Software Engineering: A Practitioner's Approach, 6/e

Chapter 26
Quality Management

Quality

- The *American Heritage Dictionary* defines *quality* as
  - “a characteristic or attribute of something.”
- For software, two kinds of quality may be encountered:
  - Quality of design encompasses requirements, specifications, and the design of the system.
  - Quality of conformance is an issue focused primarily on implementation.
  - user satisfaction = compliant product + good quality + delivery within budget and schedule

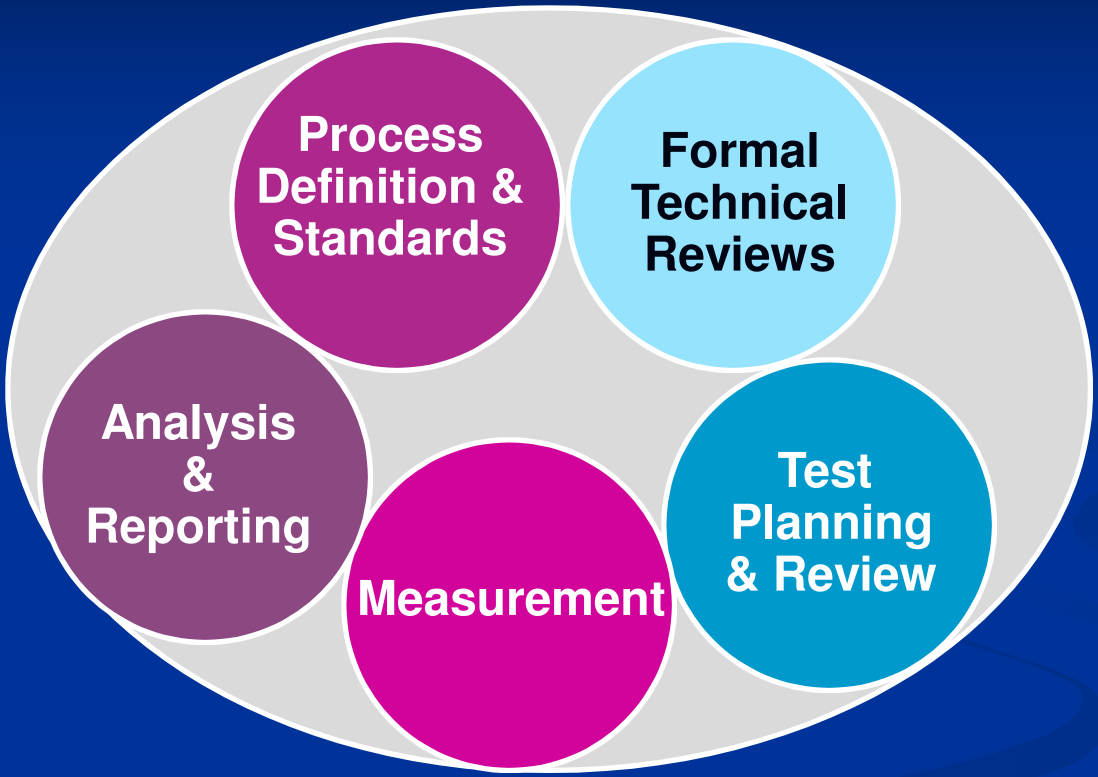
Software Quality

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

Cost of Quality

- *Prevention costs* include
  - quality planning, formal technical reviews, test equipment and Training
- *Appraisal costs* include
  - In-process and inter-process inspection, equipment calibration and maintenance, and testing
- *Failure costs*
  - *Internal failure costs* (before delivery) include
    - rework
    - repair
    - failure mode analysis
  - *External failure costs* (after delivery) include
    - complaint resolution
    - product return and replacement
    - help line support
    - warranty work

Software Quality Assurance



The SQA group serves as the customer’s in-house representative.

