The Application of Object-Oriented Method in the Development of Large and Complex Test Projects

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***Abstract*—In this paper, we are first analyzed the essence and connotation of object-oriented method, and introduced the basic process of test project development. Then it proposed a development method of the object-oriented test, which standardized the development process, and solved the problem of test risk control in the design and development of the project. Finally, it introduced the development process of large and complex test projects by object-oriented method.**

Keywords—Object-oriented; test identification; project development

I. INTRODUCTION

With the gradual improvement of the information level of electronic information equipment and the continuous updating of the technical system, the diversity and complexity of the system become more and more significant. The overall design and implementation of the electronic information equipment test tasks is becoming more and more complex. The traditional single mode test design and management technology has gradually been unable to meet the requirements of this new large and complex test task. This paper introduces a test project development based on the object-oriented method. It puts forward a better solution for standardizing the design and controlling the risk of large and complex test tasks.

II. THE CONCEPT OF OBJECT-ORIENTED METHOD

A. The object-oriented Method

The object-oriented method is based on the epistemology and methodology. It used object to understand and analyze the problem space, then design and develop a solution space composed by objects[1]. Since the problem space and the solution space is all composed by objects, the problem cause by the inconsistency between the problem space and the solution space structure can be eliminated. In short, object-oriented is to face the thing itself, and the object-oriented method is to use the object-oriented analysis process to understand the objective world and solve the objective world problems.

In the field of engineering design, the objects have two basic characteristics, one is data and the other is operation. Data is used to represent the static attribute of an object, and it is the state information of the object; operation is used to change the dynamic behavior of the state information of the object. When analyzing the problem space ,the object-oriented method don't describe the specific objects, but abstract their common structure and behavior characteristics, and make a unified description. It avoids data redundancy and repetition of the operation instructions.

B. The object-oriented methodology model

The object-oriented methodology usually establishes three models to study the problem space, the object model, the dynamic model and the function model.

The object models represents static, structured, and systematic data properties. It is a mapping of the relationship between the objects in the problem space and describes the static structure of the system. The object models exists in the form of object classes abstracted from objects of the same data properties[2].

The dynamic models represents instantaneous, behavioral and systematic control processes. It specifies the sequence of legitimate operations of objects in the object model. The essence of dynamic model is to describe the basic operation process of the research problem space, and to describe the basic operation process in a modeled way. It specifies how the object provides services and interactions to the outside world.

The function model shows that the system can provide stable functions, and it specifies the functions of objects in the object model[3]. The essence of the function model is to

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describe what services the problem space can provide to the outside world.

In the three models, the object model is the most basic and important model, which lays the foundation for the other two models. Firstly, the object oriented methodology establishes the object model for solving the problem domain, then establishes a dynamic model describing the behavior of objects based on the definition, dependency relations and behavior rules of different classes of objects. Finally, the function model of object classes is built according to the services that can be provided by the object class during the change process.

III. THE PROCESS OF TEST PROJECT DESIGN

A. The basic process of test

Usually, the test work is divided into six stages, mission requirements, overall design, support needs, detailed design, test implementation, analysis & summary. Each stage has different work priorities and objectives, and it is necessary to form solid results. Some achievements need to be reviewed, and some results need to be approved by higher authorities, so as to provide guidance and support for follow-up work. As shown in the "Fig. 1".

