



The components of quality assurance system

Lecture 4

Outline

- ❖ The SQA system – an SQA architecture
 - Pre-project components
 - Components of project life cycle activities assessment
 - Components of infrastructure error prevention and improvement
 - Components of software quality management
 - Components of standardization, certification, and SQA system assessment.
 - Organizing for SQA – the human components
- ❖ The considerations guiding construction of an organization's SQA system

The SQA system – an SQA architecture

- ❖ SQA system is affected by
 - the characteristics of the organization,
 - its development projects,
 - software maintenance activities, and
 - professional staffs
- ❖ An SQA system always combines a wide range of SQA components
- ❖ SQA is unique in the area of quality assurance due to the special characteristics of software.
- ❖ The environment in which software development and maintenance is undertaken directly influences the SQA components

Pre-project components

- ❖ The aim is to assure that
 - (a) the project commitments have been adequately defined considering the resources required, the schedule and budget; and
 - (b) the development and quality plans have been correctly determined
- ❖ The SQA components belonging here are meant to improve the preparatory steps taken prior to initiating work on the project itself:
 - Contract review
 - Development and quality plans.

Contract reviews

- ❖ Contract review activities must include a detailed examination of
 - the project proposal draft and
 - the contract drafts.
- ❖ Specifically, contract review activities include:
 - Clarification of the customer's requirements
 - Review of the project's schedule and resource requirement estimates
 - Evaluation of the professional staff's capacity to carry out the proposed project
 - Evaluation of the customer's capacity to fulfill his obligations
 - Evaluation of development risks.
- ❖ A similar approach is applied in the *review of maintenance contracts*
 - maintenance services
 - ✓ error corrections,
 - ✓ software adaptation and
 - ✓ limited software development activities

Development and quality plans

- ❖ The main issues treated in the project development plan are:
 - Schedules
 - Required manpower and hardware resources
 - Risk evaluations
 - Organizational issues: team members, subcontractors and partnerships
 - Project methodology, development tools, etc.
 - Software reuse plans.
- ❖ The main issues treated in the project's quality plan are:
 - Quality goals, expressed in the appropriate measurable terms
 - Criteria for starting and ending each project stage
 - Lists of reviews, tests, and other scheduled verification and validation activities.

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Software project life cycle components

❖ Two stages:

- the development life cycle stage
- the operation–maintenance stage.

❖ The main components are:

- Reviews
- Expert opinions
- Software testing
- Software maintenance
- Assurance of the quality of the subcontractors' work and the customer- supplied parts.

Reviews

- ❖ The design phase of the development process produces
 - printed products - design reports, software test documents, software installation plans and software manuals, etc
- ❖ Reviews can be categorized as
 - formal design reviews (DRs) and peer reviews
- ❖ Formal design reviews (DRs)
 - The committees - composed of senior professionals, including the project leader and, usually, the department manager, the chief software engineer, and heads of other related departments – examine the documents
 - The DR report includes a list of required corrections (“action items”).
 - Options open for consideration:
 - ✓ Immediate approval of the DR document and continuation to the next development phase.
 - ✓ Approval to proceed to the next development phase after all the action items have been completed and inspected by the committee’s representative.
 - ✓ An additional DR is required and scheduled to take place after all the action items have been completed and inspected by the committee’s representative.

❖ Peer reviews

- inspections and walkthroughs
- directed at reviewing short documents, chapters or parts of a report, a coded printout of a software module, etc
- The main objective is to detect as many design and programming faults as possible
- The output is a list of detected faults and, for inspections, also a defect summary and statistics to be used as a database for reviewing and improving development methods
- a peer's participation is usually voluntarily and viewed as a supplement to the regular workload

Expert opinions

- ❖ Turning to outside experts may be particularly useful in the following situations:
 - Insufficient in-house professional capabilities in a given area.
 - In small organizations in many cases it is difficult to find enough suitable candidates to participate in the design review (DR) teams. In such situations, outside experts may join a DR committee or, alternatively, their expert opinions may replace a DR.
 - In small organizations or in situations characterized by extreme work pressures, an outside expert's opinion can replace an inspection.
 - Temporary inaccessibility of in-house professionals (waiting will cause substantial delays in the project completion schedule).
 - In cases of major disagreement among the organization's senior professionals, an outside expert may support a decision.

