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SOFTWARE QUALITY ASSURANCE (SQA)

Chapter 1

Objectives

- After completing this chapter, you shall be able to
  - ✓ Explain and define the meaning of Quality and Software Quality
  - ✓ Understand the importance of Quality
  - ✓ Explain and differentiate between Quality Assurance and Quality Control
  - ✓ Understand and explain QA activities at each phase of SDLC
  - ✓ Understand the SQA function in an organization
  - ✓ Understand and explain the objectives of SQA
  - ✓ Explain the benefits of SQA function
  - ✓ Identify and understand SQA Roles and Responsibilities
  - ✓ Understand and explain management involvement in Software Quality

SOFTWARE QUALITY OVERVIEW

Quality

- “Quality” is a major business factor, a **distinguisher** that makes the difference
- An **end user’s definition** of quality would be: “**absence of defects that would make software either stop completely or produce unacceptable results**”.
- Definition of quality must meet **two** important **criteria**
  - Quality must be **measureable** when it occurs
  - Quality should be **predictable** when it occurs

The meaning of "**Quality**" by the "Quality Gurus"

Quality	By
Achieving high levels of user satisfaction, portability, maintainability, robustness, and fitness for use	Dr. Barry Boehm
Conformance to user requirements	Phil Crosby
"striving for excellence" in reliability and functions by continuous improvement in the process of development, supported by statistical analysis of the causes of failure	Edwards Deming
Achieving excellence levels of fitness for use, conformance to requirements, reliability and maintainability	Watts Humphrey (SEI)
On time, within budget and meeting user needs	James Martin
High levels of user satisfaction and low defect levels, associated with low complexity	Tom McCabe
Combination of "low defect levels, adherence of software functions to users need , and high reliability."	John Musa
High levels of user satisfaction and adherence to requirements	Bill Perry

Quality

- Table below lists the elements of quality definitions quoted by the “Quality Gurus” and indicate which elements meet both criteria

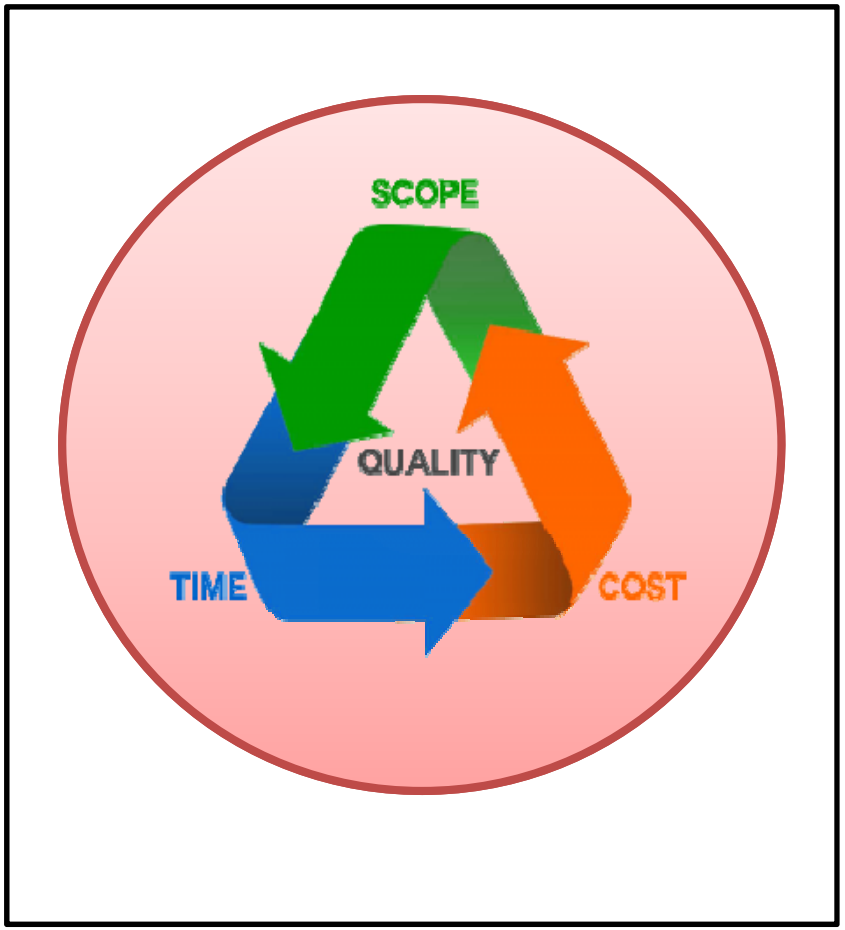
Quality Factor	Predictable	Measurable
Defect Level	Yes	Yes
Defect Origins	Yes	Yes
Defect Severity	Yes	Yes
Defect Removal Efficiency	Yes	Yes
Product Complexity	Yes	Yes
Project Reliability	Yes	Yes
Project Maintainability	Yes	Yes
Project Schedules	Yes	Yes
Project Budgets	Yes	Yes
Portability	Yes	Yes
Conformance to Requirements	No	Yes
User Satisfaction	No	Yes
Fitness for Use	No	Yes
Robustness	No	No