Role of the SQA Group-I

- **Prepares an SQA plan for a project.**
  - The plan identifies
    - evaluations to be performed
    - audits and reviews to be performed
    - standards that are applicable to the project
    - procedures for error reporting and tracking
    - documents to be produced by the SQA group
    - amount of feedback provided to the software project team
- **Participates in the development of the project's software process description.**
  - The SQA group reviews the process description for compliance with organizational policy, internal software standards, externally imposed standards (e.g., ISO-9001), and other parts of the software project plan.

Role of the SQA Group-II

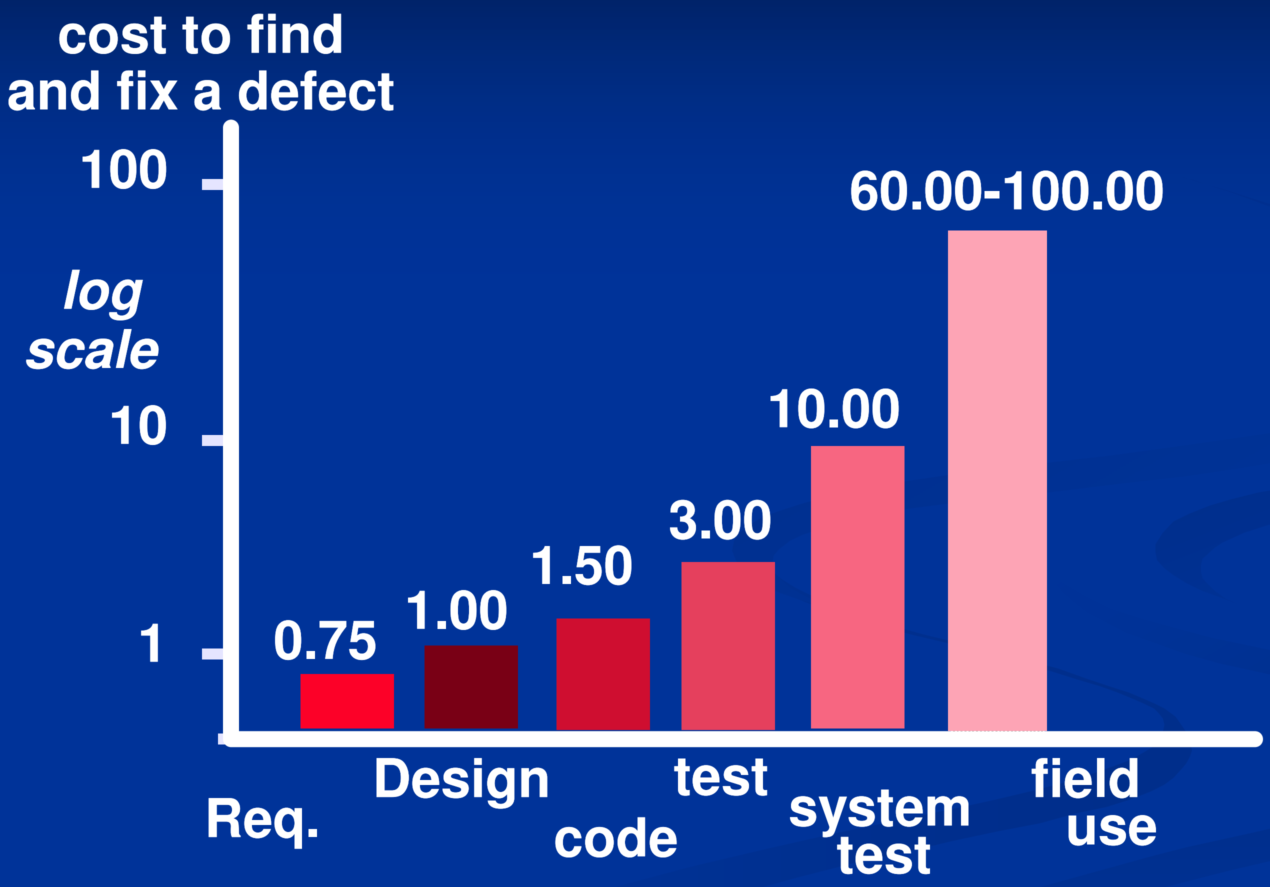
- **Reviews software engineering activities to verify compliance with the defined software process.**
  - identifies, documents, and tracks deviations from the process and verifies that corrections have been made.