Software Testing

- ❖ Software tests are formal SQA components that are targeted toward review of the actual running of the software
- ❖ The tests are based on a prepared list of test cases that represent a variety of expected scenarios
- ❖ The objective of the software tests
 - detection of software faults and other failures to fill the requirements,
 - formal approval of a module or integration setup so that either the next programming phase can be begun or the completed software system can be delivered and installed
- ❖ Tests
 - Manual and automated
 - test report - include a detailed list of the faults detected and recommendations about the performance of tests following a subsequent round of corrections based on the test findings
 - It is recommended that software tests be carried out by an independent, outside testing unit rather than by the project team

Software maintenance components

❖ **Corrective maintenance**

- User's support services and correction of software code and documentation failures.

❖ **Adaptive maintenance**

- Adaptation of current software to new circumstances and customers without changing the basic software product. These adaptations are usually required when the hardware system or its components undergo modification (additions or changes).

❖ **Functionality improvement maintenance**

- The functional and performance-related improvement of existing software, carried out with respect to limited issues.

Software maintenance components 2

❖ The main SQA components employed in the quality assurance of the maintenance system are as follows

- *Pre-maintenance components*
 - ✓ Maintenance contract review
 - ✓ Maintenance plan.
- *Software development life cycle components*
- *Infrastructure SQA components*
 - ✓ Maintenance procedures and instructions
 - ✓ Supporting quality devices
 - ✓ Maintenance staff training, retraining, and certification
 - ✓ Maintenance preventive and corrective actions
 - ✓ Configuration management
 - ✓ Control of maintenance documentation and quality records.
- *Managerial control SQA components*
 - ✓ Maintenance service control
 - ✓ Maintenance quality metrics
 - ✓ Maintenance quality costs.

Assurance of the quality of the external participant's work

- ❖ External participants - subcontractors, suppliers of COTS software and the customer
- ❖ The larger and more complex the project, the greater the likelihood that external participants will be required, and the larger the proportion of work transmitted to them
- ❖ Most of the SQA controls applied to external participants are defined in the *contracts* signed between the relevant parties
- ❖ Special software assurance efforts are required to establish effective controls over the external participant's *work*.
 - If an external participant's work is performed using software assurance standards below those of the supplier's, risks of not meeting schedule or other requirements are introduced into the project.
- ❖ Special SQA efforts are needed to assure the quality of the *hardware, software, staff and training* supplied by the customer

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Infrastructure components for error prevention and improvement

- ❖ The goals of SQA infrastructure are the prevention of software faults or, at least, the lowering of software fault rates, together with the improvement of productivity
- ❖ This class of SQA components includes:
 - Procedures and work instructions
 - Templates and checklists
 - Staff training, retraining, and certification
 - Preventive and corrective actions
 - Configuration management
 - Documentation control.

Procedures and work instructions

- ❖ **Quality assurance procedures** usually provide detailed definitions for the performance of specific types of development activities in a way that assures effective achievement of quality results.
 - are planned to be generally applicable and to serve the entire organization
- ❖ **Work instructions**, in contrast, provide detailed directions for the use of methods that are applied in unique instances and employed by specialized teams.
- ❖ Procedures and work instructions are based on the organization's accumulated experience and knowledge
 - constant care should be taken to update and adjust those procedures and instructions to current technological, organizational, and other conditions

Supporting quality devices

- ❖ One way to combine higher quality with higher efficiency is to use supporting quality devices, such as templates and checklists
- ❖ Templates and checklists, based on the accumulated knowledge and experience of the organization's development and maintenance professionals, contribute to meeting SQA goals by:
 - Saving the time required to define the structure of the various documents or prepare lists of subjects to be reviewed.
 - Contributing to the completeness of the documents and reviews.
 - Improving communication between development team and review committee members by standardizing documents and agendas.

