

# Research on Requirement Information Architecture of Civil Aircraft Development Flight Test

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**Keywords:** Civil Aircraft; Flight Test; Stakeholder; Requirement definition

**Abstract:** Based on the theory of system engineering, this paper summarizes the methods and requirements of demand identification, identifies the stakeholders of the test flight, captures the needs of various stakeholders, and finally proposes demand system architecture for civil aircraft flight test.

## 1. Introduction

Since the 1960s, the United States has attempted to introduce the concept of systems engineering in aerospace projects, and adopted a method of demand management in the project development process. Complete identification of requirements and identification of the requirements information architecture is the basis for demand management. Experience has shown that the use of demand management methods in complex projects can effectively manage the project development process [1]. As a typical complex project, commercial aircraft projects need to strengthen project management through demand management. Flight test is an indispensable part of the development of commercial aircraft. At the same time, it has many stakeholders and it is difficult to organize and manage. How to accurately identify test flight stakeholders, capture various requirements and determine the test flight demand system structure in the early stage of the project is the key to the efficient completion of the new model flight test of civil aircraft. This article studies this issue.

## 2. Capture the needs of flight test stakeholders

Stakeholders are individuals, groups, or organizations that influence project decisions, activities, or outcomes, as well as individuals, groups, or organizations that are or are perceived to be affected by project decisions, activities, or outcomes. The purpose of the complete identification of stakeholders is to further identify, acquire, coordinate and maintain stakeholder needs. This process is the initial process in the aircraft-level test flight requirements process, to standardize project requirements and to lay the foundation for new product design and realization [2].

Identifying stakeholders is the first step that stakeholders need to capture. The biggest challenge in building a stakeholder list is how to fully identify stakeholders. In addition to the upstream design and manufacturing units in the traditional sense, stakeholders in flight testing also have regulators, customers, aircraft suppliers and so on. The capture required by the stakeholders is shown in Figure 1.

Identifying stakeholders as early as possible is critical to flight testing. Effective synthesis, including trade-offs, mergers, compromises, and sequencing, should be based on the needs of the original stakeholders captured. There are a large number of situations in which the original needs of different stakeholders are mutually constrained and conflicted, such as conflicts in test airspace, conflicts between special flight test conditions and project schedules. For these parts, weight analysis, trade-offs and integration activities are required and repeated communication and coordination with relevant stakeholders is required to achieve a viable and multi-stakeholder stakeholder need. For different types of stakeholders, the important factors to consider in project decision-making are different, which means that the priorities of stakeholders for different

decision-making are different, so it is necessary to consider the importance of Priority order. The stakeholder related to the test flight is shown in Figure 2.