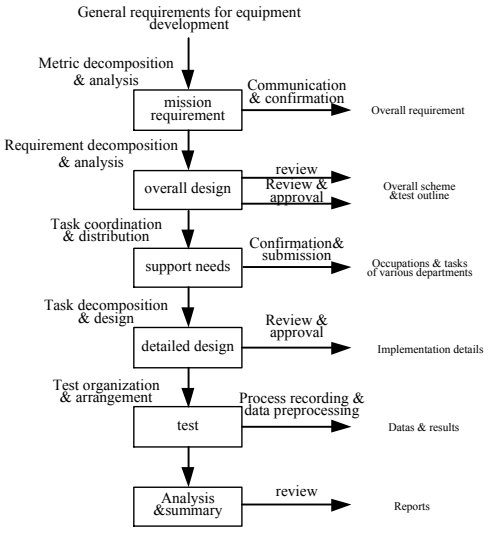

Fig. 1, The basic process diagram of test

B. The main work in each stage

1) the requirement analysis

Requirement analysis refers to the analysis of the technical metrics of the under-proof products. The testing units generally appraise and examine the products according to the general requirements. Test requirement analysis is the process of understanding the technical metrics of the subjects. In the process of requirement analysis, we need to organize higher authorities, product users, argumentation units, and development units to discuss and analyze each index item by item, and determine the specific meaning, scope of application, application boundary conditions and other requirements of each index. The tester of the testing unit analyzed and explained the requirements, and formed a memorandum or summary to avoid ambiguities and disputes in the future. In short, requirement analysis is the process of defining the scope of the test and the specific meaning of the test index, so as to provide a basis for the overall design of the test.

2) the overall design

The overall design process ,which based on the analysis of the test requirements, is a process of preparing the general test plan and the test outline. The overall test plan needs to design and explain why each index is evaluated in this way, and the test outline directly specifies how each metric should be assessed. The overall test scheme should start with the realization of the basic method and clarify the relevant factors of the test. The test techniques and methods designed in the general plan should adopt mature or experienced technical methods as far as possible, so as to reduce the risk of testing. The new technology and new methods which must be adopted should be determined by risk analysis and review evaluation. The test outline don't need to explain why is each metric so assessed, but it should specify specific assessment methods for each metric concisely and clearly. After approval by the higher authorities, it is the programmatic basis for the implementation of the test.

3) the support needs

The approval of the test outline marks the determination of the basic framework of the test work. The test unit needs to complete the internal organizational division of labor and the establishment of organizational structure according to the content of the test work and the needs of each work. Support needs usually include, support with test equipment, command support, communication support, site support, meteorological support, logistics support and so on. The support needs should sent to the protection unit in the form of formal document

notification, so as to ensure the implementation of various safeguards.

4) the detailed design

The detailed design is the specific requirement for the implementation of test technology. There are two ways to draw up detailed test implementation rules, one way is to start with data-oriented, design it from top to bottom. Because the final test is to get the data and analysis data to judge whether the product is qualified, so the test process is the process of obtaining data, analyzing data and evaluating data. The second way is modular design using function decomposition. This is mainly aimed at the internal security needs of the pilot units, which is also considered in the process of testing outline, but it is not specific enough. In the detailed design stage, each test subject and each safeguard method must be divided into independent parts, so as to facilitate the implementation of the test organization.

5) the test implementation

The test implementation is a process of drawing up the test plan, organizing the test implementation, recording the test data and dealing with the test problems, which based on the implementation rules formed by the detailed design. As a complex system engineering, some unexpected problems will inevitably occur during the implementation of the test, including technical and environmental problems, human errors and so on. Therefore, the most important task in the test implementation is to avoid problems affecting the test and to deal with various emergencies. In the process of test implementation, all kinds of problems or incidents must be classified, and the scope and procedures of the test personnel should be stipulated to ensure the efficiency of the test.

6) the analysis and summary

Analysis and summary is the process of comprehensively and systematically analyzing the data collected and pretreated during the test process, compiling the test report and the test technical summary report after the end of the test. The test report shows whether the technical metrics of the products meet the overall development requirement. It is a comprehensive evaluation of the tested products, which can be used as the finalization basis. The technical summary report mainly analyses and summarizes the solution of key technical problems in the test process, which can be used as the technical summary of the test unit to support the follow-up similar test.

