



# Application of robust design in engineering software testing

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## ABSTRACT

According to the characteristics of engineering software testing including development process self-testing, tripartite testing and identification /type testing, a engineering software testing method based on robust design is constructed, and the technical means of application of demand centered, system design and work breakdown structure in software engineering are proposed to achieve the purpose of engineering software testing process, we need to go through four stages: test requirement analysis and planning, test design and implementation, test execution and test summary, and apply different techniques and methods of robust design to ensure the application of engineering software test in software engineering. The experimental results show that the method is clear and can ensure the reliability of engineering software testing process and improve the quality of military software testing.

## CCS CONCEPTS

•CCS→Software and its engineering→Software creation and management→Software verification and validation→Formal software verification

## KEYWORD

robust design, software test, reliability engineering

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## 1. INTRODUCTION

Engineering software testing process is a necessary stage of engineering software. Engineering software testing generally includes three testing processes: development process self-test, third-party test, software qualification/type test. Each test process will basically go through the test requirements analysis and planning stage, test design and implementation stage, test execution stage and test summary stage. After the completion of

engineering software design, the quality of engineering software testing process is directly related to the reliability and quality of software. Therefore, it is more and more necessary to pay attention to the stage of engineering software testing process. In the process of engineering software testing, the robustness of engineering software testing process is achieved by adopting the robust design method, the technical means of demand centered, system design and work breakdown structure applied in software engineering. Ensure the reliability and quality of the three testing processes of engineering software development process test, engineering software third-party test and engineering software qualification/type test.

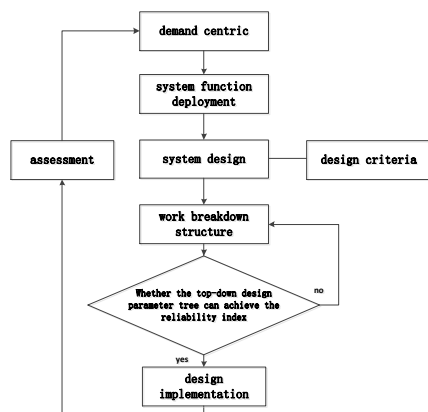
## 2. PRINCIPLE AND APPLICATION OF ROBUST DESIGN

Robust design makes the performance of the designed system insensitive to the fluctuation of the manufacturing process or the change of its working environment [1]. Although the components will drift or age, the system can continue to work at an acceptable level in its life cycle. Its main element is to make the product robust, insensitive response has a strong resistance to various interference factors inside and outside, and can work normally in a certain time and under certain conditions. Reliability is the ability of the product to complete the specified conditions and within the specified time [2]. From the definition point of view, robust design is to better ensure the realization of engineering reliability.

The principle of robust design consists of three parts: 1) conducting in-depth demand analysis to understand the design purpose of the product; 2) improving the overall technical quality of the product through overall scheme optimization and technical innovation; 3) reducing the fluctuation of product quality through stability optimization design to improve the anti-interference ability of the product. These three principles are to improve the reliability of products, so as to meet the needs of use in the product life cycle [3]. The design principle of reliability is to eliminate hidden dangers or weak links in the design process by adopting design prevention and improvement measures. In essence, the purpose of robust design and reliability design is basically the same.

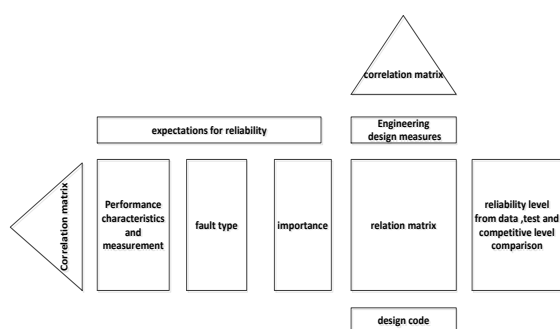
Robust design adopts the technology of requirement centered, system design and work breakdown structure in software engineering. The system design adopts top-down, axiomatic design principles, creative problem-solving methods, and follows the process of scheme design. The early stage of software product design is guided by reliability design.

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**Figure 1: Flow chart of robust design applied in software engineering**

In the reliability design, the requirements are taken as the center to expand the corresponding multi-level matrix through the method of quality function expansion, and the analysis is carried out in the engineering design. The expansion of reliability function is shown in Figure2.



