Software Quality (and ISO 25010) Part II

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http://www.sqa.net/

SW quality?

- IEEE:
  - The level at which a system, component or process meets the requirements
  - The level at which a system, component or process meets the needs and expectations of a user
- PRESSMAN:
  - Accordance with the functional and nonfunctional requirements, with explicit standards development, and features of a professionally developed software

SW quality assurance (SQA):

- IEEE
  - a planned and structured actions necessary to **provide the confidence** that a product conforms to a set of technical requirements
  - a set of activities designed to **evaluate the process** by which the software product is developed
- Galin
  - IEEE + respecting constraints on:
    - maintenance
    - time
    - money

Quality factors…

- At the base of any attempt to produce good sw there is the need to have a good requirement documentation (if it is not known what needs to be done is difficult to get it right ...)
- In particular, in addition to the correct definition of functional and non-functional requirements, all the quality aspects essential for the application, such as:
  - usability
  - manutenibility
  - relaiability
  - ...
- MUST be included in the requirements

...Quality factors and standards

- That raised the need to classify what aspects of quality have to be included in requirements or, more generally, attributable to a software application (4 components)

- The first, and extremely actual proposal is from McCall (1977) and involves 11 quality factors.

- The standard ISO/IEC 9126 Software engineering-Product quality, published for the first time in 1991 and revised and republished in 2001 builds up on the McCall and B. Boehm models
  - Software quality is defined as "*the set of characteristics that affect the ability of the product to satisfy explicit or implicit requirements*." (definition very similar to that given in the ISO 9000 /Vision 2000 standard)
  - The software product is defined as "*the set of rules, procedures, programs, documents, relevant to the use of a computer system*"

- 9126 has been revised on 2011 as 25010

Standard evolution

- **ISO/IEC 25010:2011**
  - **https://www.iso.org/obp/ui/#iso:std:iso-iec:25010:ed-1:v1:en**
- **Software Engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- System and software quality models**

- This first edition of ISO/IEC 25010 cancels and replaces ISO/IEC 9126-1:2001, which has been technically revised.
- ISO/IEC 25010 is a part of the SQuaRE series of International Standards, which consists of the following divisions:
- • Quality Management Division (ISO/IEC 2500n),
- • Quality Model Division (ISO/IEC 2501n),
- • Quality Measurement Division (ISO/IEC 2502n),
- • Quality Requirements Division (ISO/IEC 2503n),
- • Quality Evaluation Division (ISO/IEC 2504n),
- • SQuaRE Extension Division (ISO/IEC 25050 – ISO/IEC 25099).

ISO/IEC 25010

- 25010 defines two **models**:
- A **quality in use** model composed of **five** characteristics (some of which are further subdivided into subcharacteristics) that relate to the outcome of **interaction** when a product is used in a particular **context of use**. This system model is applicable to the complete human-computer system.
- A **product quality** model composed of **eight** characteristics (which are further subdivided into subcharacteristics) that relate to **static** properties of software and **dynamic** properties of the computer system.
- The characteristics defined by both models are relevant to all software products and computer systems. The characteristics and subcharacteristics that characterize them in details provide consistent terminology for **specifying**, **measuring** and **evaluating** system and software product quality. They also provide a set of quality characteristics against which stated **quality requirements** can be compared for completeness.
- Old 9126 defined internal, external, and in use models

Limits

- It is unlikely that the characteristics and sub-characteristic are always among them perfectly independent
- Characteristics and sub-characteristics are abstract properties that are related to one or more indicators that are measured by metrics. These are not always in linear relationship with characteristics they estimate
- It is missing, in any case, the link between the qualitative model and "how" to develop then good software

25010 objectives

- The scope of the models excludes purely functional properties, but it does include functional suitability.
- Recipients are:
  - Users
  - Developers / maintainers
  - Client
  - System administrators
  - Customers

25010 at work

- Usage examples:
  - identifying software and system requirements
  - validating the comprehensiveness of requirements definition
  - identifying software and system **design** objectives
  - identifying software and system **testing** objectives
  - identifying **quality control criteria** as part of quality assurance
  - establishing **measures of quality characteristics** in support of these activities
  - identify the **criteria for acceptance** of products
  - provide a framework for the **definition of software quality** in a contractual document