Software Quality

Software Quality	By
The degree to which a system, component, or a process meets specified requirements.	**IEEE** (IEEE_Std_610.12-1990)
The degree to which a system, component, or process meets customer or user needs or expectations.	**IEEE** (IEEE_Std_610.12-1990)
Conformance to explicitly stated functional and performance requirements, explicitly documented development standards, and implicit characteristics that are expected of all professionally developed software.	Roger **Pressman**, Software Engineering, A Practitioner's Approach. McGraw-Hill, 6 ed., 2001
Quality is a totality of features and characteristics of a product, or service that bear on its ability to satisfy stated or implied needs	**ISO 8402** International Standard

Discussion

Based on your understanding about “Quality”, discuss figure below.



The importance of “Quality”

- Quality is critical for survival and success
- Customers demand on quality
- Organization will not success in this global business (software industry) unless
  - They produce quality products/services
  - The organizations are also perceived by customer to produce quality products/services
- As mentioned before, essentially Quality means satisfying customer.
  - A happy customer will get you repeat business and business houses agree that the cost of getting a new customer is much higher. Thus, businesses would like to focus on getting more and more business from the same customers

The importance of “Quality”

- The reasons why businesses concerned with quality?

1) Quality: A competitive issue

- Previously software was considered as a technical business only in which functionality was the key factor of success. But nowadays, competitors can match your functionality relatively quickly and easily. Thus, the only way to differentiate your product from others, in the long run, is by its quality, and the quality of support that goes with it.
- **Customers** (internal and external) **want to be assured of quality**. Certification to international quality standards is becoming a pre-requisite for getting business.

2) Quality: An issue for survival

- Customers are demanding demonstrable quality. If business cannot deliver it, their ability to survive in a higher competitive and rapidly changing market is in doubt.
- Business want to work closely with few key suppliers (whom they treat as a business partner). They often use **quality certifications** as a way of selecting suppliers.

The importance of “Quality”

- The reasons why businesses concerned with quality?

3) Quality: For Entry into International Markets

- Since that nowadays software is a global business, the **ability to demonstrate quality** gives even a smaller company the **credibility to enter an export market**.

