Software Quality Management

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Objectives

- To present how to *judge* software and source code quality
- To present how to *measure quality characteristics* of a product, a project, a process and a person
- To present *what* is quality, *how* to perform quality management and *why* quality management
- To create a *quality management plan*
- To present *key concepts* of ISO 9001

References

1. J.A. McCall et al. Factors in Software Quality. 1977.
2. Robert T. Futrell et al. Quality Software Project Management. 2002.
3. SHARI LAWRENCE PFLEEGER et al. Status Report on Software Measurement. 1997.
4. Paul POCATILU. IT Project Management Metrics. 2007.
5. G. Canfora et al. A Family of Experiments to Validate Metrics for Software Process Models. 2005.
6. Guidance on the Documentation Requirements of ISO 9001:2008.
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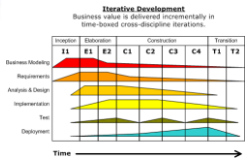
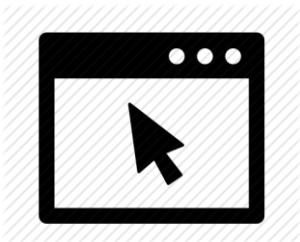
8. Stephen H. Kan. Metrics and Models in Software Quality Engineering. 2nd Edition, Addison-Wesley, 2002.

Software Products and Process

What is *mechanism* for specifying the qualities or characteristics of the documents, or software, or process.



How to Measure Quality of an Application?



- Test cases?
- Use cases?
- Check list?
- Samples?
- Hacking?

Quality of test cases!!!

How to Measure Source Code Quality?

- Check list?
- Test cases?
- Samples?
- Experts?

External Quality Characteristics [1]

Characteristic – A condition which actively contributes to the quality of the software.

- *CORRECTNESS*. Extent to which a program satisfies its specifications and fulfills the user's mission objectives.
- *RELIABILITY* Extent to which a program can be expected to perform its intended function with required precision.
- *EFFICIENCY* The mount of computing resources and code required by a program to perform a function.
- *INTERITY* Extent to which access to software or data by unauthorized persons can be controlled.
- *USABILITY* Effort required to learn, operate, prepare input, and interpret output of a program.
- *MAINTAINAILITY* Effort required to locate and fix an error in an operational program.
- *TESTABILITY* Effort required to test a program to insure it performs its intended function.
- *FLEXIBILITY* Effort required to modify an operational program.
- *PORTABILITY* Effort required to transfer a program from one hardware configuration and/or software system environment to another.
- *REUSABILITY* Extent to which a program can be used in other applications - related to the packaging and scope of the functions that programs perform.
- *INTEROPEABILITY* Effort required to couple one system with another.

ISO 9126 Quality Characteristics [2]

Quality Characteristic	Subcharacteristic
Functionality (Are the required functions available in the software?) Functionality is the set of attributes that bear on the existence of a set of functions and their specified properties.	Suitability
	Accuracy
	Interoperability
	Security
Reliability (How reliable is the software?) Reliability is the set of attributes that bear on the capability of software to maintain its level of performance under stated conditions for a stated period of time.	Maturity
	Fault tolerance
	Recoverability
Usability (Is the software easy to use?) Usability is the set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users.	Understandability
	Learnability
	Operability
	Attractiveness
Efficiency (How efficient is the software?)	Time behavior
	Resource behavior
Maintainability (How easy is it to modify the software?)	Analyzability
	Changeability
	Stability
	Testability
Portability (How easy is it to transfer the software to another operating environment?)	Adaptability
	Installability
	Coexistence
	Replace-ability

How to Measure a Quality Characteristic of Something?

- We have to turn our *vague ideas* about quality into something *measurable*.

- *Examples*:
  - *Correctness* (vague idea)
    - *Test cases* (measurable quantities)
      - Number of *passed* test cases (counts)
  - *Usability* (vague idea)
    - *Time* take to learn how to use system (measurable quantities)
      - *Average* of time of 100 users (counts)

Qualitative vs. Quantitative Measurement

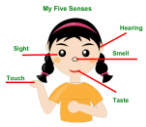
Qualitative Data	Quantitative Data
• robust aroma • frothy appearance • strong taste	• 12 ounces of latte • serving temperature 150º F. • serving cup 7 inches in height • cost $4.95

A Test

- The age of your car.
- The number of hairs on your knuckle.
- The softness of a cat.
- The color of the sky.
- The number of pennies in your pocket.