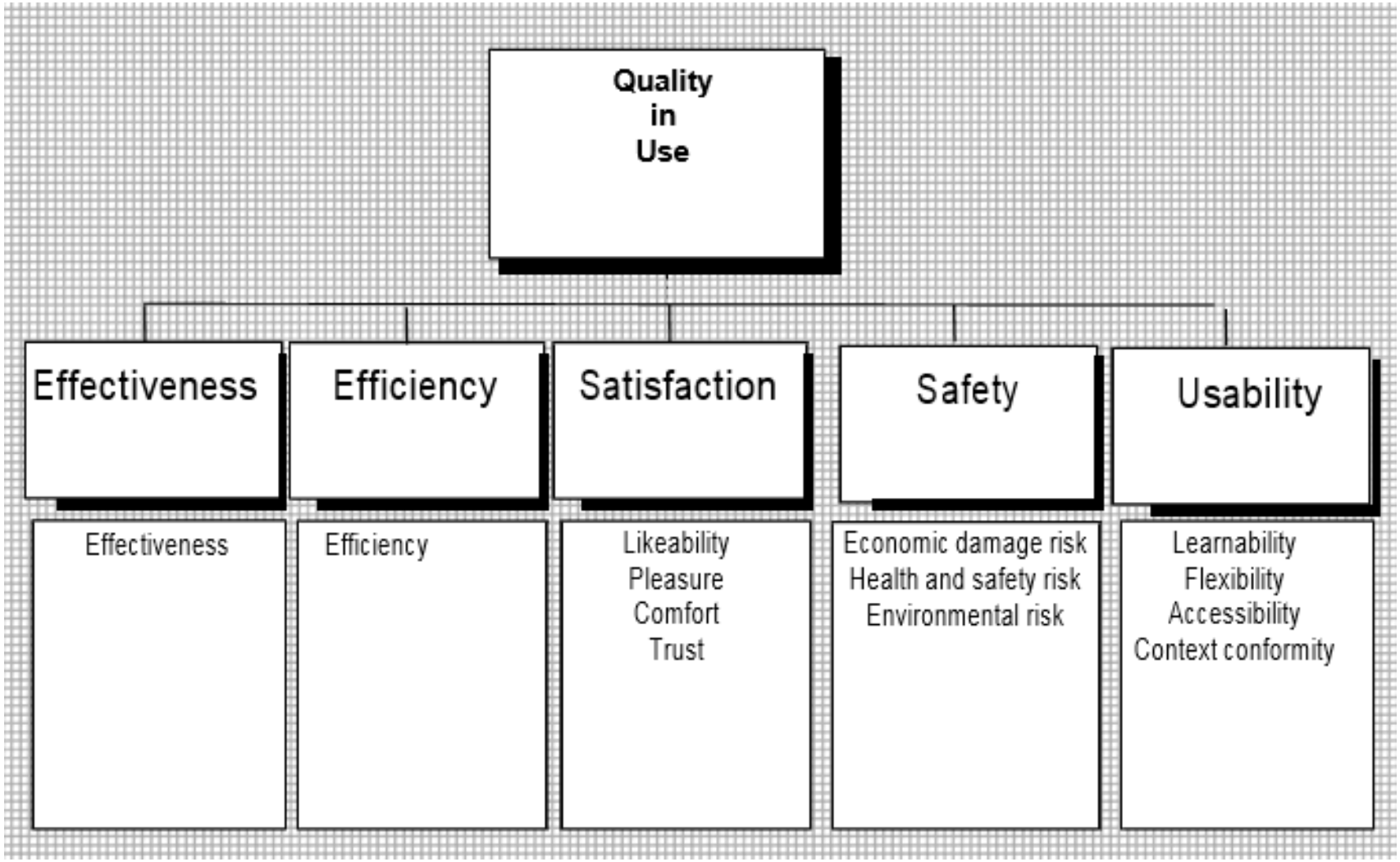
Quality in use

- Quality in use is what the user perceives in the use of the product in its actual context of use, in particular the ability of such a product to support him with effectiveness and efficiency in his work, exhibiting a good usability. This type of quality is what, above all, the developer must strive for

Product quality

- The product the intrinsic properties of the product (those measurable directly on source code). It is obtained starting from:
  - **user's requirements**, which are specifications of quality as well as specified by the user, providing the first input to the design, and
  - **technical specifications**, which represent the quality required by the user translated by the developer in the software architecture, program structure, and the user interface

In use quality model (5 characteristics)



In use sw characteristics

- **Effectiveness**, the accuracy and completeness with which the user achieves specific goals
- **Efficiency**, the effort in relation to effectiveness
- **Satisfaction**, degree to which user needs are satisfied when a product or system is used in a specified context of use
  - **Usefulness**, degree to which a user is satisfied with their perceived achievement of pragmatic goals, including the results of use and the consequences of use
  - **Trust**, degree to which a user or other stakeholder has confidence that a product or system will behave as intended
  - **Pleasure**, degree to which a user obtains pleasure from fulfilling their personal needs
  - **Comfort**, degree to which the user is satisfied with physical comfort

In use sw characteristics

- **Freedom from risk,** degree to which a product or system mitigates the potential risk to economic status, human life, health, or the environment
  - **Economic risk mitigation**, degree to which a product or system mitigates the potential risk to financial status, efficient operation, commercial property, reputation or other resources in the intended contexts of use
  - **Health and safety risk mitigation,** degree to which a product or system mitigates the potential risk to people in the intended contexts of use
  - **Environmental risk mitigation**, degree to which a product or system mitigates the potential risk to property or the environment in the intended contexts of use

In use sw characteristics

- **Context coverage,** degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in both specified contexts of use and in contexts beyond those initially explicitly identified
  - **Context completeness**, degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in all the specified contexts of use
  - **Flexibility**, degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and satisfaction in contexts beyond those initially specified in the requirements

In use sw characheristics: METRICS?

1. EFFECTIVENESS
   - # of reached objectives / # of target objectives (proportion)
   - # of correct reached objectives / # of reached objectives (proportion)
2. Efficiency
   - # of reached objectives / manpower (ratio)
3. SATISFACTION
   - Questionnaries (Likert scales)
4. Freedom for risk
   - Safety incident rate (2 years)
   - Normalized (KLOC)!

Product quality model (Static and dynamic)

(Sub)Characteristic
Functional suitability
Functional completeness
Functional correctness
Functional appropriateness
Performance efficiency
Time behaviour
Resource utilization
Capacity
Compatibility
Co-existence
Interoperability
Usability
Appropriateness recognizability
Learnability
Operability
User error protection
User interface aesthetics
Accessibility

Reliability
Maturity
Availability
Fault tolerance
Recoverability
Security
Confidentiality
Integrity
Non-repudiation
Accountability
Authenticity
Maintainability
Modularity
Reusability
Analysability
Modifiability
Testability
Portability
Adaptability
Installability
Replaceability

Functional Suitability & Performance efficiency

Functional suitability: degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions

- functional completeness: degree to which the set of functions covers all the specified tasks and user objectives
- functional correctness: degree to which a product or system provides the correct results with the needed degree of precision
- functional appropriateness: degree to which the functions facilitate the accomplishment of specified tasks and objectives. EXAMPLE: A user is only presented with the necessary steps to complete a task, excluding any unnecessary steps.

Performance efficiency: performance relative to the amount of resources used under stated conditions (Resources can include other software products, the software and hardware configuration of the system, and materials (e.g., print paper, storage media).