IV. THE ENGINEERING CONCEPTS AND METHODS FOR TEST PROJECT

From the six stages of the development and implementation of the test project, we can see that the test project is a project that is well organized, well managed and coordinated by all kinds of personnel. It mainly includes three basic elements: method, available resources and process. The method is to complete all kinds of technologies adopted in the test project, and the available resources are the various environments and conditions that must be used in the test project. Therefore, the engineering project management is carried out, and the test is defined as a project, and the project is studied according to the concept and method of engineering. The core of engineering is to combine the proven management method, the best available technology and effective resources, in order to reduce project cost and achieve higher efficiency and quality. The key to design and manage test items by engineering methods is to control the complexity and risk of the test.

A. The test complexity control

Usually, a large and complex test project needs to solve a lot of problems for various reasons, including test methods, guarantee conditions, personnel cooperation and external communication. All these will lead to very complicated test work. According to engineering methods, the central task of test engineering is to reduce complexity and decompose complex problems so as to make them operable and manageable. For test engineering, reducing complexity and decomposing problems is the process of decomposing test objectives, metrics and test methods.

The hierarchical decomposition method is commonly used in engineering complexity decomposition. It is a result oriented tree structure composed of various parts of the test project, which determines the whole contents of the test project. The decomposition of each test is different, but there is some degree of similarity between the test items. Usually, it decompose the test items into smaller, easily organized and implemented components, until sufficiently detailed. The general steps are as follows.

Step 1, identify the main components of the pilot project, including the boundary, connotation and objectives of the test project. That is, tested products, main inspection technical metrics and test objectives.

Step 2, verify whether each component is decomposed in sufficient detail for test design. If each component is decomposed in sufficient detail, take step four, otherwise step three. In other words, different components have various decompositions.

Step 3, define the test method and test conditions.

Step 4，check whether the decomposition is correct. Mainly from the following aspects to check: A. Compared with the decomposed elements, the adequacy and necessity of low level elements to be realized; B. Clearness and completeness of boundary determination for each element; C. Rationality of implementation plan for each constituent element.

The results of work structure decomposition should be solidified. On the one hand, it is easy to analyze and evaluate the decomposition process and ensure scientific integrity. On the other hand, it facilitates the communication between test items. A decomposition diagram of a large and complex test is shown in the "Fig. 2"

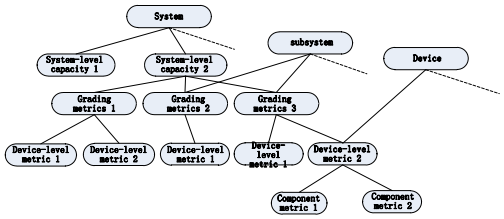

Fig. 2 Decomposition of a large and complex test

Through the analytic hierarchy, the test equipment that need to be evaluated and the main technical metrics are decomposed into each measureable and assessable units gradually. Develop appropriate and correct methods for each unit, then we can evaluate the whole test project.

B. The test risk control

Risk control is the primary problem in engineering design. Because product testing is a highly innovative project of great importance, the risk of testing should be first controlled. The various test risks are hidden in all steps. If these risks are not controlled and solved timely, and gradually taken into the next stage, it is extremely difficult and complex to make future modifications, even can't be remedied. According to engineering experience, the overall trend of changing the cost at different stages of the project is shown in "Fig. 3".

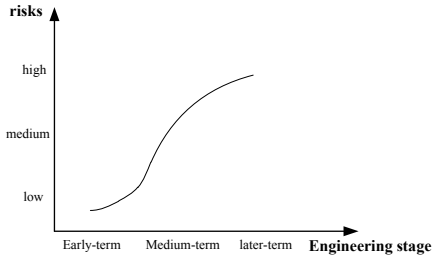

Fig. 3 Schematic diagram of the trend of risk and cost at different stages

The test item project is a sub project in the major project of product development. Therefore, the relationship between product development must be considered in the test. The future improvement and the use of products must be considered. In the design of test items, risks must be controlled as early as possible. Risks controlling is mainly in the task requirements and the overall design of the pilot project. The risks of understanding the technical metrics of the product and the risks of the key technology in the overall design of the test must be strictly controlled in the early stage of the test project.