Answers

- The age of your car.
  - Quantitative.
- The number of hairs on your knuckle.
  - Quantitative.
- The softness of a cat.
  - Qualitative.
- The color of the sky.
  - Qualitative.
- The number of pennies in your pocket.
  - Quantitative.



Qualitative vs. Quantitative Measurement Review

Qualitative Measurement	Quantitative Measurement

• Deals with *descriptions (words, categories)*.
• Data can be *observed* but not measured.
  • Colors, textures, smells, tastes, appearance, beauty, etc.
  • 'Good job!' or 'He wasn't very nice.'
• Qualitative → Quality
  • Qualitative measurement collects information that is not numerical.
	• Deals with *numbers*.
	• Data which can be *measured*.
	  • Length, height, area, volume, weight, speed, time, temperature, humidity, sound levels, cost, members, ages, etc.
	• Quantitative → Quantity
	  • Quantitative measurement is measurement of data that can be put into numbers.

What to Measure Quality?

- Software Requirements Specification
- Software Design Specification
- Software Testing Specification
- Software Project Plan
- Software Risk Management Plan
- Software Quality Assurance Plan

- *Software Project*
- *Software Development Process*
- *Environment*

Quality Characteristics of a Product

- *Quality*
  - Performance
  - Correctness
  - Scalability
  - Modifiability
  - Usability
- *Documentation*
- *Defects*
- *Size*
  - Lines of code
  - Number of components

Product Quality Metrics [8]

- Mean time to failure
  - The *time* between failures
- Defect density (rate)
  - The *defects relative to* the software size (lines of code, function points, etc.)
- Customer problems
  - *Total problems* that customers reported (true defects and non-defect-oriented problems) for *a time period*
- Customer satisfaction
  - Customer survey (Satisfied, Neutral, Dissatisfied)

Quality Characteristics of a Project [4]

Category	Metrics
Productivity	The number of lines of code/modules/classes/deliverables etc. developed on time unit or per resource
Quality	Project complexity Portfolio complexity The degree of client or executive management satisfaction by completing the project objectives
Deliverables	The ratio between the achieved deliverables and the planned deliverables The number of reworks because of no concordances between the specifications and the results
Costs	Statistics regarding different costs categories Project portfolio value
Resources	Statistics regarding resources usage Statistics regarding resources costs Statistics regarding resources loading and distribution

Quality Characteristics of a Process [5]

Maintainability Sub-characteristic	Definition
Analyzability	Easiness shown by the model in discovering errors or deficiencies and in guessing the parts that should be modified.
Understandability	Easiness with which the model can be understood.
Modifiability	Easiness with which the model can be modified, for possible errors, a specific modification request or new requirements.

Process Metrics

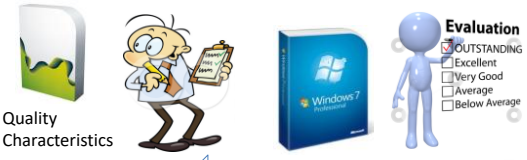
Metric	Definition
NA	Number of activities of the software process model
NWP	Number of work products of the software process model
NPR	Number of roles which participate in the process
NDWPIn	Number of input dependences of the work products with the activities in the process
NDWPOut	Number of output dependences of the work products with the activities in the process
NDWP	Number of dependences between work products and activities NDWP(PM) = NDWPIn(MP) + NDWPOut(MP)
NDA	Number of precedence dependences between activities
…	…

Person Metrics [4]

Metric	Subjective evaluation
Social abilities	Use well known models
Personnel experience	The years of experience in the project's specific field.
Degree of satisfaction	Sum of the degree of satisfaction for each requirement / total number of requirements
…	…

What is Quality?

Quality is the degree to which a set of inherent characteristics fulfills requirements (need or expectation).



