Advancements in the V-Model

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ABSTRACT

Software Testing is the most important phase of the Software Development Life Cycle. On most software projects testing activities consume at least 30 percent of the project effort. On safety critical applications, software testing can consume between 50 to 80 percent of project effort. Software testing is essential to ensure software quality. Schedule is always running tight during the software system development, thereafter reducing efforts of performing software testing management. In such a situation, improving software quality becomes an impossible mission It is our belief that software industry needs new approaches to promote software testing management. The article discussed the model that already existed, further excavates the parallelism between test stages and maintenance test stages and tries to propose a improved V model. This model make the software testing pass through the each stage of software development cycle. That can discover software mistakes as early as possible.

Categories and Subject Descriptors

D.2.4 [**Software Engineering**]: Software/ Program Verification—Model Checking

General Terms

Performance, Reliability, Security

Keywords

V-model, Software Testing, Software Engineering, Software architecture, Software Development Life cycle

1. INTRODUCTION

Today the IT Solutions & Products involve large investments and critical data of the organisation concerned. During development and maintenance of such long lived software, requirements are analysed, designed and code modules are developed, testing is planned and code is tested many times. Thus software development and maintenance services should ensure customer satisfaction. This calls for software developer to ensure the quality of development, implementation, testing and as well as maintenance. Since the schedule of software development is running tight, resulting in less effort for testing and maintenance. As testing directly links to quality of product, this demands that solution provider creates strong Testing and Maintenance Base for the technology solutions.

What should be done to enhance the software testing management? We should have well techniques for testing supported by simple and clear model to be followed to avoid unnecessary ambiguity. This articles present two-dimensional approach for managing testing. Firstly we need a testing that incorporates testing into the entire software development life cycle. Secondly software testing management has to introduce the concept of software architecture to gradually enhance its software testing management. This paper discusses the traditional V-model in detail and the advanced V-model that has basically emphasizes on the software maintenance.

2. SOFTWARE TESTING MANAGEMENT

The software architecture is the key towards an efficient software testing management. We here briefly describe the architecture of the software in this section.

2.1. What is Software Architecture?

The term software architecture as defined by Jacobson is the set of models to be built, each having its characteristic or set of modeling notations and they presents conceptual view of the process adopted for software development. Software community is well familiar with requirement models such as Use case diagram, Object model which represent conceptual view of requirements and system to be built without implementation details.

The software architecture of a program or computing system is the structure or structures of the system, which comprise software components, the externally visible properties of those components and the relationships between them. The term also refers to documentation of a system's software architecture. Documenting software architecture facilitates communication between stakeholders, documents early decisions about high-level design, and allows reuse of design components and patterns between projects [1].

The software system component consists of various elements of the system like Programs, System Utilities, System Services, User Interface, Logical Level and Hardware Level etc.

2.2. Categories of Software Tests and Maintenance tests

Software Testing as defined by Pressman is the process of executing a program or system with the intent of finding errors. [Myers79] [2] Or, it involves any activity aimed at evaluating an attribute or capability of a program or system and determining that it meets its required results. [Hetzel88] [3] The results are observed or recorded, and an evaluation is made of some aspect of the system or program. A good test case is a one that has a high probability of finding an as-yet undiscovered error and a successful test is the one that uncovers an as-yet undiscovered error.

On the other hand the maintenance of the software can account for over 60 percent of all effort expended by a development organisation and the percentage continues to rise as more software is produced[Han93][12]. Software maintenance is the modification of a software product after delivery to correct faults, to improve performance or other attributes or to adapt the product to a modified environment [10]. Thus as described by Pressman only 20 percent of all maintenance work is fixing errors and remaining 80 percent is spent adapting existing systems to changes in their external environment, making enhancements requested by the users and reengineering an application for future use.

