ELECTIVE III: SOFTWARE QUALITY ASSURANCE

SUBJECT CODE: 18MIT41E

UNIT II:

Development and quality plans: development plan and quality plan objectives – elements of development plan – elements of quality plan. Integrating quality objectives in the project life cycle: factors affecting intensity of quality assurance activities in the development process – verification, validation and qualification – a model for SQA defect removal effectiveness and cost. Reviews: review objectives – formal design reviews (DRs) - peer reviews – comparison of the team review methods – expert opinions.

Prepared by: Mrs. P.Sundari

Development and quality plans

Development plan and quality plan objectives

Planning, as a process, has several objectives, each of which is meant to prepare adequate foundations for the following:

(1) Scheduling development activities that will lead to the successful and timely completion of the project, and estimating the required manpower resources and budget.

(2) Recruiting team members and allocating development resources (according to activity schedules and manpower resource requirement estimates).

(3) Resolving development risks.

(4) Implementing required SQA activities.

(5) Providing management with data needed for project control.

Elements of the development plan

1. Project products, specifying “deliverables”
2. Project interfaces
3. Project methodology and development tools
4. Software development standards and procedures
5. Map of the development process
6. Project milestones
7. Project staff organization
8. Required development facilities
9. Development risks and risk management actions
10. Control methods
11. Project cost estimates

Elements of the quality plan

1. List of quality goals
2. Review activities
3. Software tests
4. Acceptance tests for software externally developed
5. Configuration management tools and procedures

Integrating quality activities in the project life cycle

Factors affecting intensity of quality assurance activities in the development process

Quality assurance planners for a project are required to determine:

- The list of quality assurance activities needed for a project.

- For each quality assurance activity:
  - Timing
  - Type of quality assurance activity to be applied
  - Who performs the activity and the resources required.
  - Resources required for removal of defects and introduction of changes.

Project factors:

- Magnitude of the project
- Technical complexity and difficulty
- Extent of reusable software components
- Severity of failure outcomes if the project fails

Team factors:

- Professional qualification of the team members
- Team acquaintance with the project and its experience in the area
- Availability of staff members who can professionally support the team
- Familiarity with the team members, in other words the percentage of new staff members in the team

Verification, validation and qualification

IEEE Std 610.12-1990 (IEEE, 1990) defines these aspects as follows:

- **"Verification** – The process of evaluating a system or component to determine whether the products of a given

development phase satisfy the conditions imposed at the start of that phase."

■ **"Validation** – The process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements."

■ **"Qualification** – The process used to determine whether a system or component is suitable for operational use."

According to the IEEE definitions, *verification* examines the consistency of the products being developed with products developed in previous phases.

When doing so, the examiner follows the development process and assumes that all the former development phases have been completed correctly, whether as originally planned or after removal of all the discovered defects.

This assumption forces the examiner to disregard deviations from the customer's original requirements that might have been introduced during the development process.

Validation represents the customer's interest by examining the extent of compliance to his or her original requirements. Comprehensive validation reviews tend to improve customer satisfaction from the system.

Qualification focuses on operational aspects, where maintenance is the main issue. A software component that has been developed and documented according to professional standards and style and structure convention procedures is expected to be much easier to maintain than one that provides marvelous coding improvisations yet does not follow known coding style procedures and so forth.

Planners are required to determine which of these aspects should be examined in each quality assurance activity.

A model for SQA defect removal effectiveness and cost

The model deals with two quantitative aspects of an SQA plan consisting of several defect detection activities:

(1) The plan's total effectiveness in removing project defects.

(2) The total costs of removal of project defects.

The data

Defect origin distribution

Defect origins (the phase in which defects were introduced) are distributed throughout the development process, from the project's initiation to its completion.