4) Quality is Cost Effective

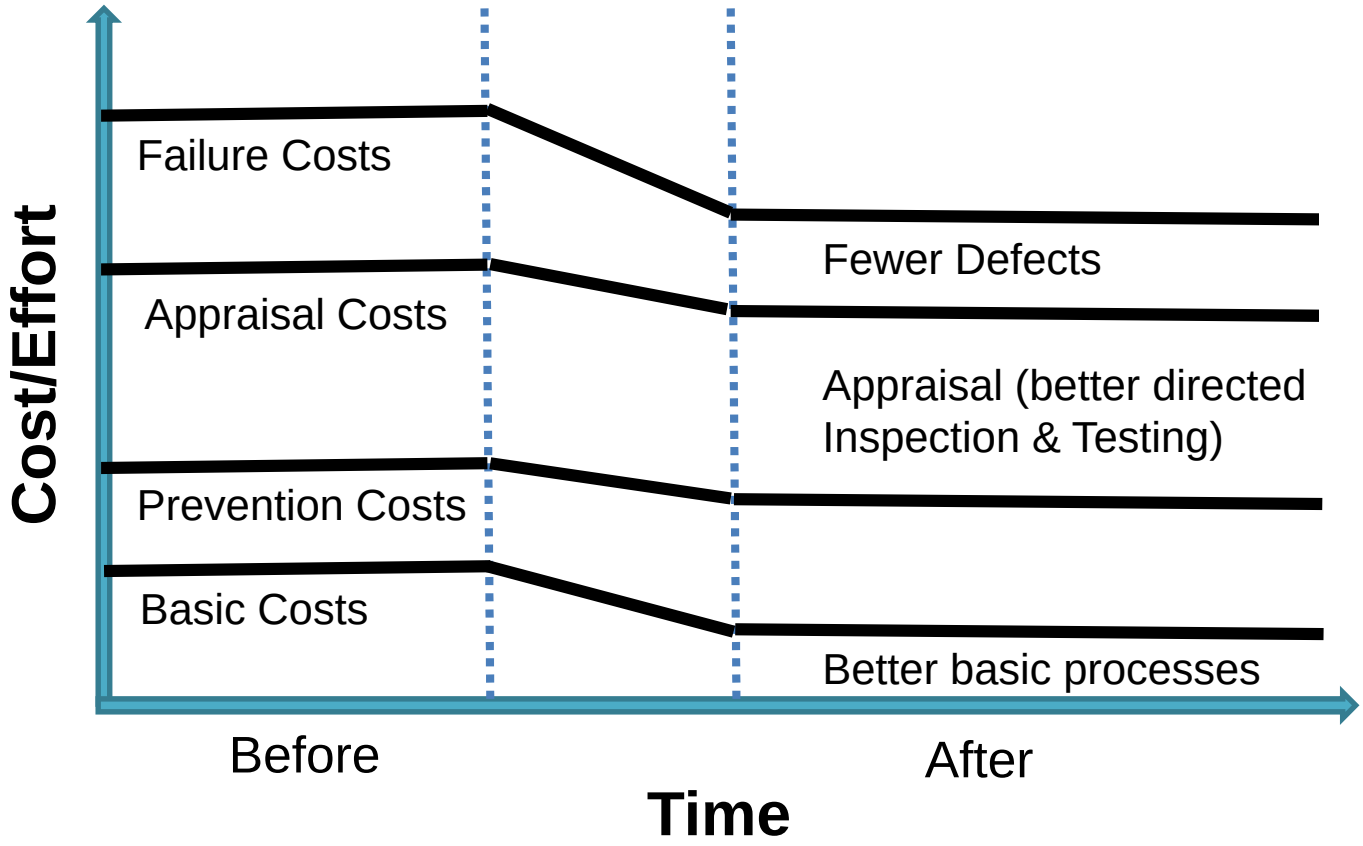
- An effective quality system leads to **increased productivity** and **permanently reduced costs**, because it enables management to **reduce defect correction costs** by emphasizing **prevention**.
- The scope for reducing costs can be demonstrated by applying the “**cost of poor quality**” technique – a way of analyzing business processes to identify targets for improving initiatives

The importance of “Quality”

- Organization’s costs can be broken down into the following categories:
  - **Prevention costs** – incurred to prevent defect from occurring. (example: training, corrective action aimed at eliminating the cause of failure, quality planning, quality assurance, etc.)
  - **Appraisal costs** – associated with measuring and monitoring activities related to quality. (example: reviewing work-products, testing software to ensure it meets requirements, quality audits, supplier rating, etc.)
  - **Failure costs** – incurred in correcting defects found by appraisals, or by customer after delivery (post delivery defects or customer reported defects).
    - **Internal Failure costs** – incurred to remedy defects discovered before the product/service is delivered to the customer (example: rework – correction of errors, failure analysis, scrap – defective product, etc.)
    - **External failure costs** – incurred to remedy defects discovered by customers (example: complaints, returns, warranty claims, repairs and servicing, etc.)

The importance of “Quality”

- The cost of low quality can amount to more than 50% of total costs in software organization. Large saving can be made by **analyzing** these **costs** and targeting resources to reduce it – by redirecting the resources towards **prevention** as shown below:

