MODULE 4

LECTURE NOTE 28

SOFTWARE QUALITY

Traditionally, a quality product is defined in terms of its fitness of purpose. That is, a quality product does exactly what the users want it to do. For software products, fitness of purpose is usually interpreted in terms of satisfaction of the requirements laid down in the SRS document. Although "fitness of purpose" is a satisfactory definition of quality for many products such as a car, a table fan, a grinding machine, etc. – for software products, "fitness of purpose" is not a wholly satisfactory definition of quality. To give an example, consider a software product that is functionally correct. That is, it performs all functions as specified in the SRS document. But, has an almost unusable user interface. Even though it may be functionally correct, we cannot consider it to be a quality product. Another example may be that of a product which does everything that the users want but has an almost incomprehensible and unmaintainable code. Therefore, the traditional concept of quality as "fitness of purpose" for software products is not wholly satisfactory.

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

- **Portability:** A software product is said to be portable, if it can be easily made to work in different operating system environments, in different machines, with other software products, etc.
- **Usability:** A software product has good usability, if different categories of users (i.e. both expert and novice users) can easily invoke the functions of the product.
- **Reusability:** A software product has good reusability, if different modules of the product can easily be reused to develop new products.
- **Correctness:** A software product is correct, if different requirements as specified in the SRS document have been correctly implemented.
- **Maintainability:** A software product is maintainable, if errors can be easily corrected as and when they show up, new functions can be easily added to the product, and the functionalities of the product can be easily modified, etc.

Software Quality Management System

A quality management system (often referred to as quality system) is the principal methodology used by organizations to ensure that the products they develop have the desired quality.

A quality system consists of the following:

Managerial Structure and Individual Responsibilities- A quality system is actually the responsibility of the organization as a whole. However, every organization has a separate quality department to perform several quality system activities. The quality system of an organization should have support of the top management. Without support for the quality system at a high level in a company, few members of staff will take the quality system seriously.

Quality System Activities- The quality system activities encompass the following:

- auditing of projects
- review of the quality system
- development of standards, procedures, and guidelines, etc.
- production of reports for the top management summarizing the effectiveness of the quality system in the organization.

Evolution of Quality Management System

Quality systems have rapidly evolved over the last five decades. Prior to World War II, the usual method to produce quality products was to inspect the finished products to eliminate defective products. Since that time, quality systems of organizations have undergone through four stages of evolution as shown in the fig. 28.1. The initial product inspection method gave way to quality control (QC). Quality control focuses not only on detecting the defective products and eliminating them but also on determining the causes behind the defects. Thus, quality control aims at correcting the causes of errors and not just rejecting the products. The next breakthrough in quality systems was the development of quality assurance principles.

The basic premise of modern quality assurance is that if an organization's processes are good and are followed rigorously, then the products are bound to be of good quality. The modern quality paradigm includes guidance for recognizing, defining, analyzing, and improving the production process. Total quality management (TQM) advocates that the process followed by an organization must be continuously improved through process measurements. TQM goes a step further than quality assurance and aims at continuous process improvement. TQM goes beyond documenting processes to optimizing them through redesign. A term related to TQM is Business Process Reengineering (BPR). BPR aims at reengineering the way business is carried out in an organization. From the above discussion it can be stated that over the years the quality paradigm has shifted from product assurance to process assurance (as shown in fig. 28.1).