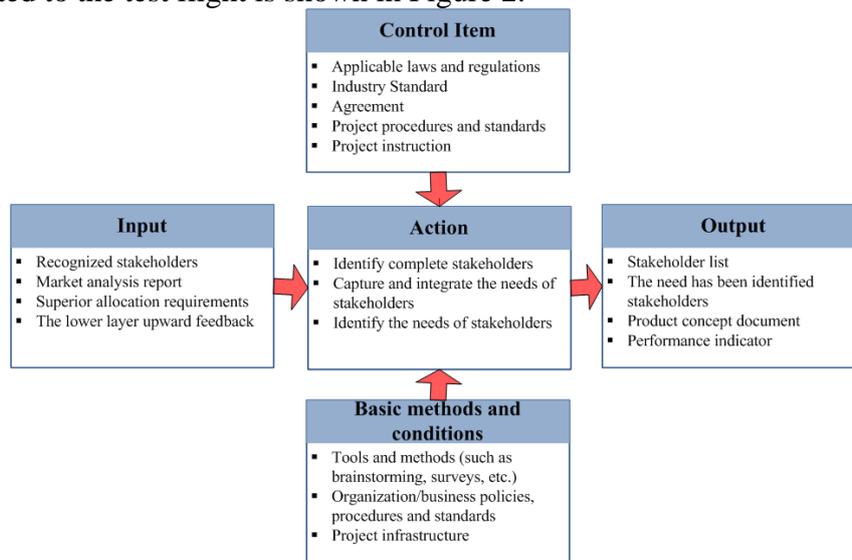


Fig 1. Stakeholders need to capture the relationship diagram

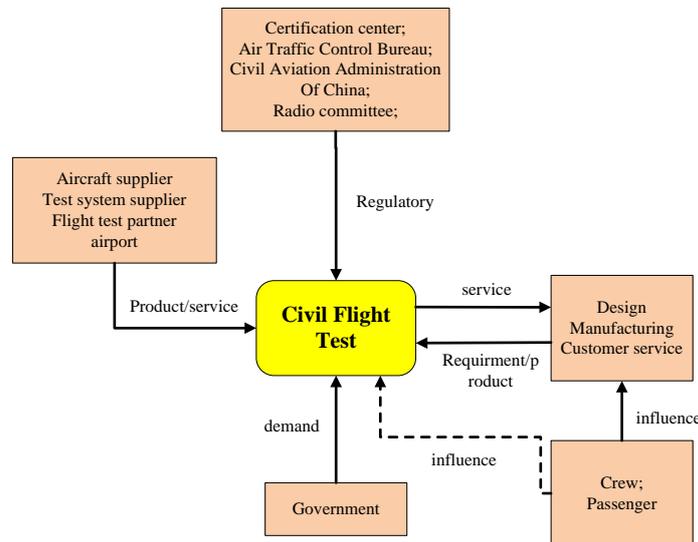


Fig 2. Flight test related stakeholders

### 3. Flight test stakeholder needs

After the stakeholder needs to capture and perform a functional analysis, formal technical requirements are generated through demand analysis. The process of requirements analysis consists in reviewing, evaluating, ranking, balancing all stakeholders and derived needs based on the results of functional analysis and translating those requirements into system functions and technical descriptions that meet the needs of stakeholders [3]. The requirements analysis process activity is shown in Figure 3.

Stakeholders tend to have a wide range of needs and have large levels of difference. Some need to be converted to test flight requirements, while others cannot. Based on the need to capture the initial stakeholder needs, these needs are analyzed to obtain the requirements for flight testing. The quality function deployment method can be used to classify and prioritize the needs of stakeholders based on the key metrics specified in the previous step. These requirements are subsequently processed and disaggregated based on importance and priority to obtain technical specifications for flight tests.

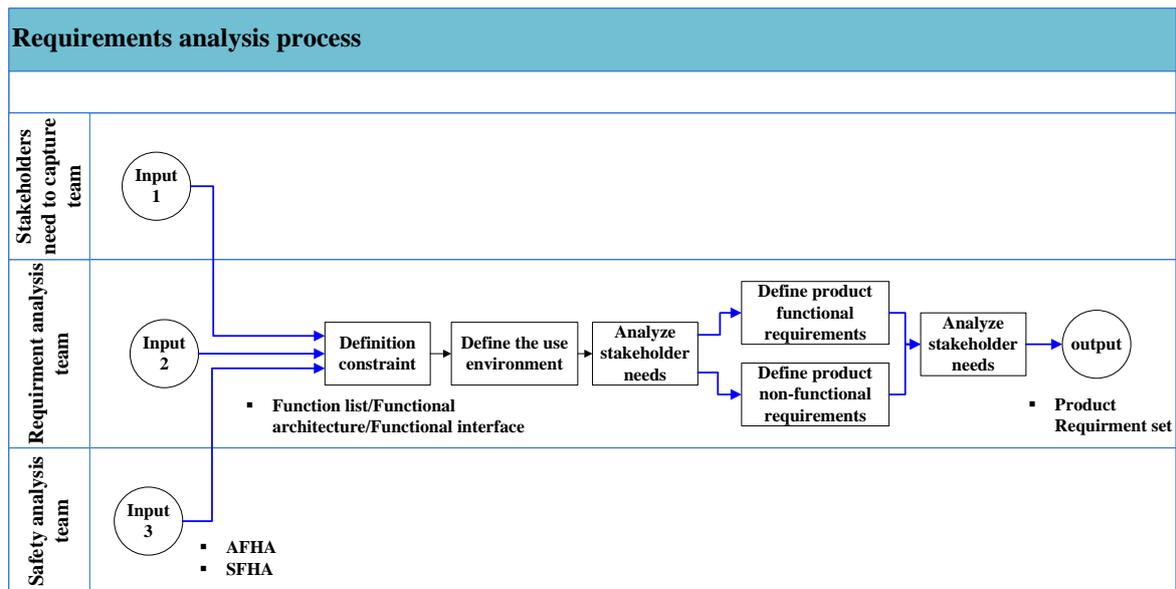


Fig 3. Requirements analysis process activity diagrams

Good requirement should have the following characteristics:

- 1) necessity;
- 2) concise;
- 3) Neutrality
- 4) feasibility;
- 5) Independence
- 6) consistency;
- 7) Traceability;
- 8) Clear;
- 9) Verifiable.

For the flight test requirement set, it should have the following attributes:

1) Integrity: The integrity of the flight test requirements set means that this set can fully describe all aspects of the flight test and does not require special instructions or descriptions to supplement it;

2) Consistency: The requirements in the flight test demand set should not contradict each other and conflict with each other.

The forms that define requirements are common with text and graphics. When defining requirements with graphics, the following should be included:

- 1) Determine the use of the model;
- 2) Identify the tools to be used and their use in the development process;
- 3) Define modeling standards and databases to make the model easy to understand.