- time behavior: degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements
- resource utilization: degree to which the amounts and types of resources used by a product or system, when performing its functions, meet requirements (Human resources are included as part of efficiency)
- capacity: degree to which the maximum limits of a product or system parameter meet requirements (parameters can include the number of items that can be stored, the number of concurrent users, the communication bandwidth, throughput of transactions, and size of database)

Functional suitability:metrics ?

- **Completeness**: completeness (to specification) of the functions of the software
  - # available functions/# required functions (proportion)
- **Correctness**: correctness of the functions
  - #correct results/# results (proportion)
  - Mean and standard deviation of the error (at least)
- **Appropriateness**: appropriateness (to specification) of the functions of the software
  - # appropriate functions/# functions (proportion)

Performance efficiency : metrics

- **Time behavior**
  - mean and standard deviation of the time needed to complete a function (max, min are useful as well)
    - Important functions
    - all functions (weighted)

- **Resource utilization**:
  - mean and standard deviation of
    - CPU usage
    - Memory usage
    - Number of open file

  - You need to choose a time slot (depends on the task)

Compatibility & Usability

Compatibility: degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions, while sharing the same hardware or software environment

- 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
- interoperability: degree to which two or more systems, products or components can exchange information and use the information that has been exchanged

Usability: degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (usability can either be specified or measured as a product quality characteristic in terms of its subcharacteristics, or specified or measured directly by measures that are a subset of quality in use)

- appropriateness recognizability: degree to which users can recognize whether a product or system is appropriate for their needs (appropriateness recognizability will depend on the ability to recognize the appropriateness of the product or system's functions from initial impressions of the product or system and/or any associated documentation)
- learnability: degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use
- operability: degree to which a product or system has attributes that make it easy to operate and control
- user error protection: degree to which a system protects users against making errors
- user interface aesthetics: degree to which a user interface enables pleasing and satisfying interaction for the user
- accessibility: degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use (The range of capabilities includes disabilities associated with age)

USABILITY: Metrics ?

- **Appropriateness recognizability**:
  - mean and standard deviation of the time needed to understand the software functionalities
  - Questionnaires (Likert scales)
- **Learnability** :
  - mean and standard deviation of the time needed to learn to use (up to 95% of the software functionalities)
  - Questionnaires (Likert scales)
- **Operability**: easily operated
  - # of max three step functions / # of functions (proportion)
- **User interface aesthetics**:
  - Questionnaires (Likert scales)

Reliability & Security

Reliability: degree to which a system, product or component performs specified functions under specified conditions for a specified period of time (Wear does not occur in software. Limitations in reliability are due to faults in requirements, design and implementation, or due to contextual changes)

- maturity: degree to which a system, product or component meets needs for reliability under normal operation
- availability: degree to which a system, product or component is operational and accessible when required for use (Externally, availability can be assessed by the proportion of total time during which the system, product or component is in an up state).
- fault tolerance: degree to which a system, product or component operates as intended despite the presence of hardware or software faults
- recoverability: degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the desired state of the system

Security: degree to which a product or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization

- confidentiality: degree to which a product or system ensures that data are accessible only to those authorized to have access
- integrity: degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data
- non-repudiation: degree to which actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later
- accountability: degree to which the actions of an entity can be traced uniquely to the entity
- authenticity: degree to which the identity of a subject or resource can be proved to be the one claimed

Reliability: metrics ?

- **Maturity**
  - MTBF (mean time between failures)
- **Availability**
  - Correct working time/usage time (real proportion: fraction)
- **Fault tolerance**:
  - # of available functions after error e_i / # of available function (proportion)
  - Mean and standard deviation of available functions after a set of errors
- **Recoverability**:
  - mean and standard deviation of the time needed to restore the system after an interruption
  - mean and standard deviation of the data lost due to an interruption (proportion)

Security: metrics?

- **Confidentiality/Integrity**: unauthorized access to the software functions
  - Probability of non authorized access (difficult operative definition)
  - # successful unauthorized access / # of unauthorized access (proportion)
  - Length of the encryption key

Maintainability & Portability

Maintainability: degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers (Modifications can include corrections, improvements or adaptation of the software to changes in environment, and in requirements and functional specifications)

- modularity: degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components
- reusability: degree to which an asset can be used in more than one system, or in building other assets
- analysability: degree of effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified
- modifiability: degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality
- testability: degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met

Portability: degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another Portability can be interpreted as either an inherent capability of the product or system to facilitate porting activities, or the quality in use experienced for the goal of porting the product or system.

- adaptability: degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments
- installability: degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment (If the product or system is to be installed by an end user, installability can affect the resulting functional appropriateness and operability)
- replaceability: degree to which a product can replace another specified software product for the same purpose in the same environment (e.g., replaceability of a new version of a software product is important to the user when upgrading)

Maintainability : metrics?

- **Modularity**:
  - # of interclass calls / # of classes
- **Analysability** :
  - # errors sources discovered / manpower (ratio)
  - Mc Cabe cyclomatic complexity (indicator)
- **Modifiability**:
  - # fixed errors fixed / manpower (ratio)
  - # new discovered errors during regression test / # fixed errors
- **Testability**:
  - # of tested changes / manpower (ratio)