For carrying out the software maintenance, certain software tests needs to be performed in order to enhance the maintainability and performance of the software. Thus software testing and software maintenance tests work together in achieving a good quality, highly reliable and an efficient software. These strategies contribute towards the software testing management. Thus this paper defines different categories of software tests based on IEEE standard glossary of Software Engineering Terminology [4,5,6,7,8] and various categories of software maintenance tests. Their definitions are summarized as shown in Table 1 and Table 2 respectively

Table 1. Category of Software tests and their definitions

S.No.	Category	Definitions
1.	Unit Testing	It focuses on each component individually, ensuring that if functions properly as a unit. It heavily uses white box testing techniques, exercising specific paths in a module’s control structure to ensure complete coverage and maximum error detection.
2.	Integration Testing	It addresses assembling and integration of components to form a complete software package. It uses black box testing techniques to address issues related to dual problems of verification and program construction.
3.	System Testing	Testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. It requires no knowledge of the inner design of the code or logic.
4.	Acceptance Testing	Testing to verify a product meets customer specified requirements. A customer usually does this type of testing on a product that is developed externally.

Table 2. Category of Software maintenance tests and their definitions

S.No.	Category	Definitions
1.	Test cases	A test case is a set of conditions or variables under which a tester will determine whether an application or software system meets its specifications at the unit level.
2.	Regression Testing	It is a technique that detects spurious errors caused by software modifications or corrections.
3.	Security Testing	Evaluates the presence and appropriate functioning of the security of the application to ensure the integrity and confidentiality of the data.
4.	Deployment Testing	The testing and/or simulation of system assets in the physical and operational environment in which they are expected to perform.

2.3 Traditional V Model

The V-model is a software development process which can be presumed to be the extension of the waterfall model. It was the first proposed by Paul Rook [11] in the late 1980s and is still in use today. The V-Model demonstrates the relationships between each phase of the development life cycle and its associated phase of testing. Instead of moving down in a linear way, the process steps are bent upwards after the coding phase, to form the typical V shape.

The V-model deploys a well-structured method in which each phase can be implemented by the detailed documentation of the previous phase. Testing activities like test designing start at the beginning of the project well before coding and therefore saves a huge amount of the project time. The purpose of V model is to improve efficiency and effectiveness of software development and reflect the relationship between test activities and development activities as shown in Figure 1. V-model is perhaps the most traditional model followed for management of software tests.

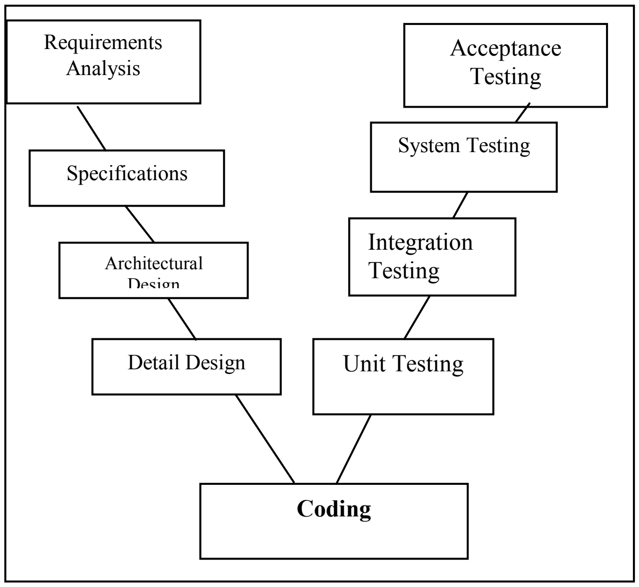

Figure 1. V Model

The basic V Model development process is divided into understanding of user's requirements, performing requirements analysis, designing the initial outline, designing advanced detailed and describing required tests in the basic development process as shown in figure 1 from left to right on each other counterparts.

