

340CT Software Quality and Process Management

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Metrics for Software Quality

- To achieve good quality software if:
 - requirements description
 - design of the solution
 - code / program produced
 - tests used to find errors
- Quality Models define:
 - Quality factors, characteristics, sub-characteristics
 - Metrics: relationship between available metrics, which can be used to indicate satisfaction of quality factors defined.

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McCall's Quality Factors & Metrics 1

e.g.: 'Efficiency' is derived from grading on Conciseness, Execution efficiency, and Operability

Graded on a 0-10 Scale

Quality factor	Software quality metric	Conciseness	Reliability	Efficiency	Integrity	Maintainability	Flexibility	Testability	Portability	Reusability	Interoperability	Usability
Audibility			X			X						
Accuracy												
Communication commonality												X
Completeness		X										
Consistency		X	X			X	X					
Data commonality		X				X						X
Error tolerance												
Execution efficiency				X								
Expandability												
Generality						X				X	X	X
Hardware independence						X	X		X	X	X	
Instrumentation								X	X	X	X	
Modularity			X									
Operability				X								X
Self-documentation							X	X	X	X	X	
Simplicity			X				X	X				
Software system independence									X	X		
Traceability												
Training		X										X

[Pressman, 5/e]

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ISO/IEC 25010: Metrics

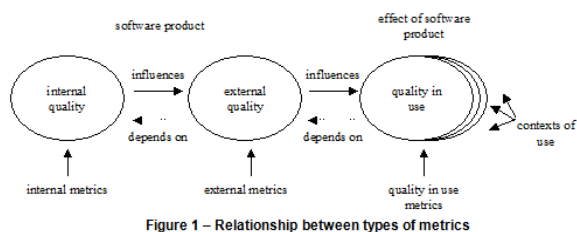


Figure 1 – Relationship between types of metrics

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ISO/IEC 25010: Internal Metrics

- Internal Metrics
 - measure the **actual software**
 - are **static measures** that do not rely on software execution
 - may be applied to a **non-executable software product** (such as **request for proposal, requirements definition, design specification or source code**) during its development
 - provide users with the opportunity to **measure the quality of the intermediate deliverables** and thereby predict the quality of the final product
 - enables users to identify quality issues and take corrective action as early as possible in the development life cycle.

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Source: (L. Zapata Aspiazu 2013) Development of a Model for Security and Usability

ISO/IEC 25010: External Metrics

- External Metrics
 - measure the **behaviour of the computer-based system** that includes the software
 - is performed when **executing the software product** in the system environment in which it is intended to operate.
 - can **only be used during the testing stages** of the life cycle process and during any **operational stages**.

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ISO/IEC 25010: Quality In Use Metrics

- Quality In Use Metrics
 - measure whether a product meets the needs of specified users to achieve specified goals with **effectiveness, productivity, safety and satisfaction** in a specified context of use.
 - measure **the effects of using the software** in a specific context of use.
 - only applicable when the final product is used in real conditions

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Quality in Use Model: ISO 25010 1



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Source: cisq.org

Quality in Use Model: Effectiveness 1

- Measurement item: example 1
 - **Completion ratio of procedures for a first time user**
 - Example: **% of users who use for the first time complete the procedures.**

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Source: E-government usability guideline

Quality in Use Model: Effectiveness 1.1

- Measurement method: example
 - **Usability test:** Requesting **non-users to take actual procedures** and checking the ratio of completion of procedures.
 - **Questionnaire:** Carrying out the questionnaire and checking the ratio of completion of procedures at the first time of usage.
 - **Log analysis:** Checking the ratio of first time users who complete the procedures based on the **system log (usage history).**

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Quality in Use Model: Efficiency

- Measurement item: example 1
 - **Average required time, No. of clicks from log-in to completion of procedure**
- Measurement item: example 2
 - **Ratio of time required between a user and skilled operator**
- Measurement method: Usability test, Questionnaire, Log analysis

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Quality in Use Model: Satisfaction

- Measurement item: example 1
 - **Degree of satisfaction of a system user**
 - Example: **% of users feel “easy to use” after utilization.**
- Measurement item: example 2
 - **Desired reuse rate of a system user**
 - Example: **% of users feel “wish to use again”.**
- Measurement method: Questionnaire

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Product Quality Model: Functionality 1

- **Functional completeness**
 - Degree to which the set of functions covers all the specified tasks and user objectives
- Measure: **Completeness of functional implementation**
 - How correctly the functional contents stated in the requirement specification are implemented with no omissions.

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Product Quality Model: Functionality 2

- **Functional correctness**
 - Degree to which a product or system provides the correct results with the necessary degree of precision
- Measure: **Correctness**
 - How much the required specific accuracy standard is actually complied with.
- Measure: **Functional correctness of calculation**
 - How accurate a calculation result can be obtained against the calculation result stated in the specification.

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Product Quality Model: Functionality 3

- **Functional appropriateness**
 - Degree to which the functions facilitate the accomplishment of specified tasks and objectives
- Measure: **Completeness of functional implementation**
 - How many functions stated in the requirement specification are implemented.
 - E.g. Compare the number of functions implemented incorrectly or fault functions detected during evaluation and the number of functions stated in the requirement specification.