When using text to represent, you should follow the requirements standard architecture. The main structure of the demand should be: “Subject + Shall + Verb + Description”, and adjectives such as fast, good, maximum, minimum, and similar cannot be used in the demand.

In the development of new models of civil aircraft, the requirements related to flight test are first defined in the top level of the project. The test flight requirements included at the top of the project are:

1) The project should plan and establish the ability to finish the development and certification flight test, production and delivery flight test.

2) The project shall use the comprehensive number of tested and modified test machines to conduct test flight and on-board verification;

3) The project flight test activities shall meet the laws, regulations and relevant requirements of the State, local government, civil aviation administration and military methods;

4) The prototype of the project model should be planned for the test after the end of the test. The

sale (discount) should be used as much as possible, but it can also be considered as a secondary use method such as ground test equipment and training equipment.

#### 4. Flight Test Requirement (FTR) Information Architecture

As an important part of complex system engineering, the requirements of the flight test process run vertically through the top of the project to the parts of the product, horizontally from the life cycle of the project, so an effective method must be used to manage the flight test requirements. Flight test requirements are typically managed with demand information architecture. The Requirement Information Architecture (RIA) is a topological relationship diagram used to represent the requirements file category, requirement hierarchy, and relationship between requirements. The demand information architecture is generally represented by a tree structure block diagram, as shown in Figure 4. The tree structure of the demand information architecture contains at least the following four basic elements [4]:

- 1) Requirements Implementation Scope
- 2) Requirements classification
- 3) Requirements Level
- 4) Requirements Topology Relationship

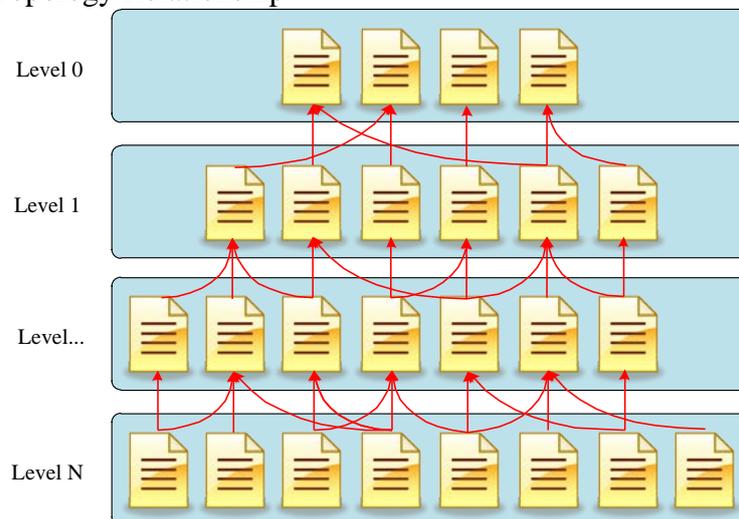


Fig 4. Schematic diagram of the demand information architecture

The requirements information architecture has the following uses [5]:

- 1) Build a database of requirements management platform
- 2) Define requirements traceability link
- 3) Product integrated design and integrated management
- 4) Demand confirmation and verification management
- 5) Project Management

In general, the project's demand information architecture is divided into six levels: business requirements and objectives (BRO), aircraft development requirements and objectives (ADRO), aircraft-level requirements, system-level requirements, and subsystem-level requirements and work-level requirements.

Aircraft-level requirements can be classified into four major areas: design, customer service, manufacturing, and flight testing. Each level of demand in each field has a downward-grading and decomposed relationship, and upwards can be traced back to the top level aims. The correspondence between subsystem level requirements and work package level requirements is determined by the actual supplier selection and subcontracting situation.

The BRO and ADRO contain the inclusion of the top of the flight test and are broken down into aircraft-level requirements. Down from aircraft-level requirements can be further broken down into system-level requirements. The planning of system-level requirements is based on the Project

Product Decomposition Structure (PBS) and is coordinated with the Work Breakdown Structure (WBS) and the Organizational Breakdown Structure (OBS). The civil aircraft flight test demand information architecture can adopt the architecture shown in Figure 5.

Through the establishment of the Integrated Project Team (IPT), the project enables the engineering, customer service, manufacturing and flight test personnel to participate extensively in the demand capture/function definition work of each system, thus ensuring the inclusion of aircraft/system level related requirements documents in various fields. Relevant needs from the fields of design, manufacturing, customer service and flight test.



Fig 5. A flight test demand information architecture

## 5. Conclusion

This paper introduces the identification methods of stakeholders, captures the stakeholders involved in the pilot flight development of civil aircraft, introduces the process of demand analysis, analyzes the test flight requirements included in the top level of the project, and analyzes the methods of the demand information architecture. The flight test requirements are broken down into five levels to complete the flight test demand management.

The article gives the process of flight test demand capture and the method of flight test demand management, which can provide reference for the management of test flight demand in the development of other civil aircraft.

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