Software testing is too important to leave to the end of the project, and the V-Model of testing incorporates testing into the entire software development life cycle. In a diagram as in Figure 1 of the V-Model, the V proceeds down and then up, from left to right depicting the basic sequence of development and testing activities. The model highlights the existence of different levels of testing and depicts the way each relates to a different development phase. Like any model, the V-Model has detractors and arguably has deficiencies and alternatives but it clearly illustrates that testing can and should start at the very beginning of the project. In the requirements gathering stage the requirements are gathered, verify and validated in order to justify the project. The business requirements are also used to guide the user acceptance testing. The model illustrates how each subsequent phase should verify and validate work done in the previous phase, and how work done during development is used to guide the individual testing phases. This interconnectedness lets us identify important errors, omissions, and other problems before they can do serious harm.

3. THE NEW MODEL

V model is the most representative model for traditional software testing management. The purpose of the V model is to improve efficiency and effectiveness of software development and reflect the relationship between test activities, development activities and maintenance activities. Once the system has been made functional and all activities have been performed, if it is not maintained properly, all the development and testing efforts shall go in vain. Thus in this section of the paper we propose a new improved V model called as the Advanced V model that reflects the relationship between the development activities, test activities and maintenance activities in order to achieve a highly efficient and reliable system.

3.1 Advanced V model

Software testing is described as a continuous improvement process that must be integrated in into an application maintenance methodology. The term software maintenance usually refers to changes that must be made to software after they have been delivered to the customer or user. The definition of software maintenance by IEEE [1993] [9] is "The modification of a software product after delivery to correct faults, to improve performance or other attributes, or to adapt the product to a modified environment."

Software testing and software maintenance are the most important phases of software development life cycle that go hand in hand to obtain a reliable software. The Advanced V model of testing incorporates testing and maintenance activities into the entire software development life cycle.

In the diagram as in Figure 2 of the Advanced V-Model, it proceeds down and then up, from left to right depicting the basic sequence of development, testing and maintenance activities. The model highlights the existence of different levels of testing with respect to their maintenance activities tests and depicts the way each relates to different development phase activities. The testing commences together with the initial phase of development of the project. In the requirements gathering stage the requirements are gathered, analysed, verified and validated in order to justify the project. The business requirements at the same time also guide to the acceptance testing. Once the acceptance testing is done the error free product needs to be deployed as per the satisfaction of the customer.

The Advanced V Model development process is divided into understanding of the user's requirements, performing requirements analysis, specification, designing the initial and detailed outline and laying out the program specifications. Then the required tests are described in the basic development process as shown in figure 2 from left to right on each other counterparts along with the maintenance tests being carried out for each of the test activity as shown in the figure. Once the activities of the development phase starts simultaneously the activities of the testing phase and maintenance phase commence. Ever imagined a software being deployed without carrying out these testing activities? No would be the prompt reply. So with the unit testing, the modules programmed are tested and test cases are designed. Then moving on to the next level is integration testing where individual modules are integrated and tested for functionality. But this is incomplete without regression testing as the updated changes are then reflected. System testing describes the testing of the system as a whole. Along with it we need to do the security testing in order to check the systems compliance to various security threats. In the modern era where technology is moving with the speed of light, the need to deploy security measures have increased. Thus security threats like unauthorized access, user permission grant needs to be checked at each phase of development activity and testing activity. Then once the user is satisfied after conducting the alpha and beta tests of acceptance test activity the software or the product is deployed at the customers place. Thus a continuous interaction of the development activities, testing activities and maintenance test activities completes the software development life cycle of the product thereby efficiently carrying out the software test management activities.