Staff training, instruction and certification

- ❖ A trained and well-instructed professional staff is the key to efficient, quality performance
- ❖ Keeping an organization's human resources knowledgeable and updated at the level required is achieved mainly by:
 - Training new employees and retraining those employees who have changed assignments.
 - Continuously updating staff with respect to professional developments and the in-house, hands-on experience acquired.
 - Certifying employees after their knowledge and ability have been demonstrated.

Preventive and corrective actions

- ❖ Systematic study of the data collected regarding instances of failure and success contributes to the quality assurance process in many ways:
 - Implementation of changes that prevent similar failures in the future.
 - Correction of similar faults found in other projects and among the activities performed by other teams.
 - Implementing proven successful methodologies to enhance the probability of repeat successes.
- ❖ Examples of the sources of these data are
 - design review reports,
 - software test reports,
 - and customers' complaints
 - for these data to make a substantial contribution to quality, they must be systematically collected and professionally analyzed

Configuration management

- ❖ The regular software development and maintenance operations involve intensive activities that modify software to create new versions and releases
- ❖ Problems
 - misidentification of the versions or releases,
 - loss of the records delineating the changes implemented
 - loss of documentation
- ❖ Configuration management deals with these hazards by introducing procedures to control the change process.
- ❖ The procedures relate to
 - the approval of changes,
 - the recording of those changes performed,
 - the issuing of new software versions and releases,
 - the recording of the version and release specifications of the software installed in each site, and
 - the prevention of any changes in approved versions and releases once they are issued.

Documentation control

- ❖ Documentation control functions refer mainly to
 - customer requirement documents,
 - contract documents,
 - design reports,
 - project plans,
 - development standards, etc.
- ❖ Documentation control activities entail:
 - Definition of the types of controlled documents needed
 - Specification of the formats, document identification methods, etc.
 - Definition of review and approval processes for each controlled document
 - Definition of the archive storage methods.

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Management SQA components

- ❖ Project progress control (including maintenance contract control)
 - Resource usage
 - Schedules
 - Risk management activities
 - The budget.
- ❖ Software quality metrics for
 - Quality of software development and maintenance activities
 - Development teams' productivity
 - Help desk and maintenance teams' productivity
 - Software faults density
 - Schedule deviations
- ❖ Software quality costs
 - costs of control (prevention costs, appraisal costs, and managerial preparation and control costs)
 - costs of failure (internal failure costs, external failure costs, and managerial failure costs)

❖ Main Objectives

- Utilization of international professional knowledge.
- Improvement of coordination with other organizations' quality systems.
- Objective professional evaluation and measurement of the achievements of the organization's quality systems

❖ Quality management standards

- SEI CMM assessment standard
- ISO 9001 and ISO 9000-3 standards

❖ Project process standards

- IEEE 1012 standard
- ISO/IEC 12207 standard

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Organizing for SQA – the human components

❖ Organizational software quality framework

- organization's management
- software testing personnel and SQA units
- professionals and other practitioners interested in software quality (SQA trustees, SQA committee members and SQA forum members)

❖ The main objective

- To develop and support implementation of SQA components.
- To detect deviations from SQA procedures and methodology.
- To suggest improvements to SQA components

Management's role in SQA

- ❖ The responsibilities of top management, departmental management and project management include the following:
 - Definition of the quality policy
 - Effective follow-up of quality policy implementation
 - Allocation of sufficient resources to implement quality policy
 - Assignment of adequate staff
 - Follow-up of compliance of quality assurance procedures
 - Solutions of schedule, budget and customer relations difficulties

The SQA unit

- ❖ The SQA unit's task is to serve as the main moving force, initiator, and coordinator of the SQA system and its application.
- ❖ This task can be broken down into a number of primary roles:
 - Preparation of annual quality programs
 - Consultation with in-house staff and outside experts on software quality issues
 - Conduct of internal quality assurance audits
 - Leadership of quality assurance various committees
 - Support of existing quality assurance infrastructure components and their updates, and development of new components.