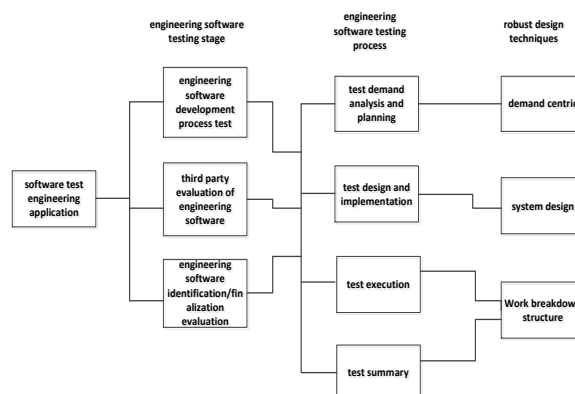
**Figure 2: Reliability function deployment**

### 3. USING ROBUST DESIGN METHOD TO TEST ENGINEERING SOFTWARE

Software testing is a necessary stage of software engineering [4], and the purpose of software engineering is to improve software reliability and ensure software quality. Engineering software testing mainly includes three processes: development process testing, tripartite testing and qualification/type testing. The software engineering software development process test is the software internal test carried out by the development unit according to the overall test requirements of the project, including four stages: test demand analysis and planning, test design and implementation, test execution and test summary. Mainly from the requirements coverage, test case execution rate and test defect acceptance rate to measure the degree of software reliability. The third-party testing stage is that the overall unit of the project entrusts the evaluation institution with software evaluation qualification to carry out the third-party evaluation service according to the third-party evaluation scheme and relevant laboratory quality management system [5]. The three-party evaluation program also includes four stages:

test demand analysis and planning, test design and implementation, test execution and test summary. It mainly measures the reliability level of software evaluation work from the detection degree of three-party evaluation defects. Appraisal/finalization test refers to the appraisal/finalization test service carried out by the evaluation institution with software evaluation qualification entrusted by the project competent authority according to the appraisal/finalization test scheme and the corresponding laboratory quality management system. Appraisal/finalization test also includes the test demand analysis and planning process, test design and implementation process, test execution process and test summary process, mainly from the appraisal/Determine the detection rate of serious defects to measure the reliability of software evaluation.

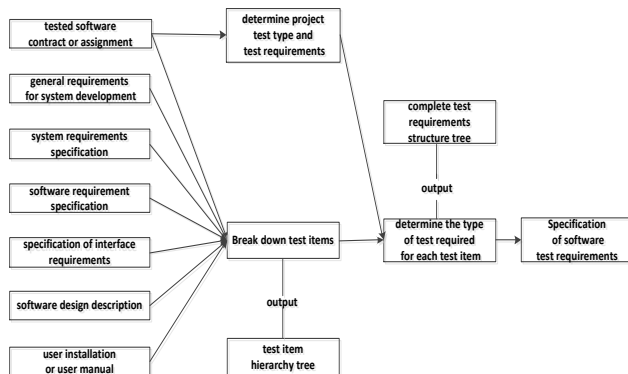
From the three testing processes of engineering software testing, we can see that each testing process must go through the analysis and planning of testing requirements, test design and implementation, test execution and test summary. In the four stages of test requirement analysis and planning, test design and implementation, test execution and test summary, the technical methods of requirement centered and system design and work breakdown structure in robust design are adopted consistently. The robust design method of engineering software test is shown in Figure 3.



**Figure 3: Robust design method of engineering software testing**

With the demand centered method [6], for engineering software, the demand is mainly based on tactical and technical indicators, and based on the specification of software requirement, the demand tree is constructed. Distinguish the basic requirements and feature requirements, which define the necessary capabilities of the software. It is a kind of expectation to the function and performance of software that the characteristic demand has the recessive demand. The division method is method is based on the quantitative evaluation. The importance of requirements is divided into five levels. Level 1 does not affect the function realization at all, level 2 does not affect the main function realization, level 3 has some important influence on the function realization, level 4 has an important influences on the function realization, and level 5 is a general and particularly important requirement related to safety. For engineering software testing [7], according to the importance level of the tested engineering software, it can be divided into