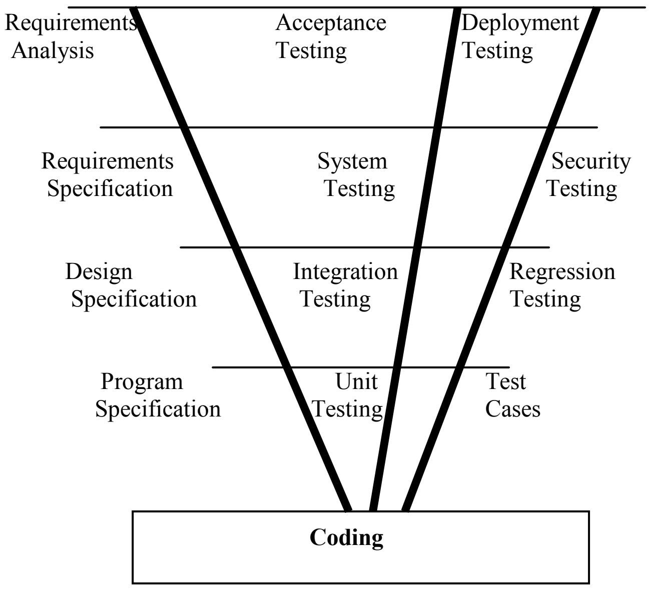

Figure 2. The Advanced V Model

4. ARCHITECTURE OF THE ADVANCED V MODEL

Architecture gives the structural description of the components and thereby helping us to understand the components in a modified and better way. This section of the paper will describe the architecture of the component for software test management.

4.1 Component structure diagram

In this section we construct a software test management structure of component from a structural point of view. The structure of the components of software testing management and software maintenance tests are the basic elements, and they compose of software testing management structure.

The necessary and beneficial structural components are analyzed from software development, testing and maintenance point of view. That is, we need to identify all the builders and destroyers of the software testing management such as customers and the role of the users are as follows:

1. Project Manager: A project manager is a facilitator. The project manager is the one who is responsible for making decisions in such a way that risk is controlled and uncertainty minimized. Every decision made by him should ideally be directly benefit the project. He must possess a combination of skills including the ability to ask penetrating questions, identify unstated assumptions, and resolve personnel conflicts along with more systematic management skills.

2. Software Development Manager: Leads a team of programmers. Development Manager is responsible for leading the software development team in support of the software development life cycle process, change management, development environments and production releases. He will provide overall supervision and technical guidance to the development team in understanding requirements, preparing high level and low-level designs, coding and building the software.

3. Software Architect: An architect acts as a technically savvy business owner. He deals with the interactions of systems, whether between components written in different languages at different times and at different locations, or between components of the same software system that use the same coding language. Architects deal with the interactions of systems, whether between components written in different languages at different times and at different locations, or between components of the same software system that use the same coding language.

4. Software Developer: A software developer is a person concerned with facets of the software development process wider than design and coding, a somewhat broader scope of computer programming or a specialty of project managing including some aspects of software product management.

5. Test Manager: Test managers really serve two different customers, their testers and corporate management. For the testers, he helps develop product test strategies, and provides test expertise to the testing group. For management, he gathers product information so that corporate management can decide when the product is ready for implementation.

6. Test Leader: Technical leader acts as in interface between the test manager and the testing team. He is responsible for the completion of the testing as per the designed time frame.

7. Test Designer: Test designer is responsible for developing test strategies and test plans. He provides an assessment on the overall status of the testing program. He stays well informed and connected with the industry and the current trends in the technologies available.

8. Software Tester: Software tester is responsible for carrying out software testing using various strategies of testing. He builds up the test cases and test plans for the project.

9. Quality Manager: Quality Manager works towards customizing software development processes. He is responsible for creating and implementing a quality management program plan for the entire organization and works towards process improvement.

10. Quality Assurance Engineer: Software quality assurance engineer deals with the location of the defect and mechanisms to prevent defects.

11. Quality Control Engineer: Software quality control engineer looks after the set of activities designed to evaluate the quality of developed software.

12. Quality Guarantee Engineer: Software quality guarantee engineer is responsible for maintaining software quality. He is responsible for tackling and solving all software problems.

Summarizing the above listed points we draw a software testing management component diagram which consists the twelve components as shown in Figure 3.