A characteristic distribution of software defect origins

No.	Software development phase	Average percentage of defects originating in phase
1	Requirements specification	15%
2	Design	35%
3	Coding (coding 30%, integration 10%)	40%
4	Documentation	10%

Defect removal effectiveness

It is assumed that any quality assurance activity filters (screens) a certain percentage of existing defects. It should be noted that in most cases, the percentage of removed defects is somewhat lower than the percentage of detected defects as some corrections (about 10% according to Jones, 1996) are ineffective or inadequate. The remaining defects, those undetected and uncorrected, are passed to successive development phases. The next quality assurance activity applied confronts a combination of

defects: those remaining after previous quality assurance activities together with “new” defects, created in the current development phase.

Cost of defect removal

Data collected about development project costs show that the cost of removal of detected defects varies by development phase, while costs rise substantially as the development process proceeds. For example, removal of a design defect detected in the design phase may require an investment of 2.5 working days; removal of the same defect may require 40 working days during the acceptance tests.

Average filtering (defect removal) effectiveness by quality assurance activities

No.	Quality assurance activity	Average defect filtering effectiveness rate
1	Requirements specification review	50%
2	Design inspection	60%
3	Design review	50%
4	Code inspection	65%
5	Unit test	50%
6	Unit test after code inspection	30%
7	Integration test	50%
8	System tests / acceptance tests	50%
9	Documentation review	50%

Representative average relative defect-removal costs

No.	Software development phase	Average relative defect cost (cost units)
1	Requirements specification	1
2	Design	2.5
3	Unit tests	6.5
4	Integration tests	16
5	System tests / acceptance tests / system documentation review	40
6	Operation by customer (after release)	110

The model

The model is based on the following assumptions:

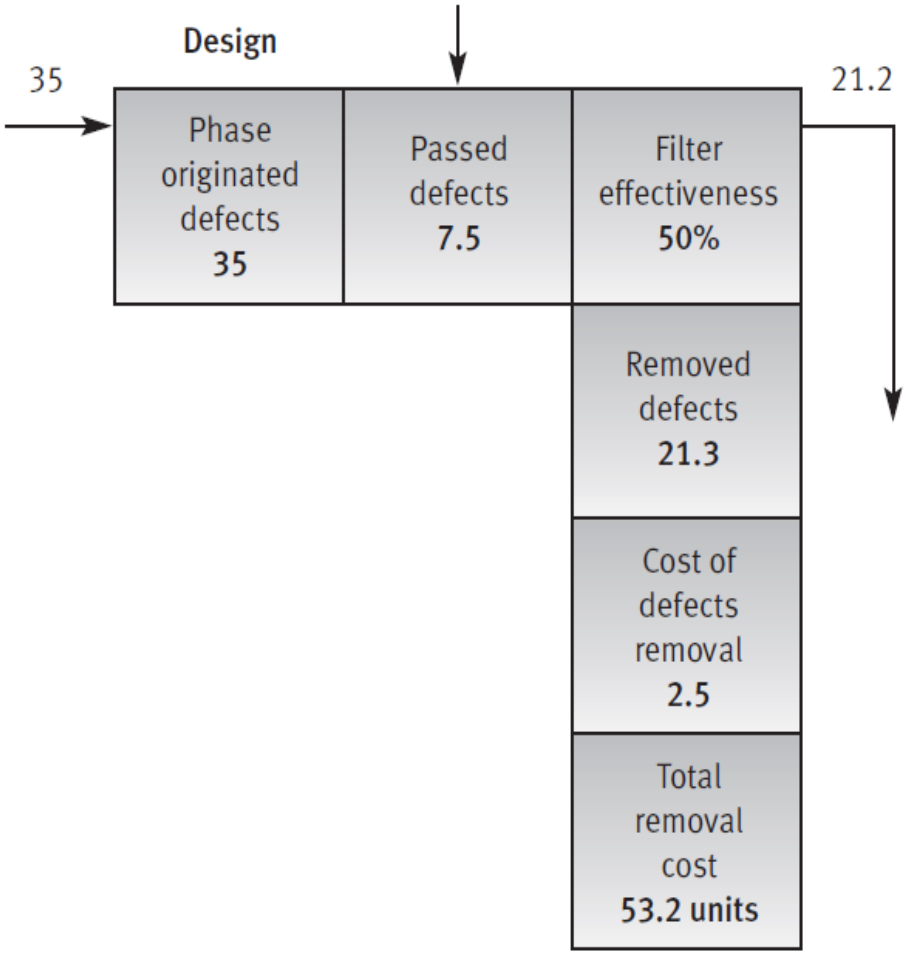
- The development process is linear and sequential, following the waterfall model.
- A number of "new" defects are introduced in each development phase.
- Review and test software quality assurance activities serve as filters, removing a percentage of the entering defects and letting the rest pass to the next development phase.
- At each phase, the incoming defects are the sum of defects not removed by the former quality assurance activity together with the "new" defects introduced (created) in the current development phase.