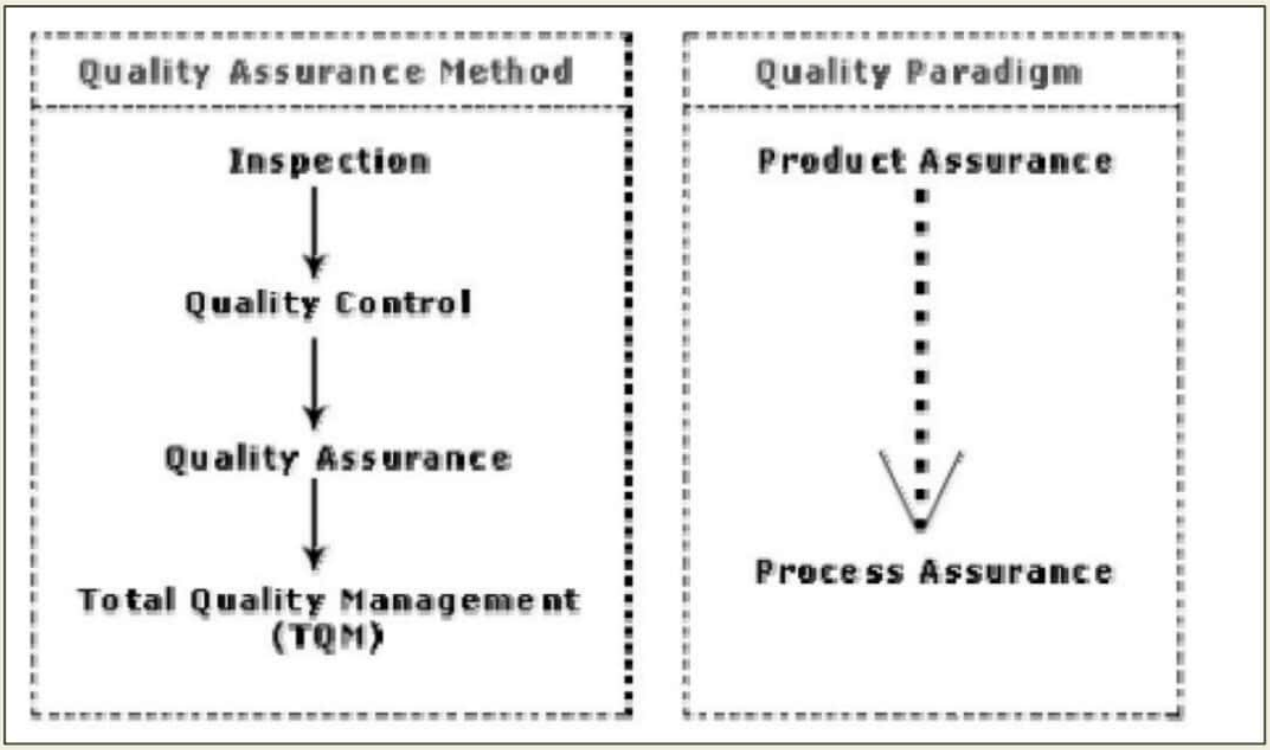

Fig. 28.1: Evolution of quality system and corresponding shift in the quality paradigm

ISO 9000 certification

ISO (International Standards Organization) is a consortium of 63 countries established to formulate and foster standardization. ISO published its 9000 series of standards in 1987. ISO certification serves as a reference for contract between independent parties. The ISO 9000 standard specifies the guidelines for maintaining a quality system. We have already seen that the quality system of an organization applies to all activities related to its product or service. The ISO standard mainly addresses operational aspects and organizational aspects such as responsibilities, reporting, etc. In a nutshell, ISO 9000 specifies a set of guidelines for repeatable and high quality product development. It is important to realize that ISO 9000 standard is a set of guidelines for the production process and is not directly concerned about the product itself.

Types of ISO 9000 quality standards

ISO 9000 is a series of three standards: ISO 9001, ISO 9002, and ISO 9003. The ISO 9000 series of standards is based on the premise that if a proper process is followed for production, then good quality products are bound to follow automatically. The types of industries to which the different ISO standards apply are as follows.

ISO 9001 applies to the organizations engaged in design, development, production, and servicing of goods. This is the standard that is applicable to most software development organizations.

ISO 9002 applies to those organizations which do not design products but are only involved in production. Examples of these category industries include steel and car manufacturing industries that buy the product and plant designs from external sources and are involved in only manufacturing those products. Therefore, ISO 9002 is not applicable to software development organizations.

ISO 9003 applies to organizations that are involved only in installation and testing of the products.

Software products vs. other products

There are mainly two differences between software products and any other type of products.

- Software is intangible in nature and therefore difficult to control. It is very difficult to control and manage anything that is not seen. In contrast, any other industries such as car manufacturing industries where one can see a product being developed through various stages such as fitting engine, fitting doors, etc. Therefore, it is easy to accurately determine how much work has been completed and to estimate how much more time will it take.
- During software development, the only raw material consumed is data. In contrast, large quantities of raw materials are consumed during the development of any other product.

Need for obtaining ISO 9000 certification

There is a mad scramble among software development organizations for obtaining ISO certification due to the benefits it offers. Some benefits that can be acquired to organizations by obtaining ISO certification are as follows:

- Confidence of customers in an organization increases when organization qualifies for ISO certification. This is especially true in the international market. In fact, many organizations awarding international software development contracts insist that the development organization have ISO 9000 certification. For this reason, it is vital for software organizations involved in software export to obtain ISO 9000 certification.
- ISO 9000 requires a well-documented software production process to be in place. A well-documented software production process contributes to repeatable and higher quality of the developed software.
- ISO 9000 makes the development process focused, efficient, and cost-effective.
- ISO 9000 certification points out the weak points of an organization and recommends remedial action.
- ISO 9000 sets the basic framework for the development of an optimal process and Total Quality Management (TQM).

