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SE ZG501
Software Quality Assurance and Testing
Lecture No. 4

The need for a comprehensive definition of requirements

Cover all attributes of software and aspects of the use of software, including usability aspects, reusability aspects, maintainability aspects, and so forth in order to assure the full satisfaction of the users.

The great variety of issues related to the various attributes of software and its use and maintenance, as defined in software requirements documents, can be classified into content groups called *quality factors.*

Classifications of software requirements into software quality factors

The classic model of software quality factors, suggested by McCall, consists of 11 factors.

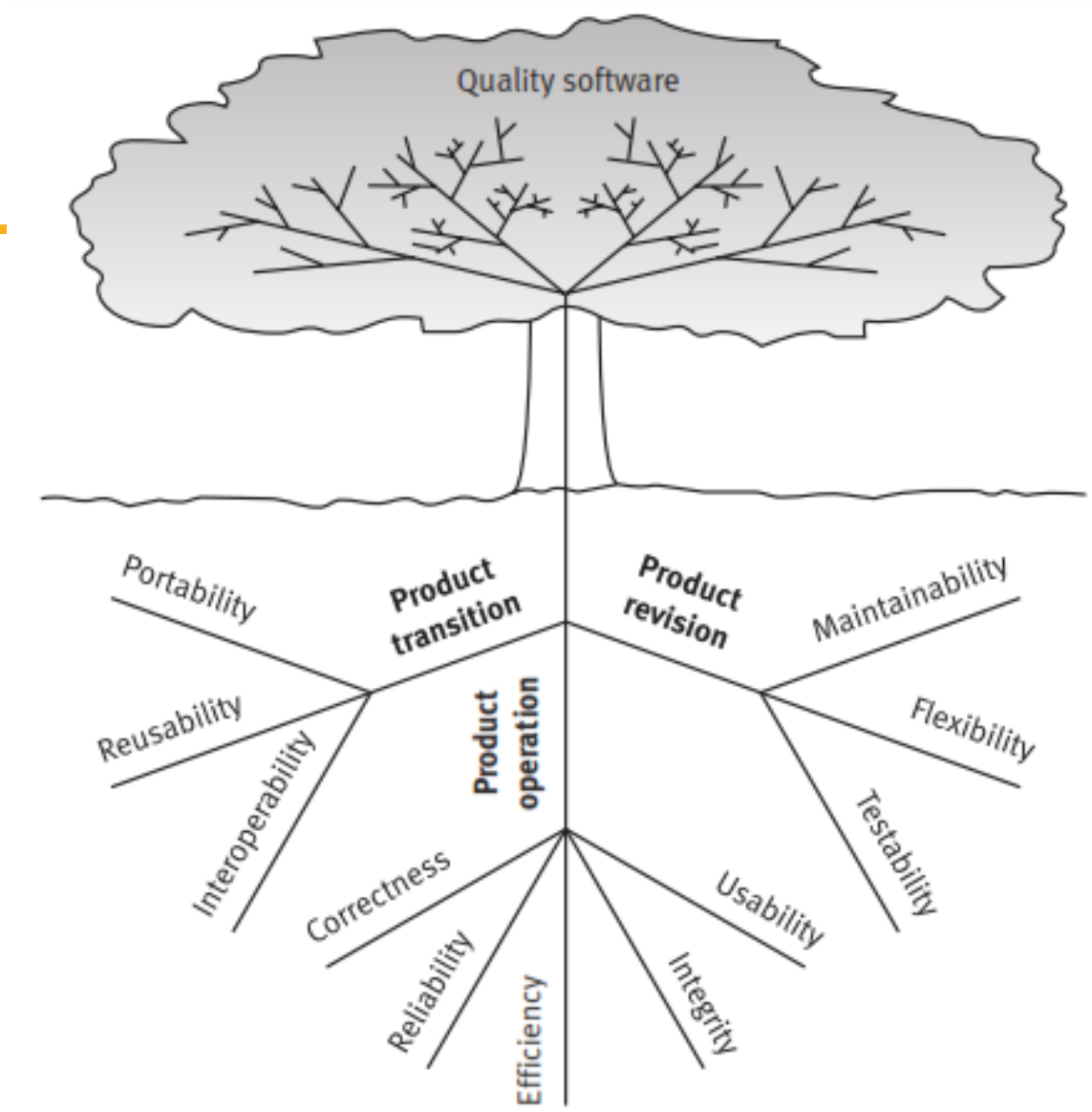
Subsequent models, consisting of 12 to 15 factors

The McCall factor model, despite the quarter of a century of its "maturation", continues to provide a practical, up-to-date method for classifying software requirements

McCall's factor model

Classifies all software requirements into 11 software quality factors.