The risks of understanding technical metrics in task demand are mainly avoided by communicating with the overall demonstration unit and the superior authorities in the preparation process. Organize seminars if necessary. Usually, problems not identified on the seminar should be further solidified in the form of test methods at the test outline review conference, in order to understand the technical metrics. When the key technologies can't be completely resolved or verified in the overall test design, the application of new technology in the test process should be controlled. In the overall test design, we must make a full demonstration. Organize the verification in advance if necessary.

V. THE OBJECT-ORIENTED ANALYSIS METHOD IN THE TEST PROJECTS

A. The object oriented decomposition in the test projects

Through the research of the object-oriented method and the analysis of the main contents of the test project, we can see

that the test project is more suitable to use the object oriented method to analysis and design the test projects. The implementation process of the test projects is a process of division and coordination between each department in the test implementation unit. The overall goal of the pilot project is to reduce the risks and ensure the successful completion of the task, which is also the problem space to be solved. According to the object-oriented analysis method, firstly we need to build object models according to the problem space.

The object model of the test projects is to classify the function departments of the test implementation units according to the coordination relationship of the test organizations. The classification is based on their work contents and responsibilities in the whole test projects. The dynamic model is the process of carrying out the test work and obtaining the test data according to the test work flow and the tasks undertaken . The function model of the test projects is the functions provided by the existing function departments, specific implementation units, etc. Function models are divided into two categories from the top level: overall work function and support function.

Through this division and design, the test engineering process can be summarized as follows: The whole process of the test projects is realized by the completion of the general work and the support work (function model) according to the working process (dynamic model) by the testing units (object models).

Different tests are the application of the above three kinds of models in specific tests. The object model and dynamic model are determined by the organizational structure of the test unit and the division of functions among different departments. The main difference in the applications of various models in specific tests is the realization of function models.

The overall work in the function model can be divided into the overall organizational command and the overall technical implementation. The main body of organizing and directing the overall work is the leading organ of the test implementation unit, and the main body of technical implementation is the tester system. In the function model, supportability work can be assigned to different business departments according to their functions, and each business department has specific operations. On the basis of this decomposition analysis, the design and implementation of the pilot project can be further summarized, that is, the support unit implements the specific tasks assigned by the overall unit .

Therefore, in the process of object-oriented decomposition of the test project, it is very important to establish a complete function model, and the key to the function model is to decompose and assign the overall work of the project.

B. The analysis of the test item function model

From the perspective of risk control, the overall work of the test projects function model can be divided into three aspects: First is the pre research of the key technology of the test; second is the analysis of the test demand, the risk analysis, the compilation of the outline and the plan; third is the judgment of the test result, the compilation of the report and the data reuse. The most critical test work of the analysis and design of the test projects is to control and reduce the risk, and the biggest risk in the overall test is the risk of the key technology. However, the research of key technologies often takes longer time to accumulate. Some key technologies need to be verified before they can be applied to the test. But the test task has a deadline, so this work can not usually be carried out after the start of the test project.

There are three ways to carry out the research on the key technology of the test: first, communicate with the equipment demonstration unit before the inform of the test task, master the possible test contents in the next two to three years, and carry out the pre research accordingly. Second, we should strengthen the analysis of scientific and technological information, track the direction of the technological development of the tested equipment and the demand for equipment, and make a pre research on the new technology, new ideas and simulation equipment for a certain scientific research stage, and serve as a technology reserve. Third is that plenty of our equipment is copying the foreign equipment, so we can carry out research on the foreign equipment which technologically advanced and successful application in local wars[4]. At the same time, some technology methods that can be widely applied in future tests should be determined in a standard form.

VI. CONCLUDING REMARKS

In this paper, an object-oriented analysis and design method is proposed for large and complex test projects. The key points of each stage of the test project are described. The test complexity control and risk control methods are introduced. Finally, the application of the object-oriented analysis and design method in the test project is studied, and the analysis method of the function model in the test project is mainly introduced. Some of the research results in this paper have been applied in the overall design of some large and complex test task.

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