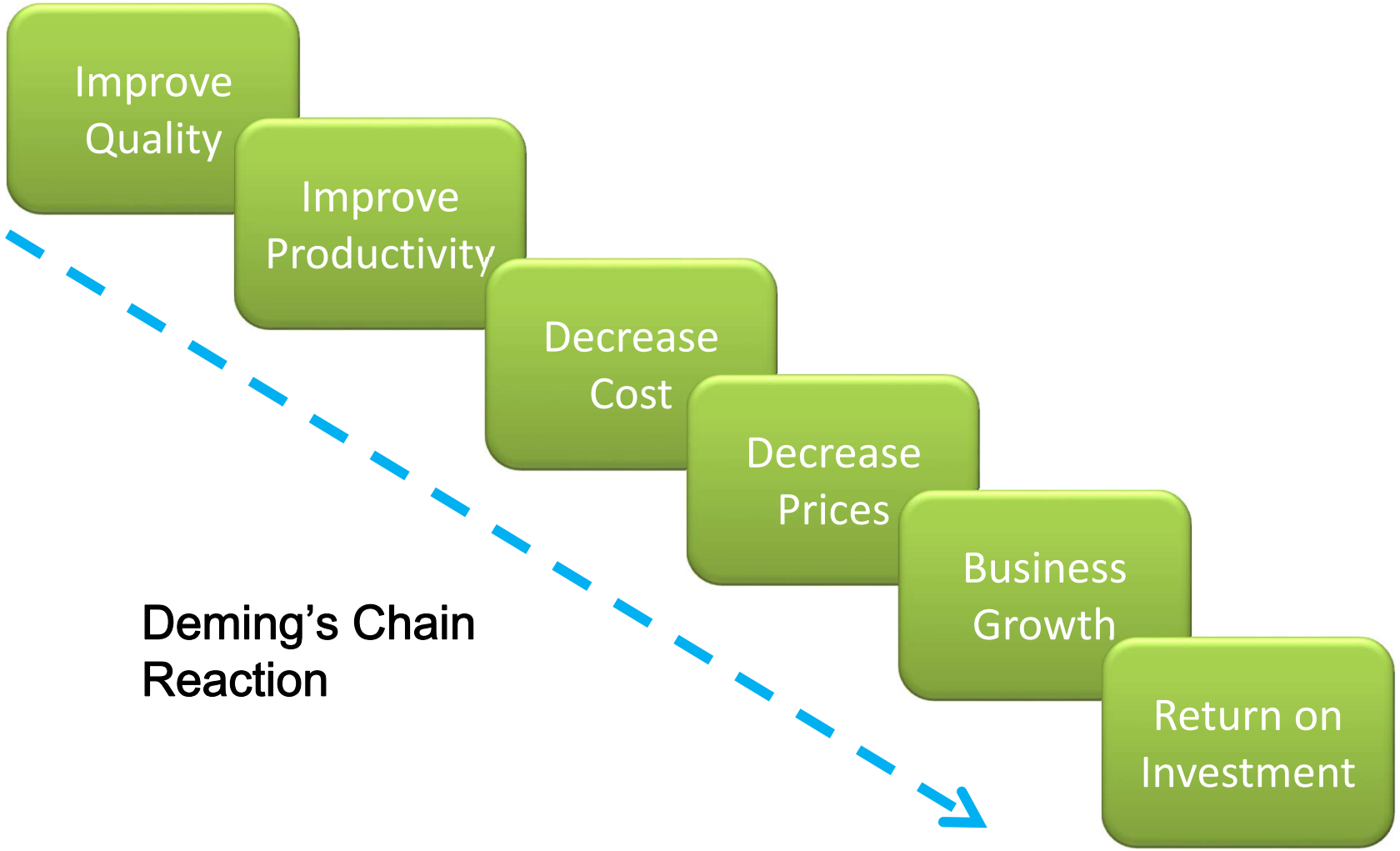


The importance of “Quality”

- The reasons why businesses concerned with quality?
  5) **Quality for Retaining Customers and Increasing Profits**
     - **Poor quality costs customers** much **more than suppliers** – a silent customer is more dangerous than a complaining customer – you’ll never know when you lost him
     - **Better quality** leads to improved **customer satisfaction**, **delightful customer relationship** and ultimately results in year-on-year **retention of existing customers**
     - As said earlier, the sales cost pf attracting a new customer is high. Studies from management consulting firms show that for a software company a 5% increase in **customer retention increased profits** by 35%.
  6) **Quality as the Hallmark of Global Business**
     - World-class businesses place a strategic **emphasis on quality** – enables them to **grow** their **business** and **outperform their competitors**.
     - “**Deming’s Chain Reaction**” illustrated the reason why world-class businesses emphasis on quality

The importance of “Quality”