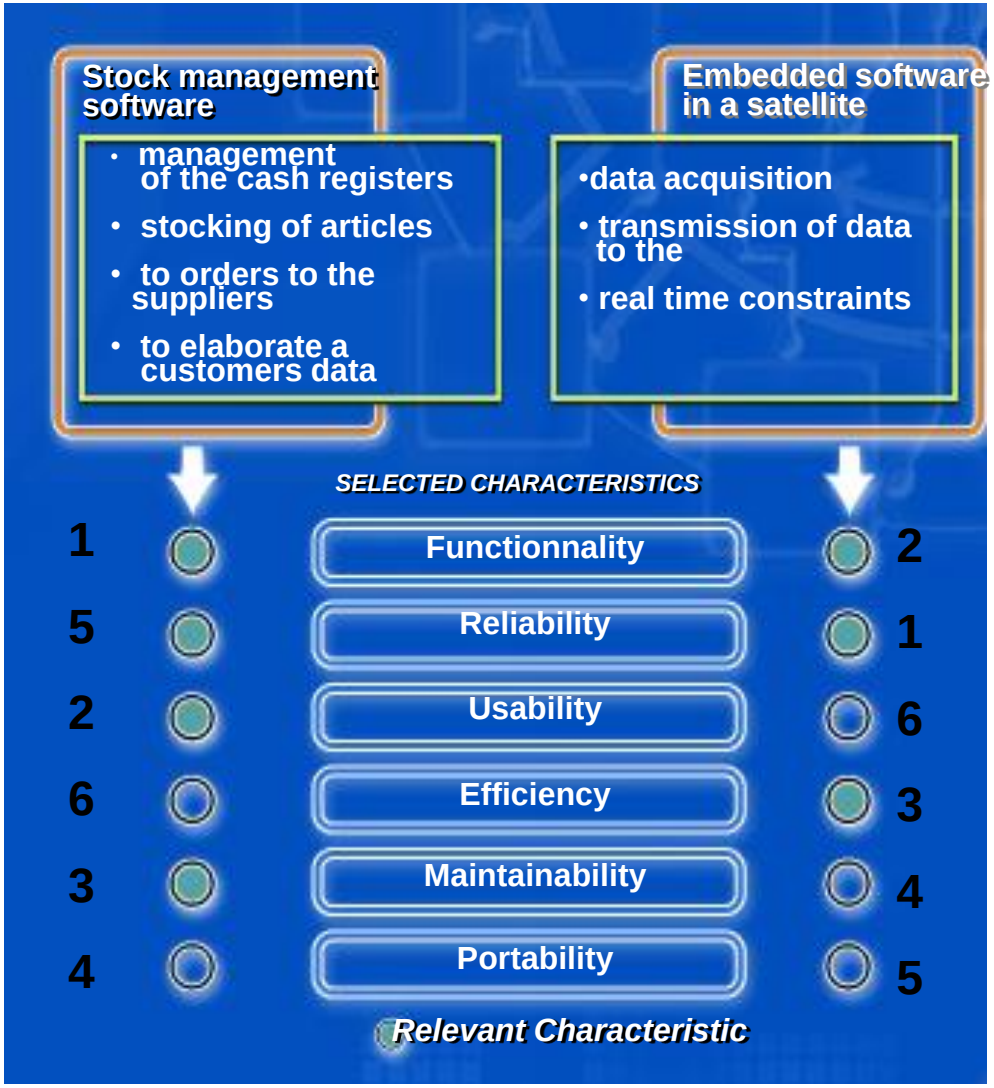
PORTABILITY: metrics

- **Adaptability** :
  - # of modifications after having changed the operating environment
  - manpower
  - Normalized (KLOC /FP)
- **Installability** :
  - mean and standard deviation of the time needed to install the sw
  - # of problems / number of installations (ratio)
- **Replaceability** :
  - # of modifications
  - manpower
  - Training time
  - Normalized (KLOC /FP)

Qualities are software specific

Quality features that a software must possess typically differ from product to product

A management software that organizes the activities of a warehouse, and a control software of a satellite, have very different quality requirements



Measures

3 kinds of measures

1. **direct -** Detectable without the influence of external factors, such as the environment (hw and sw) in which the software "turns" the behavior and characteristics of users etc. .. Example of these measures are those found on the source code (static analysis and code reading) and those found by a reading of specific documents
2. **non-direct -** Derived from measures of one or more attributes. For example, measures relating to response times depend on not only the behavior of the software itself, but also the operating environment in which runs the software (hw and sw)
3. **indicators** – Some measures can be estimated from other measures (useful in the case of measures which cannot be detected directly). For example, the response time of software is not itself measurable when the sw is still in an unreachable state. So, the length of the code can be used a a simple and rough indicator of what will be the response time of the product into the environment of use

3 types of "semantics"

- Dimension
- Time
- Occorrences

Dimension (absolute scale / ratio scale)

- Functional size, espressed through Funtion Points, but they can also be measured screenshots, files on which the application performs the calculations, etc.
- Program size, like:
  - **Logical Source stmt** (instructions), **Physical Source stmts** (LOC)
  - Program word count size, code vocabolary: operands and operators, (Halstead measures)
  - Program modules, classes
- Resource usage: disk space or memory, temporarily or permanently,% CPU, i/o and volume of data transferred, etc.
- ...

Time (absolute scale /ratio scale)

- Real time, clock time, or running time
- Common measures:
  - System operation time, (e.g., reliability)
  - Execution time
  - User time (period spent by a user to complete a task)
  - Effort, time of production (for example, to develop x lines of code)
  - Time interval of events types, the time interval between two consecutive events in a period of observation (e.g., the interval between two consecutive component failures)

Occorrences (nominal scale)

- the number of defects found in a test,
- structural complexity measures, such as those of McCabe's
- number of inconsistencies with respect to a reference (e.g. non-compliance with respect to a rule or a standard encoding)
- the number of changes to a program (or the number of LOC/FP/STMT modified)
- the number types of defects detected (according to a classification)
- the number of shares necessary to interact with a computer to perform a task, (e.g., the number of keys to press, the number of movements of the eye needed etc.)
- ...