Quality Characteristics

Quality Requirements ← Meets — Product

Evaluation

Quantification?

Quality requirements should be included in a specification.

How to Measure Quality of Something? [3]

- Describe the *entity* being measured.
- Describe *what* you want to find out.
- Describe *the attributes* you will measure and the set of possible resulting measures.
- Describe *how* to approach measuring the attributes.
- Have *standards* to compare against.
- *Example*:
  - Software application
    - Performance > Resource utilization
      - CPU utilization, memory utilization, response time
  - Run the application, start Task Manager, locate values
  - Max CPU utilization: 10%, max memory utilization: 200Mb

Software Quality Management

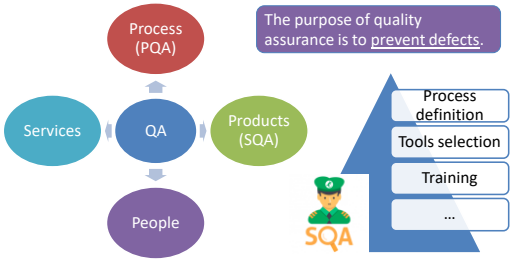
- Software *quality management* is concerned with ensuring that software *meets* its required standards.
- Software standards are an encapsulation of *best practice*.
- There are *no standardized* and universally applicable software metrics.
- Software *measurement* gathers information about the software product, process, project and environment.

How to Perform Quality Management?

- The *product*, *project*, *process*, and/or environment selection
- The *attributes* selection
- The quality *requirements*
- The *methods* to evaluate products and process
  - Qualitative (CATEGORIES): subjective
  - Quantitative (HOW MANY): objective

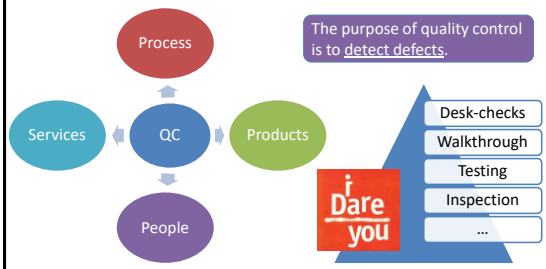
Quality Assurance

QA is the part of quality management focused on *providing confidence* that quality requirements will be fulfilled.



Quality Control

QC is the part of quality management focused on *fulfilling quality requirements*.



Software Quality Assurance Plan

- Purpose
- Reference documents
- Management
- Documentation
- *Standards, practices, conventions, and metrics*
- *Software reviews*
- *Test*
- *Problem reporting* and corrective action
- *Tools*, techniques, and methodologies
- Media control
- Supplier control
- Records collection, maintenance, and retention
- *Training*
- Risk management
- Glossary
- SQAP change procedure and history

The IEEE 730-2002

Why Quality Management?

- Improving *customer's satisfaction*
- Reducing *development cost*
- Reducing *maintenance cost*
- Required by some *standards (ISO, CMMI)*

QA/QC Hire (HP)

- Bachelor's Degree in Computer Science/Software Engineering or comparable.
- Solid understanding of, and practical experience with software quality tools and processes (e.g. test planning, progress tracking, defect tracking, black box/white box testing, code coverage measurement, code complexity measurement, code analyzers, test automation, etc.).
- Knowledge of SW Engineering tools (e.g. source code revision control systems, build process, etc.).
- Thorough understanding of the entire Software Development process (using traditional waterfall-like development and/or agile/iterative development) in order to establish quality metrics and practices along the development cycle and not only in final product testing.
- Experience working with customers (understanding customer needs/expectations).

- *Define and measure product quality.*
- *Define and establish appropriate quality management processes and tools across the R&D organization.*
- *Work closely with the Development and QA teams to establish and execute appropriate practices to actually meet the defined quality goals.*
- *Work closely with the Management team to report on relevant quality metrics, and make recommendations as to whether a product is ready to be released to customers.*
- *Look for opportunities to increase product quality and team efficiency, and drive improvement programs across the entire development project.*

What is a Quality Management System? [6]

- A quality management system is a way of defining *how an organization can meet the requirements* of its customers and other stakeholders affected by its work.

