

CHAPTER 4

SOFTWARE QUALITY ASSURANCE

CONCEPTS:

QUALITY:

According to American heritage dictionary, quality is the characteristics or attributes of something. But above all it must have some standards.

The quality is often used to describe our goal of producing error free systems that meet the user requirements with minimum effort. But defining quality as the delivery of the best product won't be sufficient.

In today's world the process of development should also be following the standard in order to maintain the quality. For this, quality is broadly categorized as:

- Quality of Conformance
- Quality of Design

I) **QUALITY OF CONFORMANCE**

It is the characteristics of the system by which the conformity of design specifications being strictly followed during constructions. It focuses on implementation of the system. It is often termed as external quality or product quality.

II) **QUALITY OF DESIGN**

It is the characteristics of the system specified by the designers. It encompasses requirements specifications and design of the system. It is often called internal quality or process quality.

SOFTWARE QUALITY according to R.S. Pressman:

Conformance to explicitly stated functional and performance requirements, explicitly documented development standards, and implicit characteristics that are expected of all professionally developed software is software quality.

SOFTWARE QUALITY FACTORS:

The modern view of quality associates a software product with several quality factors such as:

1. Portability

2. Usability
3. Reusability
4. Correctness
5. Robustness
6. Reliability
7. Maintainability
8. Dependability
9. Efficiency
10. Performance
11. Verifiability
12. Evolvability
13. Interoperability
14. Productivity
15. Timeliness
16. Visibility
17. Understandability
18. Malleability, etc.

SOFTWARE QUALITY ASSURANCE:

Software quality assurance is planned and systematic activities that are required to ensure high quality in software.

The process of ensuring the quality of the software as well as the quality of the software development standards is SQA.

HISTORY:

In military contracted software development, **during 1970s**, concept of SQA and SQC was developed and employed. Then the special SQA personals were started to get involved in software development. Even then all the peoples involved in the development process are equally responsible for the perpetuation of the quality.

SQA ACTIVITIES:

SQA is composed of a variety of tasks associated with the **software engineers** who perform the technical work and an **SQA group** that have the responsibility for

- quality assurance planning,
- oversight, record keeping,
- analysis, and reporting

Software engineers address quality by applying solid technical methods and measures, conducting formal technical reviews, and performing well planned software testing. The **SQA groups** assist the software team in achieving a high quality end product.

SQA GROUPS:

To achieve high quality **SQA Groups** must perform some special SQA activities as follows:

1. Prepares an SQA plan for a project i.e. planning
2. Participate in the development of the project's software process description i.e. oversight
3. Review software engineering activities to verify the compliance with the defined software process i.e. review.
4. Audit designated software work products to verify compliance with those defined as a part of the software process i.e. investigate
5. Ensures that deviations in software work and work products are documented and handled according to a documented procedure i.e. analysis
6. Records any noncompliance i.e. record keeping
7. Reports to senior management i.e. reporting

SOFTWARE REVIEWS:

Reviewing the software is the process of filtering of low quality components. The reviews are applied at the different points during the software development which helps in the detection of errors and defects.

Reviews can be done in many ways like **an informal meeting, seminar, presentation, conference, walkthrough, inspection etc.** Other than these a modified approach is also used called **formal technical review.**

➤ Cost Impact of Software Defects:

The cost of errors increase with the phases of software development, so reviews help in the removal of such errors and expenses raised from those errors. The chart below shows **cost of the software errors and their removal**