Measure compositions

- Occorrences (Count), Dimension (Size) and Tempo (Time)

- 9 possible combinations

Composition (1) : dividing by time

- Rate
- Frequencies
- Time proportions

Composition	*Suitable for*	*Examples*
Count / Time	**Rate** **Frequency**	– **User mistakes in a month** – **defect rate in the first two usage years** – **transactions per second**
Size / Time	**Rate**	– **Software LOC developed in one day**
Time / Time	**Time proportion**	– **% of operative time**
		–

Dividing by occorrences

- Occorrence proportions
- Means
- Time intervals

Combination	*Suitable for*	*Examples*
Count / Count	**Occorrence proportions** **Occorrence mean**	– **% of test cases that discovered at least one error** – **mean of discovered errors**
Size / Count	**size means**	– **mean of LOC per method**
Time / Count	**time means intervals**	– **Time between two errors (MTBF)** – **Mean of the time required to fix a defect**

Dividing by size

- Density
- Dimension proportion
- Efficiency / Effort

Combination	*Suitable for*	*Examples*
Count / Size	**Parameter density**	– **Defect density**
Size / Size	**Dimension proportion**	– **% of implemented FP with respect to the planned FP**
Time / Size	**Efficiency / Effort**	– **Execution time of a LOC** – **Required effort to test a LOC**

Visualizations

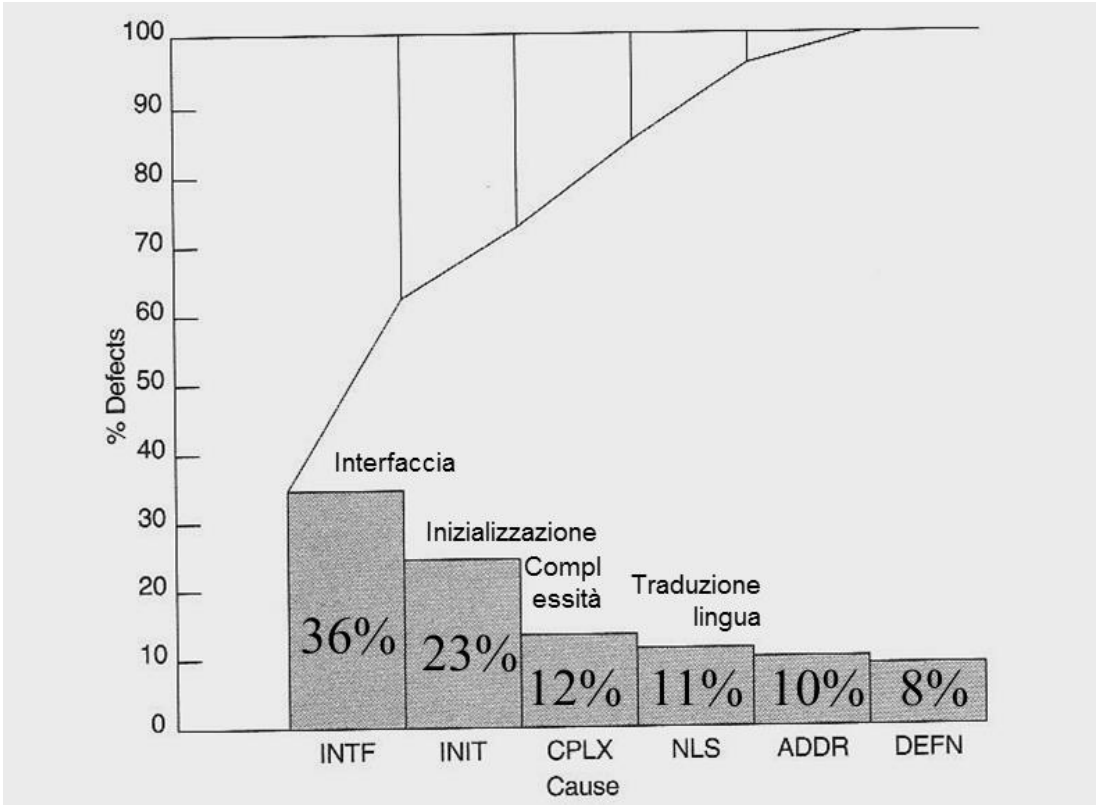
The measurements must be displayed
The ISO recommends these views:

frequency vs. measures (histograms, Pareto diagrams)

time vs. measures (trend analysis or predictive estimates)

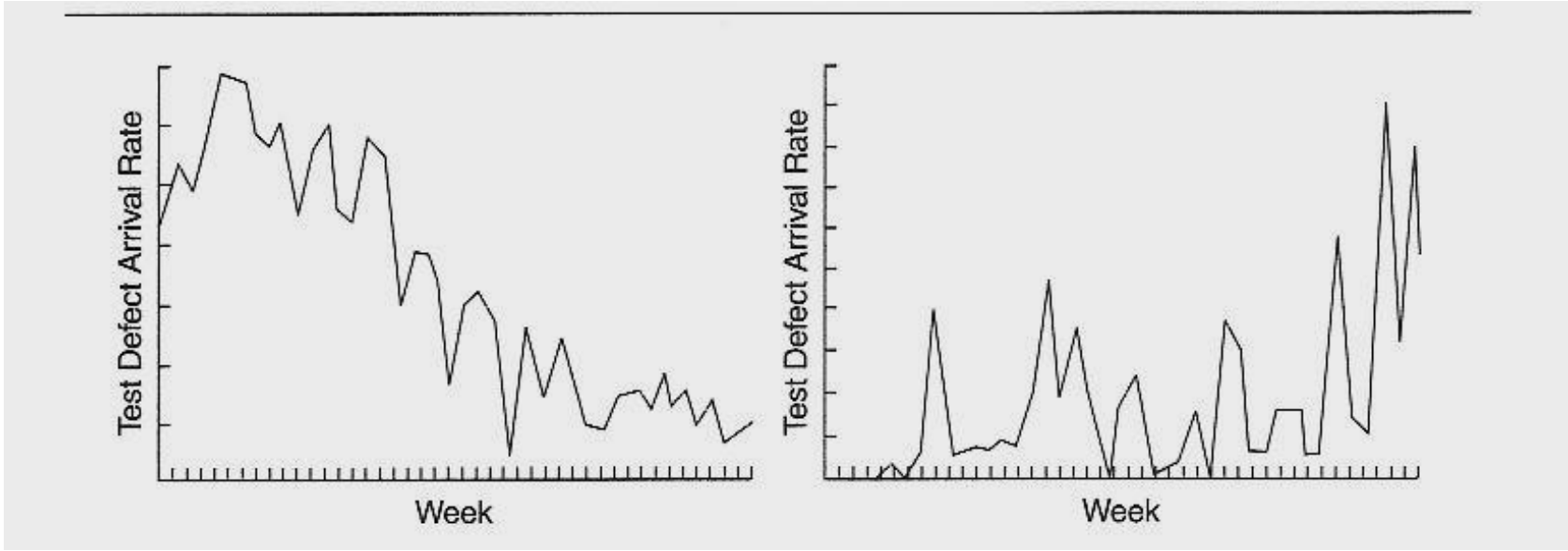
measures vs. measures (scatter plot, correlation, etc.)