- The cost of defect removal is calculated for each quality assurance activity by multiplying the number of defects removed by the relative cost of removing a defect.
- The remaining defects, unfortunately passed to the customer, will be detected by him or her. In these circumstances, full removal entails the heaviest of defect-removal costs.

The model presents the following quantities:

- POD = Phase Originated Defects
- PD = Passed Defects (from former phase or former quality assurance activity)

A filter unit for defect removal effectiveness



■ %FE = % of Filtering Effectiveness (also termed % screening effectiveness)

■ RD = Removed Defects

■ CDR = Cost of Defect Removal

■ TRC = Total Removal Cost: TRC = RD × CDR.

Standard quality assurance plan

No.	Quality assurance activity	Defect removal effectiveness	Cost of removing a detected defect (cost units)
1	Requirement specification review	50%	1
2	Design review	50%	2.5
3	Unit test – code	50%	6.5
4	Integration test	50%	16
5	Documentation review	50%	16
6	System test	50%	40
7	Operation phase	100%	110

A comprehensive quality assurance plan ("comprehensive defects filtering system") achieves the following:

(1) Adds two quality assurance activities, so that the two are performed in the design phase as well as in the coding phase.

(2) Improves the "filtering" effectiveness of other quality assurance activities.

The main conclusions drawn from the comparison are:

(1) The standard plan successfully removes only 57.6% (28.8 defects out of 50) of the defects originated in the requirements and design phase, compared to 90.2% for the comprehensive plan, before coding begins. This is to be expected as a direct

result of the more intensive defect-removal efforts that characterize the comprehensive plan.

(2) The comprehensive plan, as a whole, is much more economical than the standard plan as it saves 41% of total resources invested in defect removal, compared to the standard plan.

(3) Compared to the standard plan, the comprehensive plan makes a greater contribution to customer satisfaction by drastically reducing the rate of defects detected during regular operations (from 6.9% to 2.6%).

Comprehensive quality assurance plan

No.	Quality assurance activity	Defect-removal effectiveness	Cost of removing a detected defect (cost units)
1	Requirement specification review	60%	1
2	Design inspection	70%	2.5
3	Design review	60%	2.5
4	Code inspection	70%	6.5
5	Unit test – code	40%	6.5
6	Integration test	60%	16
7	Documentation review	60%	16
8	System test	60%	40
9	Operation phase	100%	110

Reviews

As defined by IEEE (1990), a review process is:

> "A process or meeting during which a work product, or set of work products, is presented to project personnel, managers, users, customers, or other interested parties for comment or approval."

Review objectives

Direct objectives

■ To detect analysis and design errors as well as subjects where corrections, changes and completions are required with respect to the original specifications and approved changes.

■ To identify new risks likely to affect completion of the project.

■ To locate deviations from templates and style procedures and conventions.

Correction of these deviations is expected to contribute to improved communication and coordination resulting from greater uniformity of methods and documentation style.

■ To approve the analysis or design product. Approval allows the team to continue to the next development phase.

Indirect objectives

■ To provide an informal meeting place for exchange of professional knowledge about development methods, tools and techniques.

■ To record analysis and design errors that will serve as a basis for future corrective actions. The corrective actions are expected to improve development methods by increasing effectiveness and quality, among other product features.