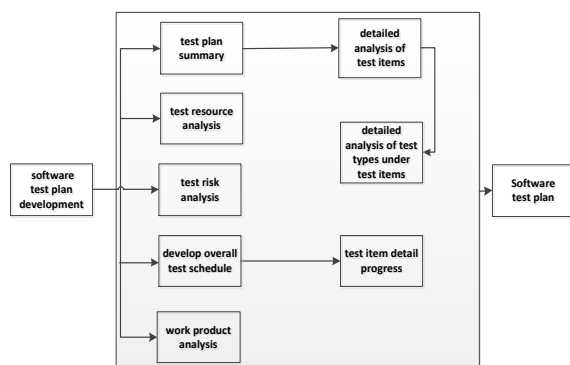
A-level, B-level and C-level to select the corresponding requirement importance to the corresponding test requirement analysis and planning stage in the process of engineering software testing [8]. The test requirements analysis process of applying robustness design is shown in the figure.



**Figure 4: Engineering software test requirements analysis process**

For system design, there are two basic principles, the first is the principle of independence, the second is the principle of information. The principle of independence is also called the principle of modularization, which is characterized by specific components and specific functions. It can greatly reduce the coupling between modules. The realization of uncoupling based on the principle of independence is better than coupling. The principle of information is called the principle of simplification, that is to say, the design with the least amount of information is the best design idea.

The purpose of system design is to find an optimal technical scheme, which generally selects the top-down design idea. Through in-depth analysis and selection of requirements as the center, function allocation starts from the top level of the system modular design according to the system design principles. In software testing, system design techniques and design principles are used to analyze engineering software requirements and carry out modular and uncoupled design. An optimal software evaluation plan is obtained [9]. The design flow chart of engineering software test plan is shown in the figure below.



**Figure 5: Engineering software test scheme design process**

The work breakdown structure is divided into a top-down hierarchical system based on the generated design parameter tree. This system shows the relationship between each work and their relationship with the whole, showing the relationship between the whole system and the level. In the process of engineering software testing, the test specification based on the test plan is the product of work breakdown structure. The following test records and test summaries are the product of work breakdown structure of engineering software test system.

## 4. EXPERIMENTAL VERIFICATION

A terrain vehicle is mainly used for personnel mobility, multi-purpose transportation, combat support and service support. The car is composed of seven subsystems: power, transmission, steering, braking, load-bearing, body and electrical appliances. Its reliability mainly considered from the following two aspects: a) the acquisition controller software filters all the acquired data to reduce the numerical fluctuation; b) when the data collected by the acquisition controller software exceeds the normal range, it is discarded. If the data caused by external sensor failure or connection problem is outside the normal range in a very short time, the default value can be automatically and reasonably filled.

According to the robust design software testing scheme, the user requirements centered method is adopted to ensure that the system can meet the tasks of personnel mobility, multi-purpose transportation, combat support and service support. Reliability design is developed through quality function by using system analysis. The system needs to complete three testing processes: software development process test, tripartite test and identification/finalization test. Each test process must go through the process of test requirement analysis and planning, test design and implementation, test execution and test evaluation. Through the work breakdown structure, the two aspects of reliability requirements that need attention are carried out in the test demand analysis and planning stage, and the test contents of the two aspects of reliability are respectively described in the test plan. Through the test case design in the test description, through the test record to verify the system design defects, and whether to meet the requirements of software engineering. If the defect does not satisfy the reliability design, it can be regressed until the problem returns to zero. Finally, in the summary of the test, the test process truly and objectively describes whether the system can meet the needs of users, in order to achieve the expected purpose. Software development process self-test, third-party test, qualification/type test three test stages are carried out by this method in each stage of practical activities.

## 5. CONCLUDING REMARKS

In the process of engineering software testing, robust design method is adopted, which is applied to the three testing processes of engineering design and development process self-test, third-party test and qualification/type test. In each testing process, the corresponding robust design technology method is adopted in the four activity stages of test demand analysis and planning, test design and implementation, test

execution and test summary to ensure the engineering software Reliability and quality of test activities. Marriage shows that the technology of robust design centered on requirements, system design and work breakdown structure can be used to improve the reliability level of software testing process and ensure the quality of engineering software testing in every stage of software testing process.

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