Pareto diagrams



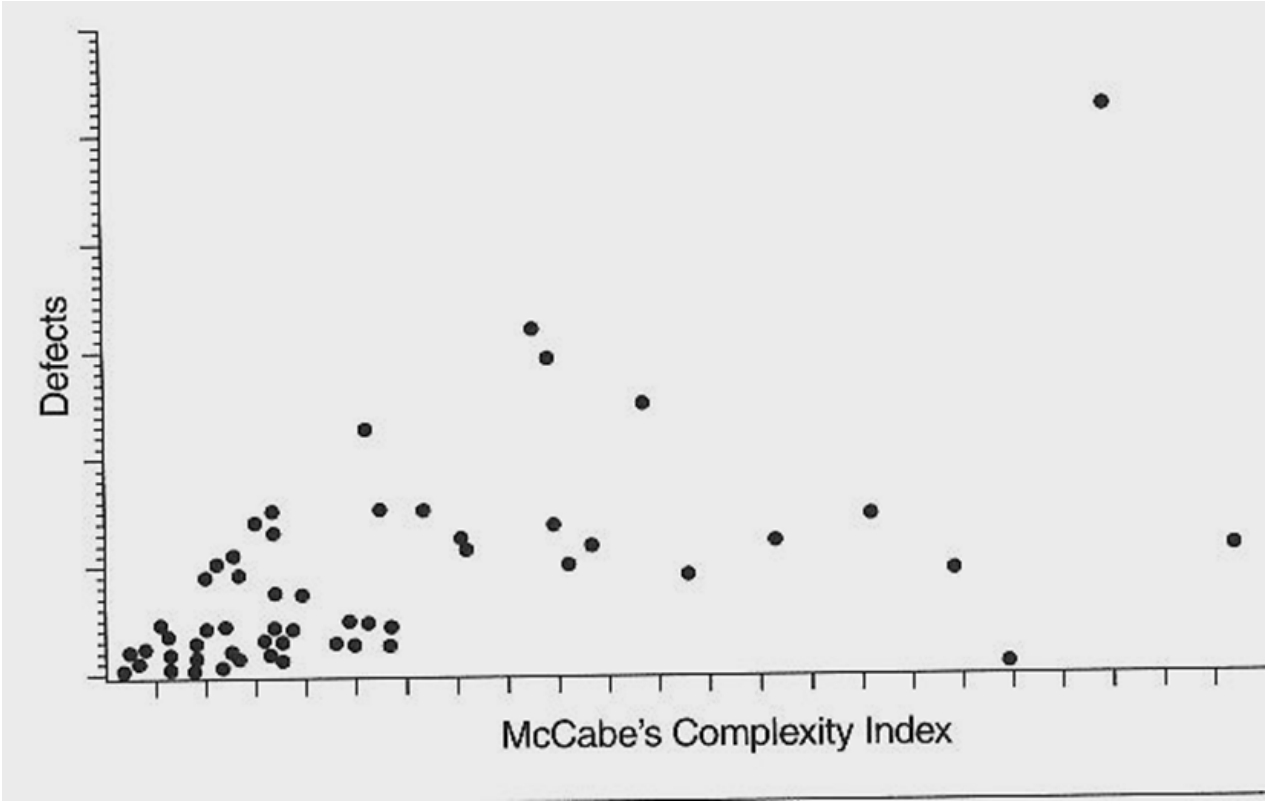
Defect distribution

Time



Test defect arrival rate

Scatter plot



Looking for a correlation

Examples of static metrics – **Functional suitability**

Metric Name	Purpose of the metrics	Method of application	Measurement, formula and data element computations	Interpretation of measured value	Metric Scale Type	Measure type	Source of Input to measurement	12207 reference	Beneficiaries
Functional appropriateness	How appropriate are the checked functions?	Measure the ratio of implemented functions that are suitable for performing the specified tasks to those implemented. The following may be measured; -all or parts of design specifications -completed modules/parts of software products	X=1-A/B A= Number of functions in which problems are detected in evaluation B= Number of functions checked	0 <= X <= 1 The closer to 1, the more adequate.	absolute	X=count/count A=count B=count	Req spec Design Source code Review report	6.5Validation 6.6Joint review	Requirer Developer
Functional implementation completeness	How complete is the functional implementation?	Count the number of missing functions detected in evaluation and compare with the number of function described in the requirement specifications 1.	X=1-A/B A=Number of missing functions detected in evaluation. B=Number of functions described in requirement specifications NOTE: Input to the measurement process is the updated requirement specifications. Any changes identified during life cycle must be applied to the requirement specifications before using in measurement process.	0 <= X <= 1 The closer to 1, the more completed.	absolute	X=count/count A=count B=count	Req spec Design Source code Review report	6.5Validation 6.6Joint review	Requirer Developer

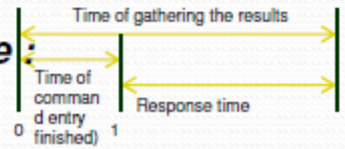
Examples of dynamic metrics – **Efficiency**