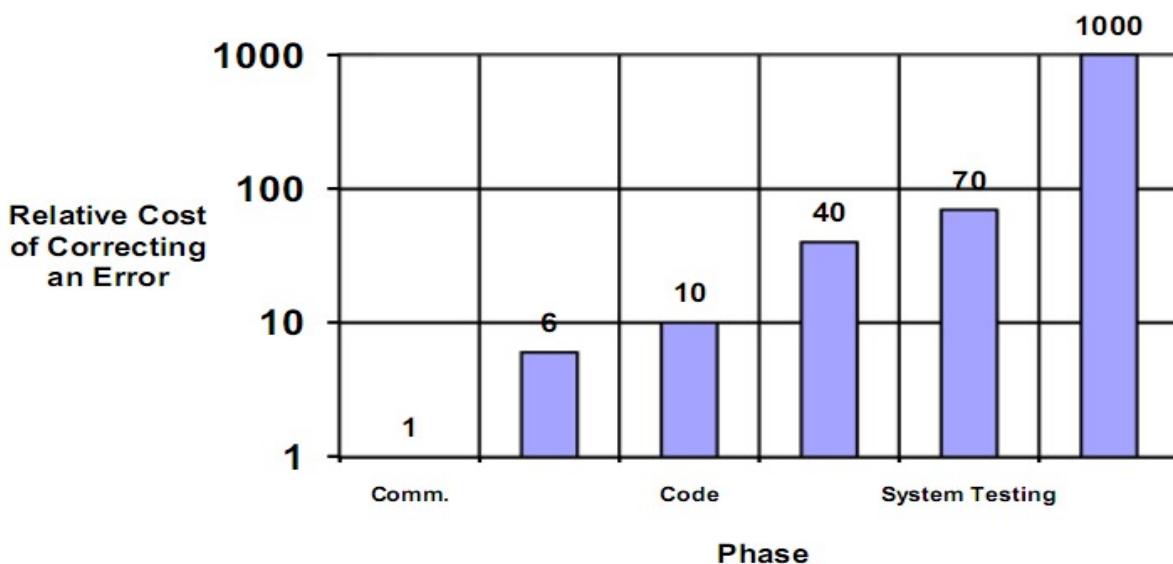


Fig: Relative Cost of Correcting an Error

➤ Relative Cost of Correcting an Error:

It can be concluded that the presence of defects increase the cost of the software. And the cost of removal of defects increases with time i.e. cost of removal of the error increases as the phase of the detection and removal of the error delays.

It has been shown by the studies that the design activities introduce maximum i.e. 50 to 60 % of all errors during the software development life cycle. Software reviews help to alleviate the errors introduced. Among software review techniques FTR has been the most successful one that detects 75% errors.

FORMAL TECHNICAL REVIEWS:

FTR is the SQA and SQC activity performed by software engineers. The basic objectives of FTR are:

- **To uncover errors in function, logic, or implementation**
- **To verify requirements are being met**
- **To ensure that standards are maintained**
- **To achieve software that is developed in a uniform manner**
- **To make projects more manageable**
- **To serve as a training ground**
- **To improve the skills of the junior engineers**

The FTR is actually a class of reviews that includes walkthrough, inspections, and other small group technical assessments of software. FTR is conducted as a meeting followed by above different classes of reviews.

STEPS IN FTR:

1. FTR: The Review Meeting

As a FTR is never completed without **review meeting**, the review meeting is one of the most important parts of FTR. Before doing the review meeting planning should be done for the meeting. Review meetings need well preparation. While holding the meeting, 3-5 peoples are generally involved.

Generally a review meeting is initiated by the producer whose work product is to be reviewed. Each reviewer reviews the work product, makes note and be familiar with the product. With the introduction to agenda, the meeting starts as a walkthrough and recorder keep all the information about errors and problems. By the end of the review, all attendees decide whether accept the product or reject it.

2. FTR : Review Reporting and Record Keeping:

FTR is always outputted with a report.

The FTR report basically answers few questions:

- What was reviewed?
- Who reviewed it?
- What were the findings and conclusions?

3. FTR : Review Guidelines:

During FTR there are few guidelines to be followed as:

- a. Focus product while reviewing, not the producer Set agenda, on which focus is always maintained
- b. No debates while meeting
- c. FTR is to ensure problem areas, not solving it
- d. Note down ideas
- e. FTR meeting should not be over crowded
- f. Use checklist for reviewing
- g. Allocate enough time and resources for FTR
- h. Conduct meaningful training for all the reviewers
- i. Re-review the older ones
- j. Being gentle to point out the errors is more fruitful

FORMAL APPROACHES TO SQA:

1. Proof of Correctness :

Proof of correctness focus the use of the **technique of a formal logic system** to prove that if the input values satisfy certain constraints, the output values produced by the program, satisfy certain properties. It basically focuses correctness of code.