Summary of ISO 9001 certification

A summary of the main requirements of ISO 9001 as they relate of software development is as follows. Section numbers in brackets correspond to those in the standard itself:

Management Responsibility (4.1)

- The management must have an effective quality policy.
- The responsibility and authority of all those whose work affects quality must be defined and documented.
- A management representative, independent of the development process, must be responsible for the quality system. This requirement probably has been put down so that the person responsible for the quality system can work in an unbiased manner.
- The effectiveness of the quality system must be periodically reviewed by audits.

Quality System (4.2)

A quality system must be maintained and documented.

Contract Reviews (4.3)

Before entering into a contract, an organization must review the contract to ensure that it is understood, and that the organization has the necessary capability for carrying out its obligations.

Design Control (4.4)

- The design process must be properly controlled, this includes controlling coding also. This requirement means that a good configuration control system must be in place.
- Design inputs must be verified as adequate.
- Design must be verified.
- Design output must be of required quality.
- Design changes must be controlled.

Document Control (4.5)

- There must be proper procedures for document approval, issue and removal.
- Document changes must be controlled. Thus, use of some configuration management tools is necessary.

Purchasing (4.6)

Purchasing material, including bought-in software must be checked for conforming to requirements.

Purchaser Supplied Product (4.7)

Material supplied by a purchaser, for example, client-provided software must be properly managed and checked.

Product Identification (4.8)
The product must be identifiable at all stages of the process. In software terms this means configuration management.

Process Control (4.9)

- The development must be properly managed.
- Quality requirement must be identified in a quality plan.

Inspection and Testing (4.10)
In software terms this requires effective testing i.e., unit testing, integration testing and system testing. Test records must be maintained.

Inspection, Measuring and Test Equipment (4.11)
If integration, measuring, and test equipments are used, they must be properly maintained and calibrated.

Inspection and Test Status (4.12)
The status of an item must be identified. In software terms this implies configuration management and release control.

Control of Nonconforming Product (4.13)
In software terms, this means keeping untested or faulty software out of the released product, or other places whether it might cause damage.

Corrective Action (4.14)
This requirement is both about correcting errors when found, and also investigating why the errors occurred and improving the process to prevent occurrences. If an error occurs despite the quality system, the system needs improvement.

Handling, (4.15)
This clause deals with the storage, packing, and delivery of the software product.

Quality records (4.16)
Recording the steps taken to control the quality of the process is essential in order to be able to confirm that they have actually taken place.

Quality Audits (4.17)
Audits of the quality system must be carried out to ensure that it is effective.

Training (4.18)
Training needs must be identified and met.

Salient features of ISO 9001 certification
The salient features of ISO 9001 are as follows:

- All documents concerned with the development of a software product should be properly managed, authorized, and controlled. This requires a configuration management system to be in place.
- Proper plans should be prepared and then progress against these plans should be monitored.
- Important documents should be independently checked and reviewed for effectiveness and correctness.
- The product should be tested against specification.
- Several organizational aspects should be addressed e.g., management reporting of the quality team.

Shortcomings of ISO 9000 certification
Even though ISO 9000 aims at setting up an effective quality system in an organization, it suffers from several shortcomings. Some of these shortcomings of the ISO 9000 certification process are the following:

- ISO 9000 requires a software production process to be adhered to but does not guarantee the process to be of high quality. It also does not give any guideline for defining an appropriate process.

- ISO 9000 certification process is not fool-proof and no international accreditation agency exists. Therefore it is likely that variations in the norms of awarding certificates can exist among the different accreditation agencies and also among the registrars.

- Organizations getting ISO 9000 certification often tend to downplay domain expertise. These organizations start to believe that since a good process is in place, any engineer is as effective as any other engineer in doing any particular activity relating to software development. However, many areas of software development are so specialized that special expertise and experience in these areas (domain expertise) is required. In manufacturing industry there is a clear link between process quality and product quality. Once a process is calibrated, it can be run again and again producing quality goods. In contrast, software development is a creative process and individual skills and experience are important.

- ISO 9000 does not automatically lead to continuous process improvement, i.e. does not automatically lead to TQM.