***Characteristics:* Efficiency**
***Sub-characteristic:* Time behaviour**
***Example of measure:* Response time**

External time behaviour metrics a) Response time

Metric name	Purpose of the metrics	Method of application	Measurement, formula and data element computations	Interpretation of measured value	Metric scale type	Measure type	Input to measure-ment	ISO/IEC 12207 SLCP Reference	Target audience
Response time	What is the time taken to complete a specified task? How long does it take before the system response to a specified operation?	Start a specified task. Measure the time it takes for the sample to complete its operation. Keep a record of each attempt.	T = (time of gaining the result) - (time of command entry finished)	0 < T The sooner is the better.	Ratio	T= Time	Testing report Operation report showing elapse time	5.3 Sys./Sw. Integration 5.3 Qualification testing 5.4 Operation 5.5 Mainte-nance	User Developer Maintainer SQA

Example:



Practical usage
AIPA recommendations for
Public administration software
(based on 9126)

(Autorità per l'Informatica nella Pubblica Amministrazione)

Functionality (1)

°	Sub-char	Indicatore	Formula	Tecnica di misura	Valore soglia
	Adeguatezza (suitability)	copertura funzionale	n° di funzioni presenti nel prodotto / numero di funzioni specificate nel progetto esecutivo	checklist applicate alla documentazione e verifiche ispettive sul prodotto	100%
		copertura documentazione	n° di funzioni descritte nel manuale / numero di funzioni presenti nel prodotto	checklist applicate alla documentazione	100%
		copertura test	n° di test eseguiti / numero di test specificati nel progetto esecutivo	checklist applicate alla documentazione, verifiche ispettive	99%
	Accuratezza (accuracy)	accuratezza documentazione	n° di funzioni esattamente descritte nel manuale / numero di funzioni descritte nel manuale	checklist applicate alla documentazione	80%

Functionality (2)

	Interoperabilità	tasso di interfacce incontrate	n° di interfacce realizzate / n° di interfacce specificate nel progetto esecutivo	checklist applicate alla documentazione e verifiche ispettive sul prodotto	100%
	Aderenza (compliance)	tasso di interfacce standardizzate rispetto a quelle esistenti in azienda	n° di interfacce standardizzate / n° di interfacce che devono essere standardizzate secondo il progetto esecutivo	checklist applicate alla documentazione e verifiche ispettive sul prodotto	100%
	Sicurezza (security)	copertura sicurezza informazioni	n° di informazioni riservate che dispongono di "log" di accesso / n° di informazioni riservate specificate nel progetto esecutivo	checklist applicate alla documentazione e verifiche ispettive sul prodotto	100%
		copertura sicurezza informazioni	n° di informazioni riservate con accesso limitato / n° di informazioni riservate con accesso limitato specificate nel progetto esecutivo	checklist applicate alla documentazione e verifiche ispettive sul prodotto	100%

Reliability

°	Sub-char	Indicatore	Formula	Tecnica di misura	Valore soglia
	Maturità (maturity)	densità di errori sul prodotto (dopo i test finali)	n° degli errori applicativi / volume del prodotto operativo	Verifiche su archivi di log ed interviste all'utenza	0.1 (in un anno/FP)
	Tolleranza (fault tollerance)	tasso di errori applicativi che hanno provocato un fermo della applicazione	n° degli errori applicativi / n° degli errori applicativi che hanno provocato dei fermi	Verifiche su archivi di log	1%
	Ripristinabilità (recoverability)	tasso di disponibilità	totale del tempo operativo / totale del tempo di osservazione	Verifiche su archivi di log	98%
		tempo medio di vita di un errore	tempo totale di vita di un errore / n° degli errori osservati	Verifiche su archivi di log	72 ore

Usability(1)

°	Sub-char	Indicatore	Formula	Tecnica di misura	Valore soglia
	Facilità di comprensione (understandability)	Facilità di comprensione del manuale	Tempo necessario ad un operatore medio a richiedere una funzione (guidata dal manuale)	Verifica ispettiva (Walkthroughs)	entro 10 minuti qualsiasi funzione
	Apprendibilità	Disponibilità di help in linea	n°. di help / n° di oggetti (funzioni/campi)	checklist applicate alla documentazione e verifiche ispettive sul prodotto	50%
		Disponibilità di funzioni di apprendimento in linea	n° di funzioni di “learning” / n° di oggetti (funzioni/campi)	checklist applicate alla documentazione e verifiche ispettive sul prodotto	50%

Usability (2)

	Operabilità	Grado di disponibilità di valori di default	n° di comandi e campi dei menu che dispongono di valori di default / Totale dei comandi e dei campi che li ammettono secondo il progetto esecutivo	checklist applicate alla documentazione e verifiche ispettive sul prodotto	90%
		Grado di disponibilità di liste di dati su cui scegliere per dare input alle applicazioni	n° di liste disponibili / totale dei campi dove sarebbero applicabili	checklist applicate alla documentazione e verifiche ispettive sul prodotto	90%
		Uniformità dei comandi	n° dei comandi che hanno formato standard / totale n° dei comandi	checklist applicate alla documentazione e verifiche ispettive sul prodotto	100%
		n ° medio di tasti da premere per eseguire una funzione (o di click sul mouse)	n° di tasti premuti per eseguire una funzione	verifiche ispettive	max 10
		Intervallo tra due errori umani nell'utilizzo della applicazione	Intervallo medio temporale tra due successivi errori umani	verifiche ispettive	10 minuti

Efficiency

°	Sub-char	Indicatore	Formula	Tecnica di misura	Valore soglia
		Response time	Intervallo di tempo medio tra immissione di una richiesta a terminale che non richiede trattamento di dati, ed ottenimento della risposta a terminale	Verifiche su archivi di log e verifiche ispettive sul prodotto (e sul codice)	10 sec
		Turnaround time	Intervallo di tempo medio tra immissione di una richiesta che richiede trattamento di dati ed ottenimento dell'output relativo	Verifiche su archivi di log e verifiche ispettive sul prodotto (e sul codice)	TP=10sec Stampa=2m