Formal design reviews (DRs)

Formal design reviews, variously called “design reviews”, “DRs” and “formal technical reviews (FTR)”, differ from all other review instruments by being the only reviews that are necessary for approval of the design product. Without this approval, the development team cannot continue to the next phase of the software development project. Formal design reviews may be conducted at any development milestone requiring completion of an analysis or design document, whether that document is a requirement specification or an installation plan.

Some common formal design reviews

DPR – Development Plan Review

SRSR – Software Requirement Specification Review

PDR – Preliminary Design Review

DDR – Detailed Design Review

DBDR – Data Base Design Review

TPR – Test Plan Review

STPR – Software Test Procedure Review

VDR – Version Description Review

OMR – Operator Manual Review

SMR – Support Manual Review

TRR – Test Readiness Review

PRR – Product Release Review

IPR – Installation Plan Review

The formal design reviews will focus on:

- The participants
- The prior preparations
- The DR session
- The recommended post-DR activities.

The participants in a DR

All DRs are conducted by a review leader and a review team.

Preparations for a DR

Review leader preparations

The main tasks of the review leader in the preparation stage are:

- To appoint the team members
- To schedule the review sessions
- To distribute the design document among the team members (hard copy, electronic file, etc.).

Review team preparations

Team members are expected to review the design document and list their comments prior to the review session.

Development team preparations

The team's main obligation as the review session approaches is to prepare a short presentation of the design document. Assuming that the review team members have read the design document thoroughly and are now familiar with the project's outlines, the presentation should focus on the main professional issues awaiting approval rather than wasting time on description of the project in general.

The DR session

(1) A short presentation of the design document.

(2) Comments made by members of the review team.

(3) Verification and validation in which each of the comments is discussed to determine the required actions (corrections, changes and additions) that the project team has to perform.

(4) Decisions about the design product (document), which determines the project's progress. These decisions can take three forms:

- *Full approval* – enables immediate continuation to the next phase of the project. On occasion, full approval may be accompanied by demands for some minor corrections to be performed by the project team.

- *Partial approval* – approval of immediate continuation to the next phase for some parts of the project, with major action items (corrections, changes and additions) demanded for the remainder of the project. Continuation to the next phase of these remainder parts will be permitted only after satisfactory completion of the action items.

This approval can be given by the member of the review team assigned to review the completed action items, by the full review team in a special review session, or by any other forum the review leader thinks appropriate.

- *Denial of approval* – demands a repeat of the DR. This decision is applied in cases of multiple major defects, particularly critical defects.

Post-review activities

The DR report

One of the review leader's responsibilities is to issue the DR report immediately after the review session**.**

The report's major sections contain:

■ A summary of the review discussions.

■ The decision about continuation of the project.

■ A full list of the required actions – corrections, changes and additions that the project team has to perform. For each action item, the anticipated completion date and project team member responsible are listed.

■ The name(s) of the review team member(s) assigned to follow up performance of corrections.