- **Audits designated software work products to verify compliance with those defined as part of the software process.**
  - reviews selected work products; identifies, documents, and tracks deviations; verifies that corrections have been made
  - periodically reports the results of its work to the project manager.

- **Ensures that deviations in software work and work products are documented and handled according to a documented procedure.**

- **Records any noncompliance and reports to senior management.**
  - Noncompliance items are tracked until they are resolved.

Why SQA Activities Pay Off?



Reviews & Inspections

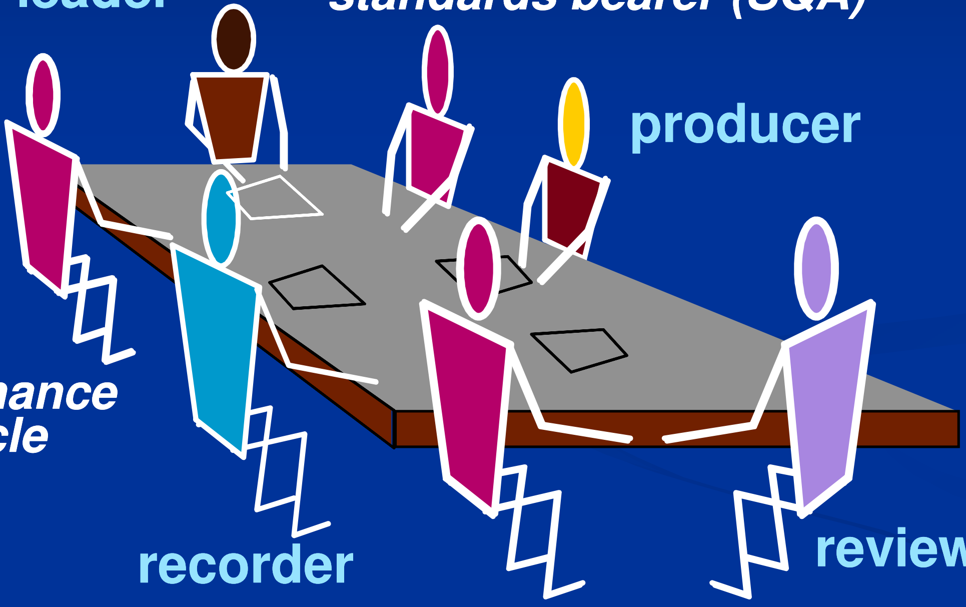
> **... there is no particular reason why your friend and colleague cannot also be your sternest critic.**
>
> ***Jerry Weinberg***

What Are Reviews?

- a meeting conducted by technical people for technical people
- a technical assessment of a work product created during the software engineering process
- a software quality assurance mechanism
- a training ground

Reviews serve to uncover errors and defects that can then be removed at various points during software engineering.

The Players



review leader

standards bearer (SQA)