6) Quality as the Hallmark of Global Business



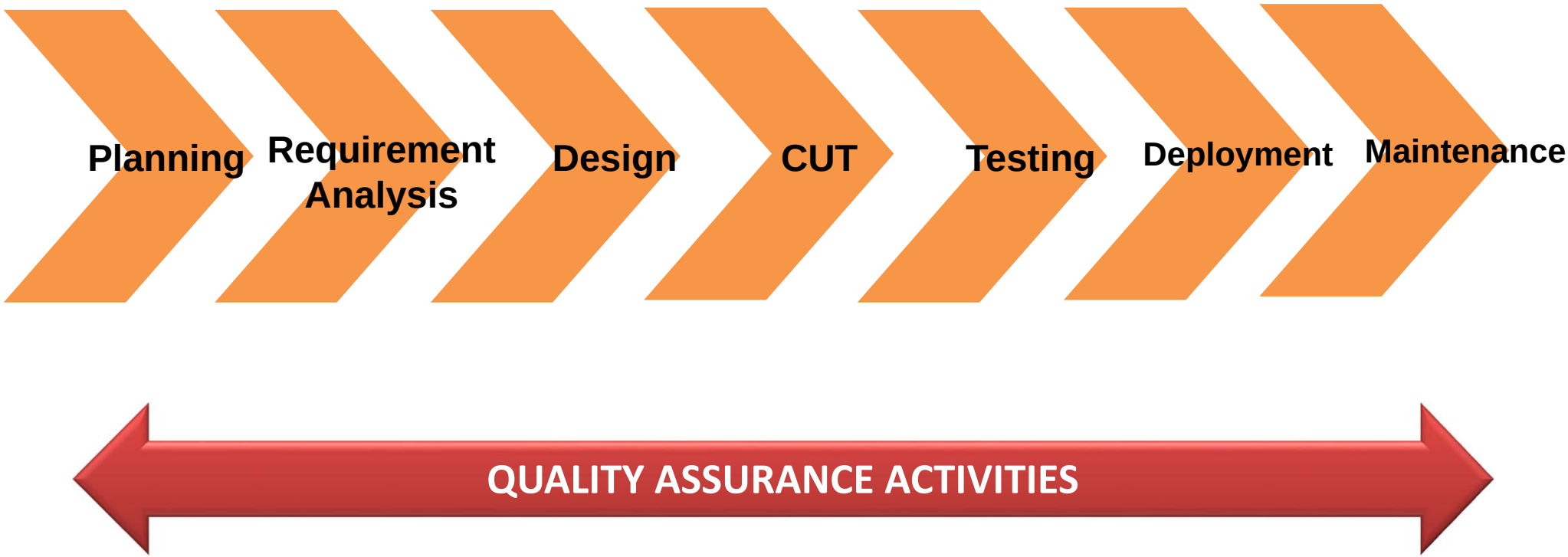
Discussion

Provide an example of any **quality issues** in real situation where you have come across (either it is a product issue or service issue)?

Quality Assurance VS Quality Control

Quality Assurance (QA)	Quality Control (QC)
Prevention (Proactive)	Correction (Reactive)
Process	Product
Confidence to Customers	Confidence to Producers
Staff Function	Line Function
Prevent Defects	Find Defects
Examples	
Defining Processes	Walkthrough
Quality Audit	Testing
Selection of Tools	Inspection
Training	Checkpoint Review

QA at each phase of SDLC



QA at each phase of SDLC

- Quality during **Analysis** (1/4)
  - Three main activities to promote quality during Requirement Analysis
    - Measurement of process attributes
    - Verification & Validation
    - Management
  - Verification refers to the set of activities that ensure that software correctly implements a specific function – “Are we building the product right?”
  - Validation refers to a different set of activities that ensure that the software that has been built is traceable to customer requirement – “Are we building the right product?”

QA at each phase of SDLC

- Quality during **Analysis** (2/4)
  - **Verification** during analysis can be performed by
    - making sure that functional and non-functional requirements and constraints, as in the requirements specification document are traceable to customer requests that were determined during systems analysis.
    - comparing analyzed risk, estimated cost, strategy and model selected with the results of previous projects
  - **Validation** during analysis can be performed by
    - allowing users to review the project plan
    - allowing users to experiment with prototypes

QA at each phase of SDLC

- Quality during **Analysis** (3/4)
  - Managing quality in the analysis stage is a challenge because requirements is not very clear at this state.
  - Incorrect schedules, incorrect cost estimates, inadequate project accountability procedures, inadequate quality assurance procedures and imprecise goals and success criteria which are the outputs from Analysis stage are the major management deficiencies in most software development projects.
  - What is **requirement**?
    - **Specification of what a system/application must do** – the things about the system users can observe
  - Characteristics of good requirements:
    1) They are **precise**, with no room for misinterpretation by users or implementors
    2) They **specify** just **what the system must do**, not how to do it. They avoid specifying implementation details
    3) They show **conceptual integrity**, building on a simple set of facilities that interact well with each other (important from user's point of view)

QA at each phase of SDLC

- Quality during **Analysis** (4/4)
  - Besides, constraints and goal for the system also been defined during analysis stage
  - **Constraints** can be referred to as "**nonfunctional requirements**".
    - Limitation on possible implementation of the system
    - Example: *A customer may require a particular implementation language, a particular search algorithm say for a product search feature of the online catalogue module of a web application, or a particular format for a database table etc in a way not visible to the end users. It is often in our interest to negotiate away constraints since they limit implementation freedom. However, since the customers are paying for the product, they normally succeed in imposing constraints if they really want them.*
  - A **goal** is a statement that guides tradeoffs among design decisions
    - A goal may become a requirement if you find a way to quantify it, which in turn allows introduction of measure for improvement.
    - Example: A customer may care a lot about maintainability of the software , but not care much about efficiency.
      - *"High throughput" is a goal but "at least 53 transactions per second" is a requirement*