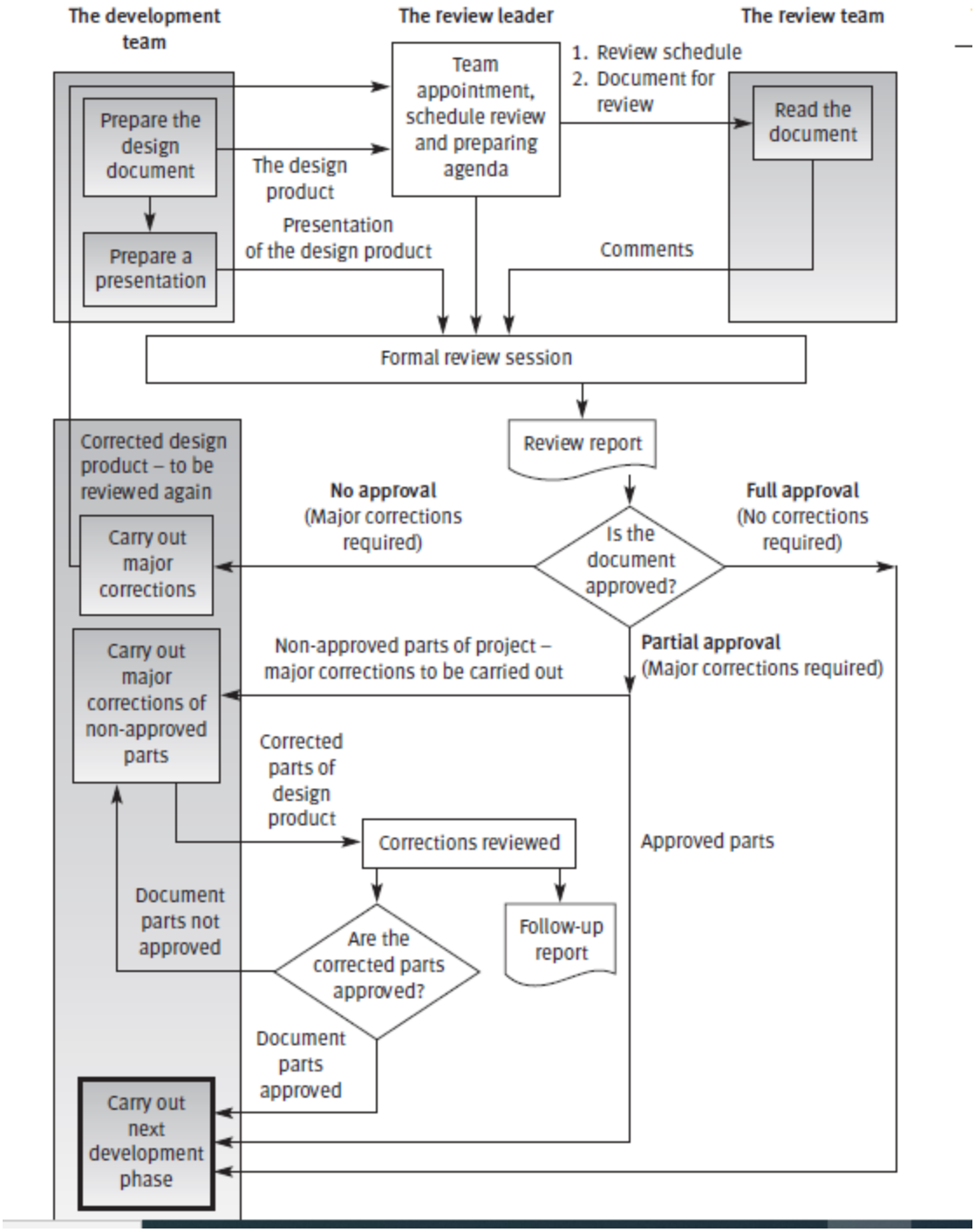
The follow-up process

The person appointed to follow up the corrections, in many cases the review leader him or herself, is required to determine whether each action item has been satisfactorily accomplished as a condition for allowing the project to continue to the next phase. Follow-up should be fully documented to enable clarification of the corrections in the future, if necessary.

Peer reviews

Two peer review methods are inspections and walkthroughs.

The major difference between formal design reviews and peer review methods is rooted in their participants and authority. While most participants in DRs hold superior positions to the project leader and customer representatives, participants in peer reviews are, as expected, the project leader's equals, members of his or her department and other units.



The formal design review process

Peer review methods will thus focus on:

- Participants of peer reviews
- Requisite preparations for peer reviews
- The peer review session
- Post-peer review activities
- Peer review efficiency
- Peer review coverage.

Participants of peer reviews

- A review leader
- The author
- Specialized professionals.

The review leader

The role of review leader ("moderator" in inspections, "coordinator' in walkthroughs) differs only slightly by peer review type. Candidates for this position must:

(1) Be well versed in development of projects of the current type and familiar with its technologies. Preliminary acquaintance with the current project is not necessary.

(2) Maintain good relationships with the author and the development team.

(3) Come from outside the project team.

(4) Display proven experience in coordination and leadership of professional meetings.

(5) For inspections, training as a moderator is also required.

The author

The author is, invariably a participant in each type of peer review.