producer

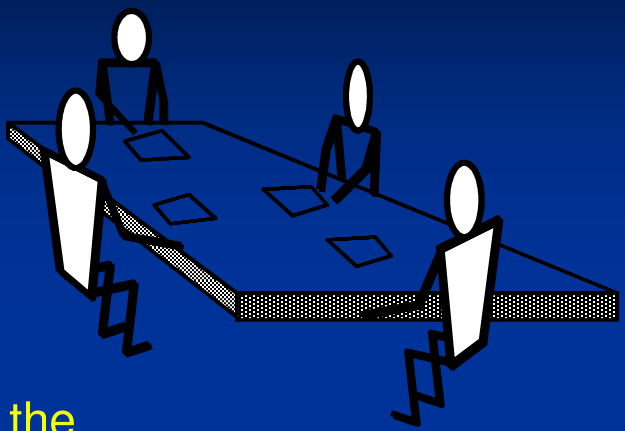
maintenance oracle

recorder

reviewer

user rep

Conducting the Review



1. be prepared—evaluate product before the review
2. review the product, not the producer
3. keep your tone mild, ask questions instead of making accusations
4. stick to the review agenda
5. raise issues, don't resolve them
6. avoid discussions of style—stick to technical correctness
7. schedule reviews as project tasks
8. record and report all review results

At the end of the review, all attendees of the Formal Technical Reviews must decide whether to (1) accpet the product without further modification, (2) reject the product due to severe errors, or (3) accept the product provisionally.

Review Summary

- A review summary report answers three questions:
  - What are reviewed
  - Who reviewed it
  - What were the findings and conclusions

Review Guidelines

- Review the product, not the producer
- Set an agenda and maintain it
- Limit debate and rebuttal
- Enunciate problem areas, but don’t attempt to solve every problem noted
- Take written notes
- Limit the number of participants and insist upon advance preparation

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Defect Amplification and Removal

- Figure 26.2
  - Errors passed through
  - Amplified errors 1: x
  - Newly generated errors

- Figure 26.3

  no reviews are conducted

- Figure 26.4

  reviews are conducted (preliminary design, detail design, code)

Sample-Driven Reviews (SDRs)

- SDRs attempt to quantify those work products that are primary targets for full FTRs.

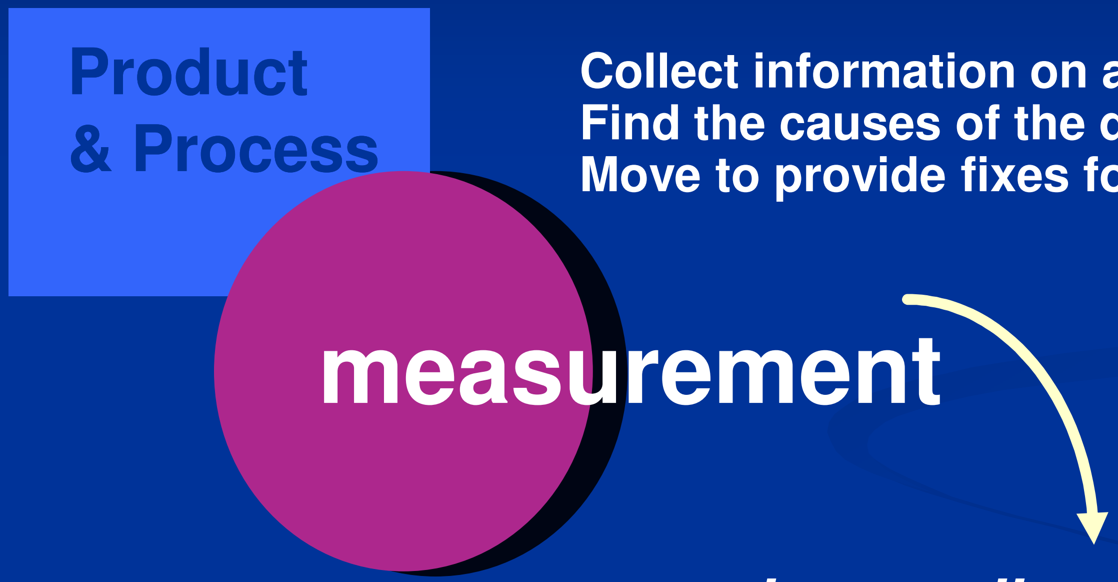
To accomplish this …

  - Inspect a fraction a_i of each software work product, Record the number of faults f_i found within a_i.
  - Develop a gross estimate of the number of faults within work product *i* by multiplying f_i by $1/a_i$.
  - Sort the work products in descending order according to the gross estimate of the number of faults in each.
  - Focus available review resources on those work products that have the highest estimated number of faults.