- Product operation factors: Correctness, Reliability, Efficiency, Integrity, Usability.
- Product revision factors: Maintainability, Flexibility, Testability.
- Product transition factors: Portability, Reusability, Interoperability.



1: McCall's factor model tree

Product operation software quality factors

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Correctness : Correctness requirements are defined in a list of the software system's required outputs.

Query display of a customer's balance in the sales accounting information system

Air supply as a function of temperature specified by the firmware of an industrial control unit.

Output specifications are usually multidimensional

- The output mission (e.g., sales invoice printout, and red alarms when temperature rises above 250°F).
- The required accuracy of those outputs that can be adversely affected by inaccurate data or inaccurate calculations.
- The completeness of the output information, which can be adversely affected by incomplete data.
- The up-to-dateness of the information (defined as the time between the event and its consideration by the software system).
- The availability of the information (the reaction time, defined as the time needed to obtain the requested information or as the requested reaction time of the firmware installed in a computerized apparatus).
- The standards for coding and documenting the software system.

Example

The correctness requirements of a club membership information system consisted of the following:

- The output mission: A defined list of 11 types of reports, four types of standard letters to members and eight types of queries, which were to be displayed on the monitor on request.
- The required accuracy of the outputs: The probability for a non-accurate output, containing one or more mistakes, will not exceed 1%.
- The completeness of the output information: The probability of missing data about a member, his attendance at club events, and his payments will not exceed 1%.
- The up-to-dateness of the information: Not more than two working days for information about participation in events and not more than one working day for information about entry of member payments and personal data.
- The availability of information: Reaction time for queries will be less than two seconds on average; the reaction time for reports will be less than four hours.
- The required standards and guidelines: The software and its documentation are required to comply with the client's guidelines.

Reliability

Reliability requirements deal with failures to provide service.

They determine the maximum allowed software system failure rate, and can refer to the entire system or to one or more of its separate functions.

Example

(1) The failure frequency of a heart-monitoring unit that will operate in a hospital's intensive care ward is required to be less than one in 20 years. Its heart attack detection function is required to have a failure rate of less than one per million cases.

(2) One requirement of the new software system to be installed in the main branch of Independence Bank, which operates 120 branches, is that it will not fail, on average, more than 10 minutes per month during the bank's office hours. In addition, the probability that the off-time (the time needed for repair and recovery of all the bank's services) be more than 30 minutes is required to be less than 0.5%.

Efficiency

Efficiency requirements deal with the hardware resources needed to perform all the functions of the software system in conformance to all other requirements.

computer's processing capabilities, data storage capability, data communication capability of the communication lines

Another type of efficiency requirement deals with the time between recharging of the system's portable units, such as, information systems units located in portable computers, or meteorological units placed outdoors.

Examples

(1) A chain of stores is considering two alternative bids for a software system. Both bids consist of placing the same computers in the chain's headquarters and its branches. The bids differ solely in the storage volume: 20 GB per branch computer and 100 GB in the head office computer (Bid A); 10 GB per branch computer and 30 GB in the head office computer (Bid B). There is also a difference in the number of communication lines required: Bid A consists of three communication lines of 28.8 KBPS between each branch and the head office, whereas Bid B is based on two communication lines of the same capacity between each branch and the head office. In this case, it is clear that Bid B is more efficient than Bid A because fewer hardware resources are required.

Integrity

Integrity requirements deal with the software system security, that is, requirements to prevent access to unauthorized persons, to distinguish between the majority of personnel allowed to see the information (“read permit”) and a limited group who will be allowed to add and change data (“write permit”), and so forth.

Example

The Engineering Department of a local municipality operates a GIS (Geographic Information System). The Department is planning to allow citizens access to its GIS files through the Internet. The software requirements include the possibility of viewing and copying but not inserting changes in the maps of their assets as well as any other asset in the municipality's area ("read only" permit). Access will be denied to plans in progress and to those maps defined by the Department's head as limited access documents.

Usability

Usability requirements deal with the scope of staff resources needed to train a new employee and to operate the software system.

Example

The software usability requirements document for the new help desk system initiated by a home appliance service company lists the following specifications:

(a) A staff member should be able to handle at least 60 service calls a day.

(b) Training a new employee will take no more than two days (16 training hours), immediately at the end of which the trainee will be able to handle 45 service calls a day.