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Product Quality Model: Functionality 3.1

- Measure: **Stability of functional specification**
 - How many functional changes are made after starting the development in relation to the functions in the requirement specification.

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Activity

Q: If we compare the number of data items implemented with the specific standard of accuracy and the number of data items requiring the specific standard of accuracy, which product quality metric is considered below?

Functional completeness or Functional correctness

✓Functional correctness

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Activity

Q: If we compare the number of functions changed after starting the development and the number of functions stated in the requirement specification, which product quality metric is considered below?

Functional completeness or Functional appropriateness?

✓Functional appropriateness (on stability of functional specification)

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Activity

Q: If we compare the number of missing functions detected during evaluation and the number of functions stated in the requirement specification, which product quality metric is considered below?

Functional completeness or Functional correctness?

✓ **Functional completeness (on completeness of functional implementation)**

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Product Quality Model: Efficiency 1

- **Time behaviour**
 - Degree to which the response and processing time and throughput rates of a product or system, when performing its functions, meet requirements
- Measure: **Response time**
 - Duration from giving an instruction to start a batch of tasks till **receiving the first response**. Average time, max. time, etc. are included.

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Product Quality Model: Efficiency 1.2

- Measure: **Turnaround time**
 - Duration from giving an instruction to **start** a batch of tasks till **completion** of tasks. Average time, max. time, etc. are included.
- Measure: **Throughput**
 - How many tasks can be processed per unit of time.

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Product Quality Model: Co-existence

- **Co-existence**
 - Degree to which a product can perform its required functions efficiently while **sharing a common environment and resources with other products**, without detrimental impact on any other product
- Measure: **Usable co-existence**
 - Degree to which that target software can be used with no restrictions or faults when it is used with other software at the same time

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Product Quality Model: Interoperability 1

- **Interoperability**
 - Degree to which two or more systems, products or components can exchange information and use the information that has been exchanged
- Measure: **Interface consistency (protocol)**
 - How accurately is interface protocol implemented.
 - E.g. Compare the number of correct interface protocol implementations as shown in the spec. and the number of interface protocol implementations according to the specification.

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Product Quality Model: Interoperability 1.2

- Measure: **Data exchange modifiability based on data format**
 - How accurately is implementation of data exchange format determined between linking systems.

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Activity

Q: If we compare the number of data formats regarded as being smoothly exchanged with other software or systems and the total number of data formats to be exchanged, which product quality metric is considered below?

Co-existence or Interoperability?

✓ **Interoperability (on data exchange modifiability)**

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Product Quality Model: Maturity 1

- **Maturity**
 - Degree to which a system meets needs for reliability under normal operation
- Measure: **Failure elimination**
 - No. of corrected and eliminated failures
- Measure: **Test completeness**
 - How many reviews and test are carried out against the number of tests that should be performed in order to meet the requirements.

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Product Quality Model: Maturity 1.2

- Measure: **Fault detection**
 - No. of detected faults
- Measure: **Test maturity**
 - How many tests have passed among all tests that should be performed in order to meet the requirements.

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Product Quality Model: Security 1

- **Confidentiality**
 - Degree to which a product or system ensures that data is accessible only to those authorized to have access
- Measure: **Access surveillance performance**
 - To what extent is access to system or data monitored according to requirement.
 - E.g. Compare the number of accesses by a user to system and data recorded in the access history database and actual number of accesses

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Product Quality Model: Security 1.2

- Measure: **Access control performance**
 - To what extent can access to the system be controlled.
 - E.g. Compare the number of detected illegal operations and the number of illegal operations stated in the specification

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Product Quality Model: Security 1.3

- Measure: **Data encryption**
 - How correctly is the encryption/decryption of data items stated in the requirement spec. implemented.
 - E.g. Compare the number of data items that are implemented as spec. and can be encrypted/decrypted and the number of data items of required data encryption/decryption functions.

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Product Quality Model: Integrity

- **Integrity**
 - Degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data
- Measure: **Preventive property of data damage**
 - To what extent can the phenomenon of serious data damage or minor data damage be prevented.

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Activity

Q: If we compare the number of data damage instances actually occurring and the number of operation and access times where data damage or breakage is expected to occur, which product quality metric is considered below?

Security or Integrity?

✓ **Integrity (on Preventive property of data damage)**

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Product Quality Model: Portability 1

- **Installability**
 - Degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment
- Measure: **Ease of implementation performance**
 - How easily can software be implemented and set in the operation environment.
 - E.g. Compare the number of implemented operations changed successfully and the total number of implemented operations for which changes were attempted.

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Product Quality Model: Portability 2

- **Replaceability**
 - Degree to which a product can be replaced by another specified software product for the same purpose in the same environment
- Measure: **Continuous usage of data**
 - How long can the same data as software before transfer be used continuously.
 - E.g. Compare the number of data confirmed as usable continuously from software before transfer and the number of data planned to be able to use from software before transfer.

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Product Quality Model: Portability 3

- Measure: **Functional comprehensibility**
 - How long can the similar functions to software before transfer be used.
 - E.g. Compare the number of functions that bring the same result and are not changed and the number of functions that have been the target of continuation from software before transfer.

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ISO/IEC 25010

**ISO/IEC 25010 Metrics
Documentation**

**ISO/IEC 25010 Metrics
Case Study**

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