SQA trustees, committees and forums

- ❖ **SQA trustees** are members of development and maintenance teams who have a special interest in software quality and are prepared to devote part of their time to these issues. Their contributions include:
 - Solving team or unit local quality problems
 - Detecting deviations from quality procedures and instructions
 - Initiating improvements in SQA components
 - Reporting to the SQA unit about quality issues in their team or unit.
- ❖ **SQA committee** members are members of various software development and maintenance units, and are usually appointed for term or *ad hoc* service. The main issues dealt with by the committees are:
 - Solution of software quality problems.
 - Analysis of problem and failure records as well as other records, followed by initiation of corrective and preventive actions when appropriate.
 - Initiation and development of new procedures and instructions; updating existing materials.
 - Initiation and development of new SQA components and improvement of existing components

SQA trustees, committees and forums 2

- ❖ **SQA forums** are composed of professionals and practitioners who meet and/or maintain an Internet site on a voluntary basis for discussion of quality issues pertaining to development and maintenance processes.
- ❖ They share their experiences and difficulties as well as try to initiate improvements in the software process.
- ❖ The forums can therefore be considered as important sources of information and SQA initiatives

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- ❖ Decisions regarding the organization's software quality management system fall into two main categories:
 - The SQA organizational base
 - The SQA components to be implemented within the organization and the extent of their use.
- ❖ These decisions are affected by a number of fundamental considerations that reflect the characteristics of
 - the organization,
 - the software development projects and maintenance services to be performed, and
 - the organization's professional staff.

Organizational considerations

❖ Type of software development clientele

- buyers of software packages, customers of custom-made software packages, and internal clientele (the organization's departments and sub-units).

❖ Type of software maintenance clientele

- an internal maintenance unit may serve purchased software packages or custom-made software specially developed for the organization's departments by software houses
- a software house may employ a subcontractor to maintain its software packages sold to clients during the warranty period and afterwards

❖ Range of software products

❖ Size of the organization

- In general, the larger the number of professionals occupied by the organization, the greater the number of different specializations, and the greater the variety of SQA components developed and applied

Organizational considerations 2

- ❖ Degree and nature of cooperation with other organizations carrying out related projects
 - organizations that carry out entire projects independently - no cooperation
 - organizations that undertake projects with partners,
 - organizations that employ subcontractors to complete specific parts of a project.
 - Usually, the greater the cooperation the greater the number of required SQA components
- ❖ Optimization objectives
 - The organization is required to select SQA components while taking into account the optimal combined contribution in the following areas:
 - ✓ software quality,
 - ✓ team productivity,
 - ✓ process efficiency,
 - ✓ financial savings

Project and maintenance service considerations

❖ Level of complexity and difficulty

- Complexity and difficulties can be caused by the algorithms applied, the project's size, the variety of development tools used, interfaces to other software and firmware systems required.

❖ Degrees of experience with the project technology

- Experience can reduce the resources required, the rate of software errors, and the time required for project completion.
- Usually, the greater the staff's experience, the fewer the SQA components required

❖ Extent of software reuse in the new projects

- Higher proportions of software reuse allow for the reduction of SQA efforts (staff, finances, time, etc.) and the employment of fewer SQA components within the project

Professional staff considerations

❖ Professional qualifications

- a highly qualified professional staff usually enables a reduction in the SQA efforts required to complete and maintain a project

❖ Level of acquaintance with team members

- Projects performed by teams who have not worked together or have served the organization for only a short time require greater and more intense SQA efforts due to the uncertainty surrounding the members' ability to cooperate and coordinate among themselves as well as the uncertainty about their professional experience and qualifications