Product revision software quality factors

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Maintainability

Maintainability requirements determine the efforts that will be needed by users and maintenance personnel to identify the reasons for software failures, to correct the failures, and to verify the success of the corrections.

This factor's requirements refer to the modular structure of software, the internal program documentation, and the programmer's manual, among other items.

Example

Typical maintainability requirements:

(a) The size of a software module will not exceed 30 statements.

(b) The programming will adhere to the company coding standards and guidelines.

Flexibility

The capabilities and efforts required to support adaptive maintenance activities are covered by the flexibility requirements.

These include the resources (i.e. in man-days) required to adapt a software package to a variety of customers of the same trade, of various extents of activities, of different ranges of products and so on.

Example

TSS (teacher support software) deals with the documentation of pupil achievements, the calculation of final grades, the printing of term grade documents, and the automatic printing of warning letters to parents of failing pupils. The software specifications included the following flexibility requirements:

(a) The software should be suitable for teachers of all subjects and all school levels (elementary, junior and high schools).

(b) Non-professionals should be able to create new types of reports according to the schoolteacher's requirements and/or the city's education department demands.

Testability

Testability requirements deal with the testing of an information system as well as with its operation.

Testability requirements for the ease of testing are related to special features in the programs that help the tester, for instance by providing predefined intermediate results and log files.

Example

An industrial computerized control unit is programmed to calculate various measures of production status, report the performance level of the machinery, and operate a warning signal in predefined situations.

One testability requirement demanded was to develop a set of standard test data with known system expected correct reactions in each stage. This standard test data is to be run every morning, before production begins, to check whether the computerized unit reacts properly.

Product transition software quality factors

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Portability

Portability requirements tend to the adaptation of a software system to other environments consisting of different hardware, different operating systems, and so forth.

Example

A software package designed and programmed to operate in a Windows 2000 environment is required to allow low-cost transfer to Linux and Windows NT environments.

Reusability

Reusability requirements deal with the use of software modules originally designed for one project in a new software project currently being developed.

They may also enable future projects to make use of a given module or a group of modules of the currently developed software.

The reuse of software is expected to save development resources, shorten the development period, and provide higher quality modules.

These benefits of higher quality are based on the assumption that most of the software faults have already been detected by the quality assurance activities performed on the original software, by users of the original software, and during its earlier reuses.

Example

A software development unit has been required to develop a software system for the operation and control of a hotel swimming pool that serves hotel guests and members of a pool club. Although the management did not define any reusability requirements, the unit's team leader, after analyzing the information processing requirements of the hotel's spa, decided to add the reusability requirement that some of the software modules for the pool should be designed and programmed in a way that will allow its reuse in the spa's future software system, which is planned to be developed next year.

These modules will allow:

- Entrance validity checks of membership cards and visit recording.
- Restaurant billing.
- Processing of membership renewal letters.

Interoperability

Interoperability requirements focus on creating interfaces with other software systems or with other equipment firmware.

Interoperability requirements can specify the name(s) of the software or firmware for which interface is required.

Example

The firmware of a medical laboratory's equipment is required to process its results (output) according to a standard data structure that can then serve as input for a number of standard laboratory information systems.

Alternative models of software quality factors

- The Evans and Marciniak factor model (Evans and Marciniak, 1987).
- The Deutsch and Willis factor model (Deutsch and Willis, 1988).

Comparison of the alternative models

Both alternative models exclude only one of McCall's 11 factors, namely the testability factor.

- The Evans and Marciniak factor model consists of 12 factors that are classified into three categories.
- The Deutsch and Willis factor model consists of 15 factors that are classified into four categories.

Taken together, five new factors were suggested by the two alternative factor models.

- Verifiability (by both models)
- Expandability (by both models)
- Safety (by Deutsch and Willis)
- Manageability (by Deutsch and Willis)
- Survivability (by Deutsch and Willis).

Table 3.1: Comparison of McCall's factor model and alternative models

No.	Software quality factor	McCall's classic model	Alternative factor models	
			Evans and Marciniak	Deutsch and Willis
1	Correctness	+	+	+
2	Reliability	+	+	+
3	Efficiency	+	+	+
4	Integrity	+	+	+
5	Usability	+	+	+
6	Maintainability	+	+	+
7	Flexibility	+	+	+
8	Testability	+		
9	Portability	+	+	+
10	Reusability	+	+	+
11	Interoperability	+	+	+
12	Verifiability		+	+
13	Expandability		+	+
14	Safety			+
15	Manageability			+
16	Survivability			+