Specialized professionals

■ **A designer:** the systems analyst responsible for analysis and design of the software system reviewed.

■ **A coder or implementer:** a professional who is thoroughly acquainted with coding tasks, preferably the leader of the designated coding team.

This inspector is expected to contribute his or her expertise to the detection of defects that could lead to coding errors and subsequent software implementation difficulties.

■ **A tester:** an experienced professional, preferably the leader of the assigned testing team, who focuses on identification of design errors usually detected during the testing phase.

■ **A standards enforcer.** This team member, who specializes in development standards and procedures, is assigned the task of locating deviations from those standards and procedures.

■ **A maintenance expert** who is called upon to focus on maintainability, flexibility and testability issues and to detect design defects capable of impeding correction of bugs or performance of future changes.

■ **A user representative.** Participation of an internal (when the customer is a unit in the same firm) or an external user's representative in the walkthrough team contributes to the review's validity because he or she examines the software system from the point of view of the user consumer rather than the designer–supplier.

Team assignments

■ **The presenter.** During inspection sessions, the presenter of the document is chosen by the moderator; usually, the presenter is not the document's author.

■ **The scribe.** The team leader will often – but not always – serve as the scribe for the session, and record the noted defects that are to be corrected by the development team.

Preparations for a peer review session

Peer review leader's preparations for the review session

Peer review team's preparations for the review session

The peer review session

Session documentation

(1) ***Inspection session findings report.***

(2) **Inspection session summary report.**

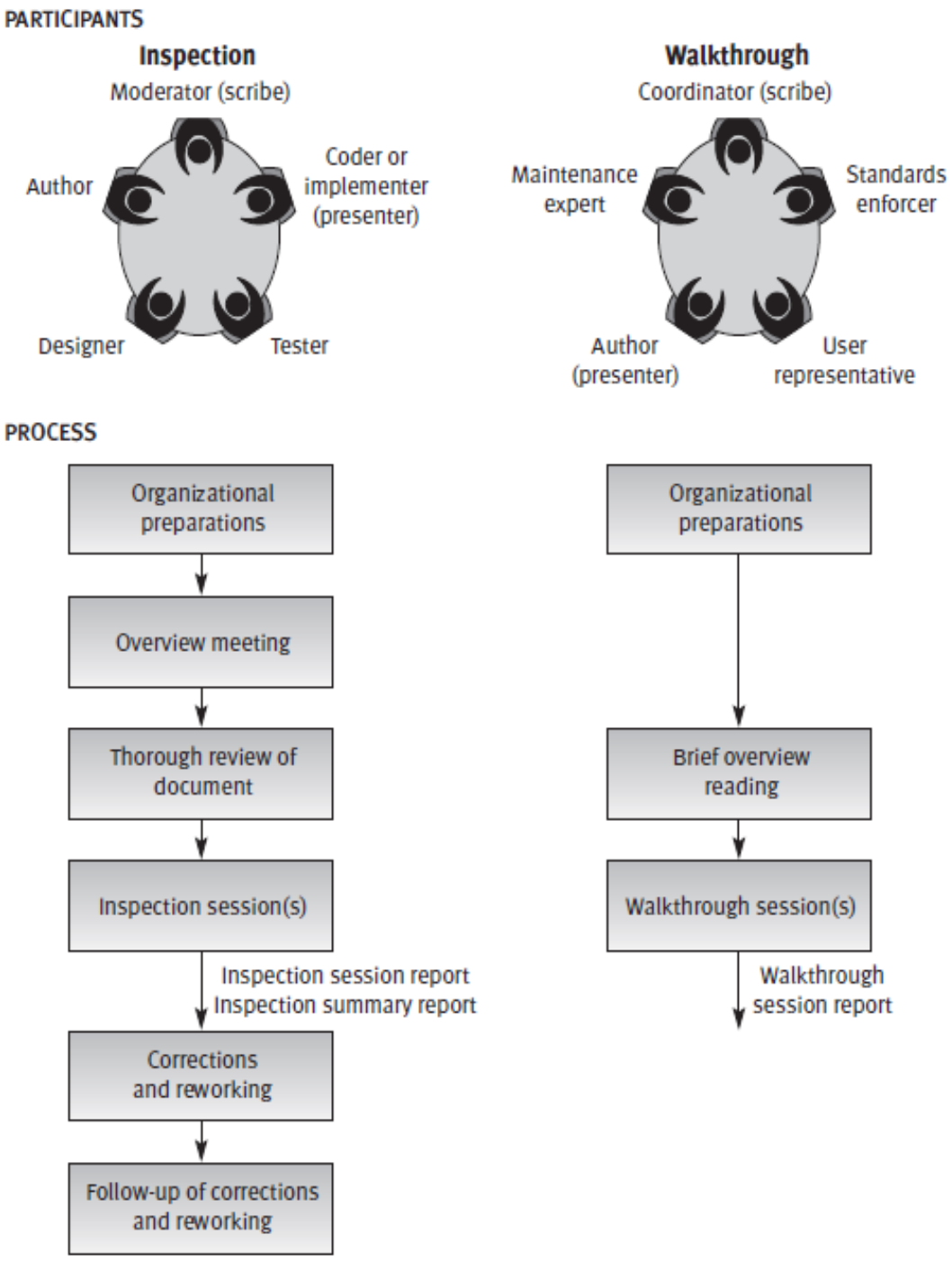
Post-peer review activities

Post-inspection activities are conducted to attest to:

■ The prompt, effective correction and reworking of all errors by the designer/author and his team, as performed by the inspection leader (or other team member) in the course of the assigned follow-up activities.

■ Transmission of the inspection reports to the internal Corrective Action Board (CAB) for analysis. This action initiates the corrective and preventive actions that will reduce future defects and improve productivity.

A comparison of the peer review methods, participants and process elements is presented in Figure.