Metrics Derived from Reviews

- inspection time per page of documentation
- inspection time per KLOC or FP
- inspection effort per KLOC or FP
- errors uncovered per reviewer hour
- errors uncovered per preparation hour
- errors uncovered per SE task (e.g., design)
- number of minor errors (e.g., typos)
- number of major errors
  (e.g., nonconformance to req.)
- number of errors found during preparation

Statistical SQA



Product
& Process

measurement

Collect information on all defects
Find the causes of the defects
Move to provide fixes for the process

... an understanding of how to improve quality ...

An Example

- Figure 26.5

  The causes of errors, number of errors be found, percentage

  vital causes according to total percentage: IES, MCC, EDR
  vital causes according to serious percentage: IES, EDR, EDL, PLT

Six-Sigma for Software Engineering

- The term “six sigma” is derived from six standard deviations—3.4 instances (defects) per million occurrences—implying an extremely high quality standard.
- The Six Sigma methodology defines three core steps:
  - *Define* customer requirements and deliverables and project goals via well-defined methods of customer communication
  - *Measure* the existing process and its output to determine current quality performance (collect defect metrics)
  - *Analyze* defect metrics and determine the vital few causes.

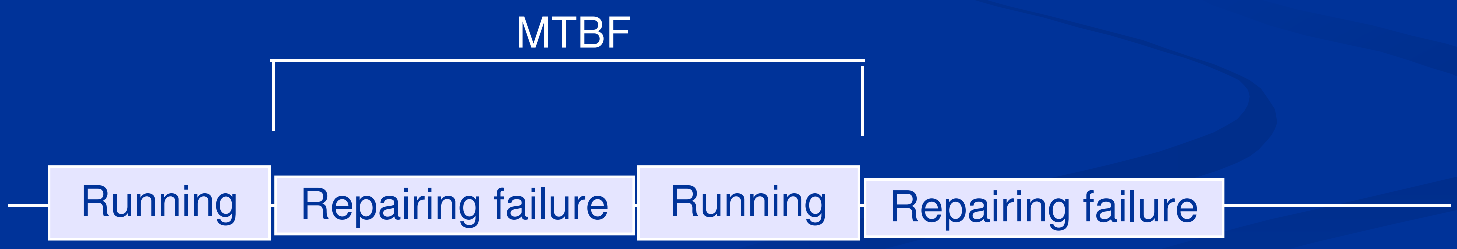
  - *Improve* the process by eliminating the root causes of defects.
  - *Control* the process to ensure that future work does not reintroduce the causes of defects.

Software Reliability

- A simple measure of reliability is *mean-time-between-failure* (MTBF), where

  MTBF = MTTF + MTTR

  Where the acronyms MTTF and MTTR are *mean-time-to-failure* and *mean-time-to-repair*, respectively.



Software Availability

- *Software availability* is the probability that a program is operating according to requirements at a given point in time and is defined as

$$\text{Availability} = [\text{MTTF}/(\text{MTTF} + \text{MTTR})] \times 100\%$$

Software Safety

- *Software safety* is a software quality assurance activity that focuses on the identification and assessment of potential hazards that may affect software negatively and cause an entire system to fail.
- If hazards can be identified early in the software process, software design features can be specified that will either eliminate or control potential hazards.

ISO 9001:2000 Standard

- ISO 9001:2000 is the quality assurance standard that applies to software engineering.
- The standard contains 20 requirements that must be present for an effective quality assurance system.
- The requirements delineated by ISO 9001:2000 address topics such as
  - management responsibility, quality system, contract review, design control, document and data control, product identification and traceability, process control, inspection and testing, corrective and preventive action, control of quality records, internal quality audits, training, servicing, and statistical techniques.