QA at each phase of SDLC

- Quality during **Design**
  - A lack of quality in the design process can invalidate an otherwise good requirements specification and can make correct implementation impossible
  - To evaluate design,
    - choose a set of design attributes that will be measured along with some objective metrics, which can be applied in a procedural way to the design
    - Prepare procedure for combining individual metrics to evaluate overall design quality
    - In industry, the use of checklist as one of the practice helps to improve design quality

QA at each phase of SDLC

- Quality during **Specification**
  - The specification is the technical foundation of software development. Thus, it should exhibit the highest quality possible.
  - There are few measures that are used for indicating Requirement Specification
    1) Conforms to the standard that has been accepted by the software organization
       - A simple check-off procedure to determine whether each part of the document required by the standard is actually present, whether standards in notation and style are met and so on
    2) The quality of the Software Requirements Specification can be evaluated with regard to several different attributes.
       - Attributes for specification: Correct, Consistent, Complete, Unambiguous, Minimal, Formal, Verifiable, Transformable, Modifiable, Traceable

QA at each phase of SDLC

Specification Attributes	Description
Consistency	Confident that requirements which are correct in isolation can still be achieved when taken together
Completeness	Guarantees that no important requirement specification has been left out
Unambiguous	All project stakeholders agree on the exact meaning of the specification
Minimal	Guard against over specifying software. • The specification should be functional. • Use notation that supports us in saying just what we want, with no additional redundant, or distracting verbiage
Verifiability	The capacity of determining that requirements are met at each stage of development

QA at each phase of SDLC

Specification Attributes	Description
Transformability	Describes the characteristics of specifications that provide for a smooth processing to create a design, the working product of the next stage of the development life cycle
Modifiability	• Refers to the ease with which changes can be made to the specifications themselves • Promoted by modularity in the specification with minimum cross-connections and dependencies between different requirements
Traceability	The inclusion of sufficient pointers, cross indexes, references etc to allow us to go forward from a requirement to find those part of a subsequent work product to satisfy the requirement or backward from a portion of the work product to find the requirements that give rise to it

QA at each phase of SDLC

- Quality during Maintenance phase
  - During maintenance phase of a software project, the complexity metrics can be used to track and control the complexity level of modified module/routines
    - Software developer must ensure that customer's support requirements are identified, must design and engineer the business and technical infrastructure from which the product will be supported
  - Support for software can be complex and may include:
    - User documentation, including on-line help text
    - Packaging and distribution arrangements
    - Implementation and customization services and/or consulting
    - Product Training
    - Help desk assistance
    - Error reporting and correction
    - Enhancement

The SQA Function

- As per Software Capability Maturity Model (CMM), Software Quality assurance includes activities:
  - **Auditing**
  - **Reviews – walkthrough, process checks**
- A person performing this role is called **Software Quality Analyst (SQA)**
- Quality Assurance as a function is a valid discipline in its own right. People can be **quality assurance experts** without being software design experts
- This expertise and commitment of Quality Assurance function is what is required to establish a **strong quality program** in an **organization** – includes **knowledge of statistical methods, quality control principles, the software process and ability to deal effectively with people in contentious situations**

Objectives of SQA

- The goals of SQA function are:
  - To **improve software quality** by appropriately **monitoring** both the **software and the development process** that produces it
  - To **ensure full compliance** with the established **standards** produces for the software and the software process
  - To ensure that any inadequacies in the product, the process, or the standards are brought to **management's attention** so these inadequacies can be fixed
- SQA as a function is responsible for **auditing the quality actions** of the line organization and for **drawing management's attention to any deviations or predictable defects**

Function of SQA

1) **Quality Assurance Practices**
   - Adequate and state-of-the-art development tools, techniques, methods and standards should be defined and available for use. They should also be under periodic review.
2) **Software Project Planning Evaluation**
   - Quality practices should be planned well in advance so that they can be implemented
3) **Requirements Evaluation**
   - Reviewing the requirements right from the beginning to see their conformance to the established quality standard

Function of SQA

4) Evaluation of the Design Process

- There should be appropriate mechanisms to ensure that the organization follows the planned methodologies, that implements

5) Evaluation of coding Practices

- Appropriate coding standards/practices and guidelines must be established and used

6) Evaluating the software integration and test process

- Testing should be performed (where possible) by an independent group that is both motivated and capable of finding defects. Test planning should begin early and the quality of testing itself should be reviewed.