2. Statistical SQA :

Statistical SQA implies the following steps:

- Collection of information about software defects.
- Software defects are categorized.
- Cause of each defects are traced.
- Using Pareto principle, vital causes of errors are identified. (80% of defects can be traced to 20% of all possible causes, and 20% are isolated)
- Steps to correct these causes are taken.

Statistical SQA : Six Sigma:

Six sigma is the most widely used strategy for statistical quality assurance. It's a rigorous and disciplined methodology that uses data and statistical analysis to measure and improve a company's operational performance by identifying and eliminating defects in manufacturing and service related processes.

Six sigma defines three core steps:

- A. **Define:** Define customer requirements, deliverables, and project goals as well as methods for customer communication.
- B. **Measure:** Measure the existing process and its output to determine current quality performance.
- C. **Analyze:** Analyze the defect metrics and determine the vital causes.

3. Clean Room Software Engineering :

The philosophy behind clean room software engineering is to avoid dependence on costly defect removal processes by writing code increments right the first time and verifying their correctness before testing.

The major tasks conducted as part of clean room software engineering are:

- Increment planning
- Requirement gathering
- Formal design
- Correctness verification
- Code generation, inspection, and verification
- Statistical test planning
- Statistical use testing
- Certification

SOFTWARE RELIABILITY:

It is defined as the probability of failure free operation of a computer program in a specified environment for a specified time. It can be measured, directed and estimated.

A measure of software reliability is *mean time between failures* where

$MTBF = MTTF + MTTR$

$MTTF = \text{mean time to failure}$

$MTTR = \text{mean time to repair}$

SOFTWARE QUALITY STANDARDS:

According to the IEEE Comp. Soc. Software Engineering Standards Committee, a standard can be:

- An object or measure of comparison that defines or represents the magnitude of a unit
- A characterization that establishes allowable tolerances or constraints for categories of items.
- A degree or level of required excellence or attainment

➤ ISO:

ISO is a consortium of 63 countries established to formulate and foster standardization. ISO published its 9000 series of standards in 1987. To **be ISO-compliant** processes should adhere to the standards described.

- ❖ **ISO 9000** Ensures quality planning, quality control, quality assurance and quality improvement.
- ❖ **ISO 9000** is a series of three standards: ISO 9001, ISO 9002 and ISO 9003.
- ❖ **ISO 9001** applies to the organizations engaged in development, design, production and servicing of goods.
- ❖ **ISO 9002** applies to those organizations which do not design products but are involved in production, so not applicable for software developing organization.
- ❖ **ISO 9003** applies to organizations involved only in installation and testing of the products.

ISO 9001:

An international standard which provides broad guidance to software developers on how to Implement, maintain and improve a quality software system capable of ensuring high quality software. It consists of 20 requirements. It differs from country to country.

ISO 9001 requirements:

1. Management responsibility
2. Quality system
3. Contract review
4. Design Control
5. Document and data control
6. Purchasing
7. Control of customer supplied product
8. Product identification and traceability
9. Process control
10. Inspection and testing
11. Control of inspection, measuring and test equipments
12. Inspection and test status
13. Control of non-confirming product
14. Corrective and preventive action
15. Handling, storage, packaging, preservation and delivery
16. Control of quality records
17. Internal quality audits
18. Training
19. Servicing
20. Statistical techniques

ISO CERTIFICATION:

STEPS:

1. **Application:** Applying to a registrar for registration.
2. **Pre-Assessment:** The registrar makes a rough assessment of the organization.
3. **Document Review and Adequacy of Audit:** The registrar reviews the documents submitted by the organization and makes suggestions for possible improvements.
4. **Compliance Audit:** The registrar checks whether the suggestions made by it during review have been complied with by the organization or not.
5. **Registration:** The registrar awards the ISO 9000 certificate after successful completion of all previous phases.
6. **Continued Surveillance:** the registrar continues to monitor the organization, though periodically.