International Standards Organization

- ISO (the International Organization for Standardization) is a *worldwide federation of national standards bodies* (ISO member bodies).
- The work of preparing International Standards is normally carried out through *ISO technical committees*.
- Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee.
- International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

ISO 9000

- ISO 9000:2008 specifies the *terms and definitions* that apply to all quality management and quality management system standards developed by ISO/TC 176.

ISO 9000

ISO 9001

- ISO 9001 is a standard that sets out the *requirements* for a quality management system.
- It helps businesses and organizations to be more efficient and improve *customer satisfaction*.
- ISO 9001 is based on the idea of *continual improvement*.
- It doesn't specify what the objectives relating to "quality" or "meeting customer needs" should be, but requires organizations to define *these objectives themselves* and continually improve their processes in order to reach them.

ISO 9001

ISO 19011 and ISO 9004

- ISO 19011 gives guidance for *performing both internal and external audits* to ISO 9001.
  - This will help ensure your quality management system delivers on promise and will prepare you for an external audit, should you decide to seek third-party certification.
- ISO 9004 provides guidance on *how to achieve sustained success* with your quality management system.

Why ISO 9001?

- Management *problems happened*
- Quality control approach *showed failure*
- Certificate is *required*

ISO 9001:2008 Terms and Definitions

- *Document* – information and its supporting medium
- *Procedure* – specified way to carry out an activity or a process (Note: Procedures can be documented or not)
- *Quality Manual* – document specifying the quality management system of an organization
- *Quality Plan* – document specifying which procedures and associated resources shall be applied by whom and when to a specific project, product, process or contract
- *Record* – document stating results achieved or providing evidence of activities performed
- *Specification* – document stating requirements

Records Required by ISO 9001:2008

- Management reviews
- Education, training, skills and experience
- Evidence that the realization processes and resulting product fulfill requirements
- Design and development inputs relating to product requirements
- Results of design and development reviews and any necessary actions
- Results of design and development validation and any necessary actions
- Results of the review of design and development changes and any necessary actions
- …

What Should We Do?

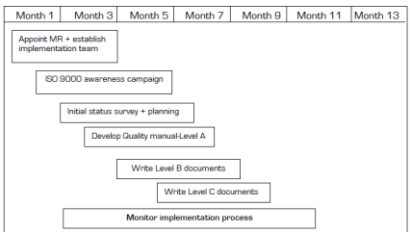
- Quality assurance <u>procedures</u> should be *documented* in an organizational <u>quality manual</u>.

Implementing ISO 9001 Quality Management System (I) [7]

1) Top management commitment
2) Establish implementation team
3) Start ISO 9000 awareness programs
4) Provide Training
5) Conduct initial status survey

Implementing ISO 9001 Quality Management System (II)

6) Create a documented implementation plan



Implementing ISO 9001 Quality Management System (III)

7) Develop quality management system documentation (Use ISO 10013:1995 for guidance in quality documentation.)

Level A: Quality manual

- States the scope of the quality management system, including exclusions and details of their justification; and describes the processes of the quality management system and their interaction. Generally gives an organization profile; presents the organizational relationships and responsibilities of persons whose work affects quality and outlines the main procedures. It may also describe organization's quality policy and quality objectives.

Level B: Quality management system procedures

- Describes the activities of individual departments, how quality is controlled in each department and the checks that are carried out.

Level C: Quality documents (forms, reports, work instructions, etc.)

- Work instructions describe in detail how specific tasks are performed; include drawing standards, methods of tests, customer's specifications, etc.
- Presents forms to be used for recording observations, etc.

Implementing ISO 9001 Quality Management System (IV)

8) Document control (Control is simply a means of managing the creation, approval, distribution, revision, storage, and disposal of the various types of documentation.)
9) Implementation
10) Internal quality audit (Use ISO 19011 for guidance in auditing, auditor qualification and programmes.)
11) Management review
12) Pre-assessment audit
13) Certification and registration
14) Continual Improvement (ISO 9004:2008 provides a methodology for continual improvement).

Thank You for Your Time