Function of SQA

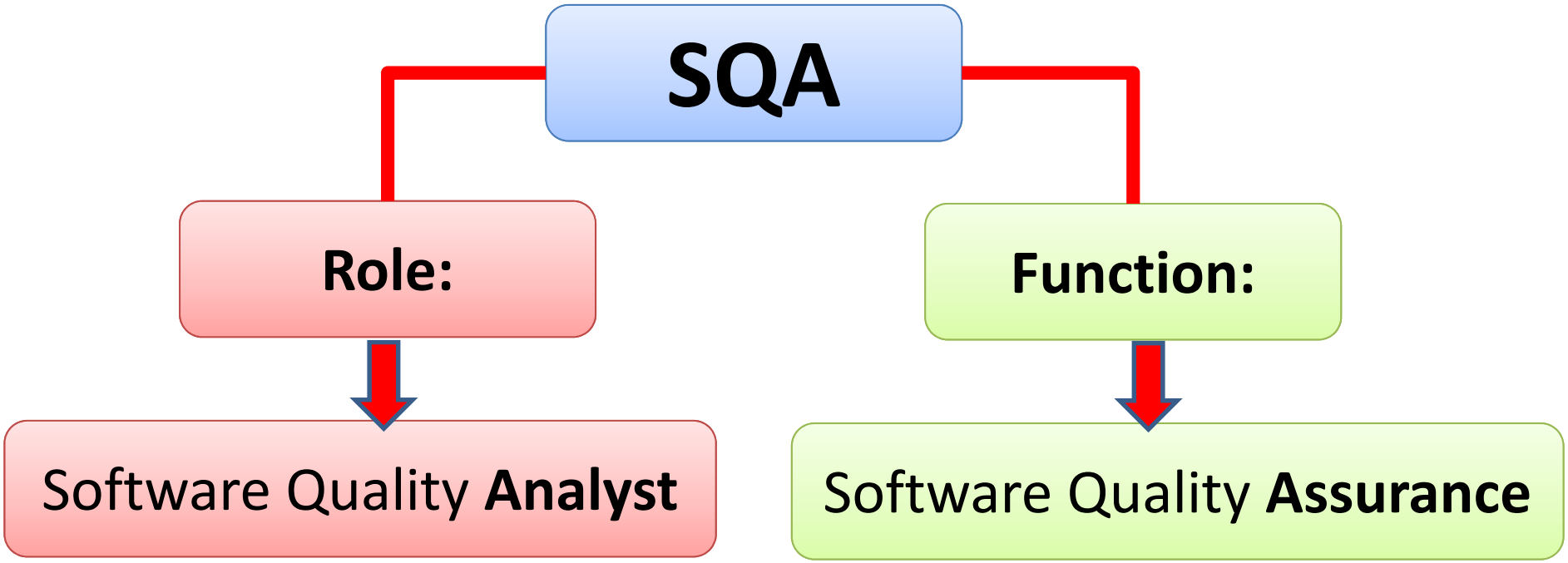
7) **In-process evaluation of the management and project control process**
   - By ensuring that the management processes are working, SQA helps to see to it that the entire organization is focused on producing quality results
8) **Tailoring of Quality Assurance Procedures**
   - Guidelines must exist to tailor the QMS processes if required
   - The SQA Plan should be tailored to the unique needs of each project and at times even to the needs of their customers.
     - For example, in a situation where adherence to customer's QA Procedures is a part of contractual requirement, SQA should help do mapping between the supplier organization's QMS and customer's QMS to avoid the need of duplication that may arise out of following both sets of processes.

The Benefits of SQA Function

- The **prime benefit** of establishing a dedicated **Quality group** is the assurance it provides management in showing that the officially established process is actually being implemented

- Quality Assurance program in an organization **ensures** that
  - ✓ An **appropriate** development **methodology** is in place
  - ✓ The projects use **standards and procedures** in their work
  - ✓ **Independent reviews and audits** are conducted
  - ✓ **Documentation** is **produced** to support **maintenance and enhancement**
  - ✓ The **documentation** is **produced during** and not after **development**
  - ✓ Mechanisms are in place and used to **control changes** (Configuration Management)
  - ✓ **Testing** emphasizes all the high-risk product areas
  - ✓ Each software task is satisfactorily completed before the succeeding one is begun. (**Phase-end Inspections**)
  - ✓ Deviations from standards and procedures are exposed as soon as possible. (**Waivers and Deviations**)
  - ✓ The quality control work is itself performed **against establishment standards**.
  - ✓ The **SQA plan** and the software **development plan** are **compatible**

SQA Roles and Responsibilities (1/3)



- The role of SQA is to monitor a group of people who executes the software projects*
- The SQA function is the "Eyes and Ears of Management".