Inspections vs. walkthrough - participants and processes

A comparison of the team review methods

Properties	Formal design reviews	Inspections	Walkthroughs
Main direct objectives	(1) Detect errors (2) Identify new risks (3) Approve the design document	(1) Detect errors (2) Identify deviations from standards	Detect errors
Main indirect objectives	Knowledge exchange	(1) Knowledge exchange (2) Support corrective actions	Knowledge exchange
Review leader	Chief software engineer or senior staff member	Trained moderator (peer)	Coordinator (peer, the project leader on occasion)
Participants	Top-level staff and customer representatives	Peers	Peers
Project leader participation	Yes	Yes	Yes; usually as the review's initiator
Specialized professionals in the team	—	(1) Designer (2) Coder or implementer (3) Tester	(1) Standards enforcer (2) Maintenance expert (3) User representative
Process of review:			
Overview meeting	No	Yes	Yes
Participants' preparations	Yes – thorough	Yes – thorough	Yes – brief

	Formal design reviews	Inspections	Walkthroughs
▪ Review session	Yes	Yes	Yes
▪ Follow-up of corrections	Yes	Yes	No
Infrastructure:			
▪ Formal training of participants	No	Yes	No
▪ Use of checklists	No	Yes	No
Error-related data collection	Not formally required	Formally required	Not formally required
Review documentation	Formal design review report	(1) Inspection session findings report (2) Inspection session summary report	Walkthrough session findings report

Expert opinions

The last review method we will discuss is the use of expert opinions. Expert opinions, prepared by outside experts, support quality evaluation by introducing additional capabilities to the internal review staff. The organization's internal quality assurance activities are thereby reinforced. Outside experts transmit their expertise by either:

■ Preparing an expert's judgement about a document or a code section.

■ Participating as a member of an internal design review, inspection or walkthrough team.

An outside expert's judgement as well as his or her participation as an external member of a review team is most beneficial in the following situations:

■ Insufficient in-house professional capabilities in a specialized area.

■ Temporary lack of in-house professionals for review team participation due to intense workload pressures during periods when waiting will cause substantial delays in the project completion schedule.

■ Indecisiveness caused by major disagreements among the organization's senior professionals.

■ In small organizations, where the number of suitable candidates for a review team is insufficient.