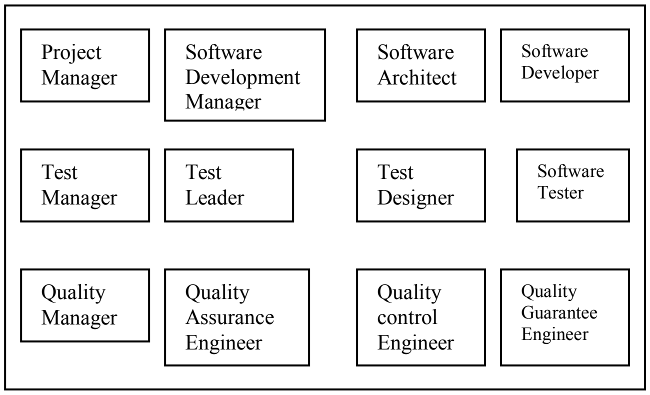

Figure 3. Component Structure diagram

4.2 Component structure service Diagram

By collecting the data and sorting out we have listed and identified twelve components step by step. The services of these twelve components obtained for the software testing management and maintenance are as follows:

Project Management Plan

1. Project Manager manages the project and provides the project management plan.
2. Software Development Manager is responsible for all issues regarding system development.
3. Software Designer provides the system designing services.
4. Software Developer provides the program design and development service.

Test Management Plan

5. Test Manager provides the acceptance testing service and test management plan.
6. Test Leader provides the system testing service.
7. Test Designer provides the Integration testing service.
8. Software tester provides the unit testing service.

Quality Management Plan

9. Quality Manager provides the deployment testing service and quality management plan.
10. Quality Assurance Engineer provides the security testing service.
11. Quality Control Engineer provides the Regression testing service.
12. Quality Guarantee Engineer provides the test case service.

The services listed above are shown in the component structure service diagram in which the services are dependent on various components required for software testing management as shown in Figure 4.

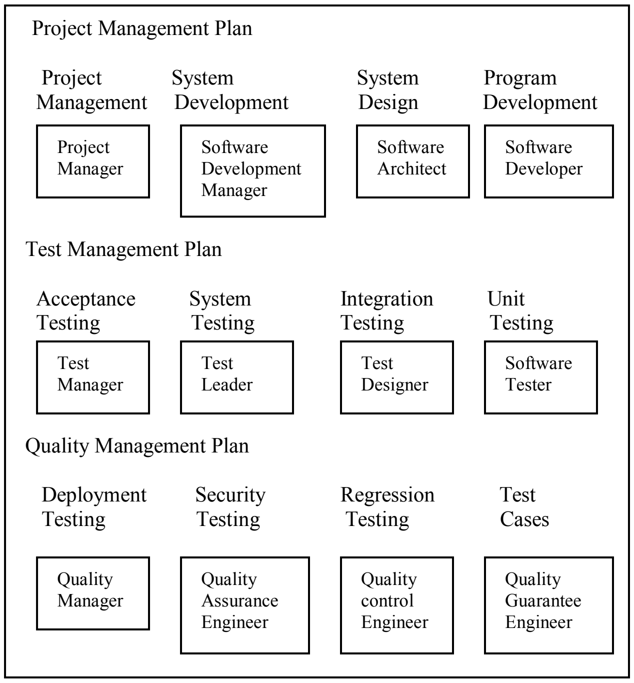

Figure 4. Component Structure service diagram

5. CONCLUSION

The major contribution of this research is in applying software architecture based on component structure diagram for efficient software testing management. We propose an Advanced V model describing that for efficient software testing management along with the development and testing process, the maintenance process is also equally important. Thus we have integrated these processes for efficient software testing management.

We have achieved what should be done, why should be done and how it should be done in software testing management at all the phases of the software development. Maintaining the software before and after testing helps improving the quality of the software to a large extent. Our approach provided important guidelines to the developing software industry where technology keeps on changing everyday.

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