* *The people executing the software projects are the only ones who can be responsible for quality*

SQA Roles and Responsibilities (2/3)

- **SQA Responsibilities**:
  - Review all development and quality plans for completeness
  - Participate as inspection moderators in design and code inspections
  - Review all test plans for adherence to standards
  - Review a significant sample of all test results to determine adherence to plan
  - Periodically audit SCM (Software Configuration Management) performance to determine adherence to standards
  - Participate in all projects (quarterly) and phase review
  - Register nonoccurrence if the appropriate standards and procedures have not reasonably met
  - If SQA fulfills its responsibilities and if senior management refuses to allow line management to commit and to ship products until the SQA issues have been addressed, then the SQA can help management improve product quality

SQA Roles and Responsibilities (3/3)

- **Example of items under SQA Review**:
  - ✓ **Requirements traceability matrix** to show that the product specification cover the requirements asked for by the customer
  - ✓ **Documentation** samples
  - ✓ Sample of **development records**
  - ✓ **Software Configuration Management activities** as per practices stated in the Configuration Management Plan, change control board
  - ✓ **Sub-contractor's quality assurance** function
  - ✓ **All plans** prepared during the tenure of software projects
  - ✓ **Peer Reviews and Testing** related activities
  - ✓ **Review of design, documentation and code** to see **adherence to** organization's **standards**

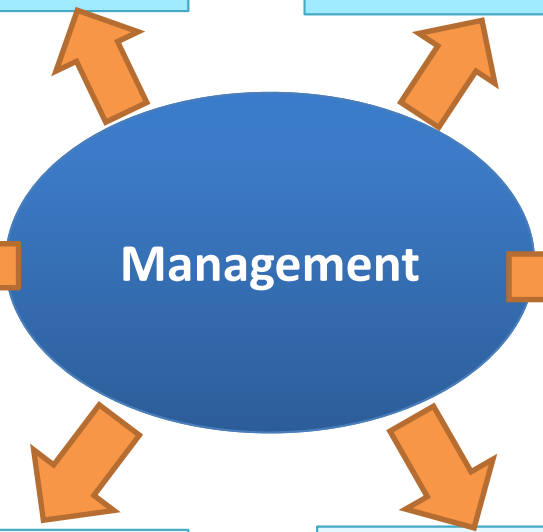
Management involvement in Software Quality (1/2)

- Quality mission cannot be accomplished **without** the solid **support** from the top **management**.
- The cause of quality cannot be simply delegated to a ‘quality champion’ or project leaders. **All managers** and **staff must own** and **take responsibility** for day-to-day **quality issues** with their control, the **quality effort must be supported, endorsed and enforced from the top**, as part of “quality culture”.
- Without this, attempts to improve quality will fail, since staff will feel **demoralized** in **absence** of solid **support** from top management
- A quality champion can be appointed by all means to do this Herculean task but the role of such a champion is only to help top management fulfill their responsibility to quality.

Management involvement in Software Quality (2/2)

Developing a policy for quality – a policy that can be implemented

Taking customers in confidence to take their buy-in, **educating** the **customer** about the importance of quality



Regularly reviewing the **quality policy** and its **implementation**

Treating **quality as a strategic business issue**

Ensuring the **quality policy is communicated** to all the **employees** and is **understood** by them

Ensuring that the **Quality policy** is **implemented** throughout the organization

Discussion

Based on your experience, give an **example of good quality product/software/services** that you know of. Explain why is it so?

Panasonic
ideas for life

LOUIS VUITTON

maybank2u.com

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Summary

- Essentially, quality means satisfying customers by meeting their specified requirements, delivering the software on time and within the budget allocated
- Quality Assurance is a long term investment for an organization and plays important roles for organization to sustain in business/industry
- Commitment by top management is crucial to accomplish quality mission in an organization
- Software product quality consist of a number of characteristics such as Functionality, Maintainability, Portability, Usability, Correctness, Reliability, Testability and Efficiency
- It is best to capture the notion of quality in a model that describes the characteristics of Quality *(will learn in the next class)*


QUALITY IS
EVERYONE'S
RESPONSIBILITY.
W. Edwards Deming
American Scientist
QUOTEHD.COM

THANK YOU