, problems to be paid attention to and available resources in each stage of aerospace engineering project development have not formed organizational process assets, and the success of project progress also greatly depends on the potential quality of developers, and the related knowledge of project development has not been effectively centralized managed, that reduce the efficiency of project development [9].
- There are difficulties in the management and control of various changes. Because of the technical difficulties of aerospace engineering development and the participation of many organizations, changes are highly probable events. On one hand, changes are often caused by

unrecognized technical or management problems in the early stage, which will lead to the emergence of short-term projects with product design, commissioning and testing once more; On the other hand, after the change, it is necessary to fully analyze the impact of the change. At present, although the space system has a relatively complete identification and control system, it still needs to be further strengthened.

3.2. Suggestions on management methods

In view of the problems and difficulties in aerospace engineering project management in China, combined with the research of system engineering and project management at home and abroad, the following suggestions are put forward.

- Plan as scientific and detailed as possible When formulating project plan, it is necessary to closely focus on the user's needs and organizational strategy, take the scope management of the project as the basis, follow the principles of scientificity and comprehensiveness, consider the constraints of resources as much as possible, and make overall consideration of the work content included in project development by using WBS.
- Improve the project knowledge management system. According to the characteristics of aerospace project development, improve the project knowledge management system from the aspects of the knowledge management process, knowledge acquisition and sharing, knowledge management platform, etc., to further improve the efficiency of project development [9].
- Strengthen communication between relevant parties. Because aerospace projects are technically difficult and involve many units, it is necessary to monitor the progress of the project, strengthen communication among relevant parties, pay special attention to the management of changes for avoiding affecting the progress due to poor information.

4. Conclusion

System engineering can be used in the life cycle management of aerospace engineering projects with great technical difficulties and complex composition. It plays an important role in the establishment and development of the aerospace industry. The further development of the aerospace field also depends on the improvement of the management capacity. Facing more severe challenges, it is still necessary to constantly explore and improve the management methods of aerospace projects.