Portability

°	Sub-char	Indicatore	Formula	Tecnica di misura	Valore soglia
	Adattabilità	Tasso di esportabilità del patrimonio dati	n°. di dati esportabili / n°. di dati	checklist applicate alla documentazione e verifiche ispettive sul prodotto	100%
		Tasso di esportabilità dell'ambiente operativo	n°. di funzioni esportabili / n°. di funzioni	checklist applicate alla documentazione e verifiche ispettive sul prodotto	90%
		Tasso di modifica parametri per cambiamento ambiente operativo	n°. di parametri da modificare / n°. di parametri	checklist applicate alla documentazione e verifiche ispettive sul prodotto	50%
		Tasso di ricompilazione per cambiamento ambiente operativo	n°. di programmi da ricompilare / n°. di programmi	checklist applicate alla documentazione e verifiche ispettive sul prodotto	50%

So what?

- How to enforce the software quality:

Software Quality Assurance (SQA)

http://www.sqa.net/index.htm

Nasa definition:

The function of software quality that assures that the standards, processes, and procedures are appropriate for the project and are correctly implemented.

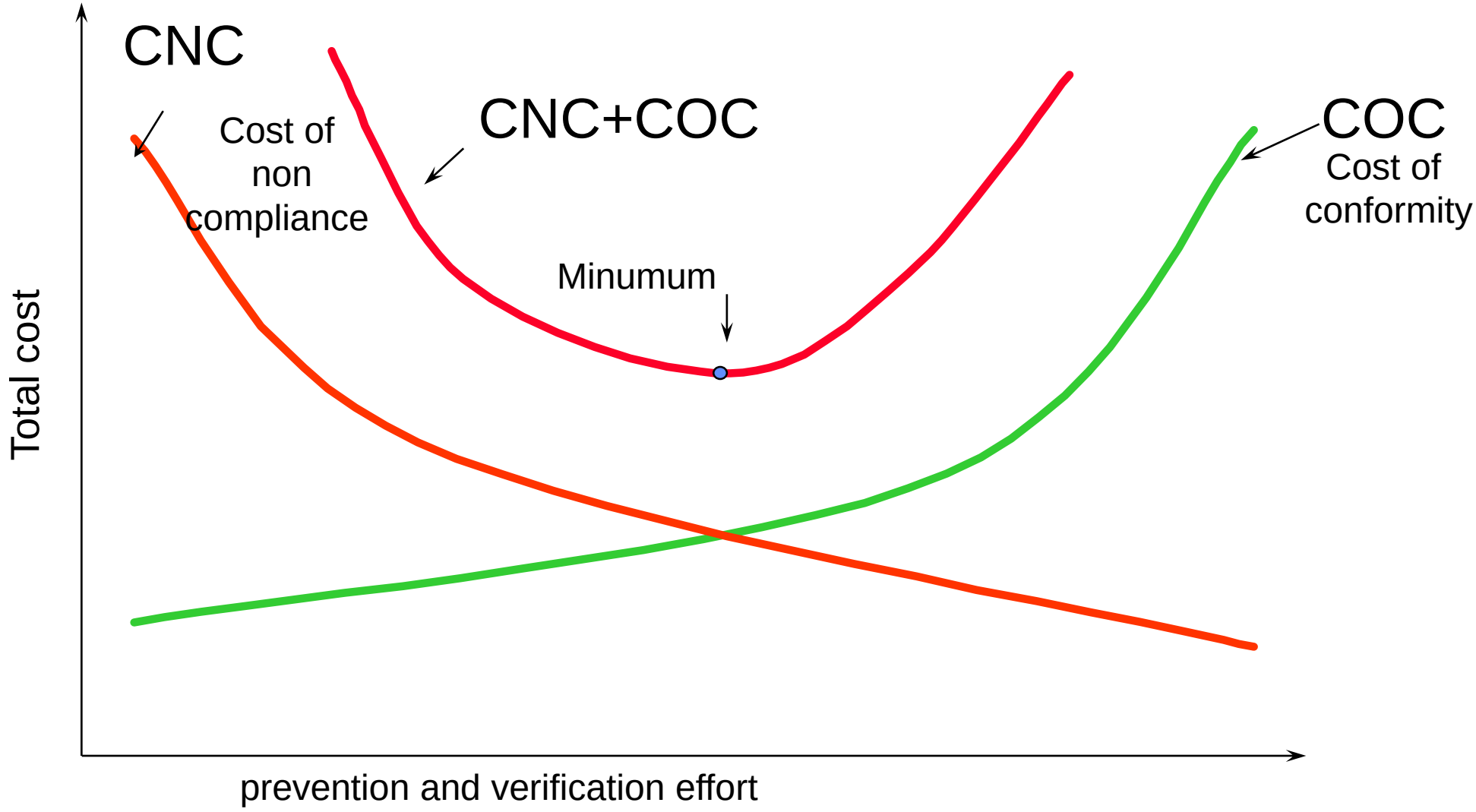
Quality cost

- Due expence sources:
  - To ensure quality
  - To fix errors

Quality cost (ISO)

- The costs of quality in the production process are the costs that you bear to adapt the quality of the product the required quality
- Cost of conformity (COC) (to satisfy all the needs expressed and implied)
  - Prevention costs: costs incurred to prevent failures cost assessment:
  - Inspection cost : costs for inspections and tests
- Cost of non-compliance (NC) (for internal and external failures) costs for internal failures: charges related to a product that does not meet the quality requirements before its delivery costs for external failures: charges related to a product that does not meet the requirements of quality after its delivery (maintenance costs and repair, warranty costs, costs and returns for the recall of the products, costs for product liability, etc.)

Quality cost



ISO and other organizations

		General	Electrotechnical
International level		*ISO*	*IEC*
European level		*CEN*	*CENELEC*
National level		*UNI*	*CEI*

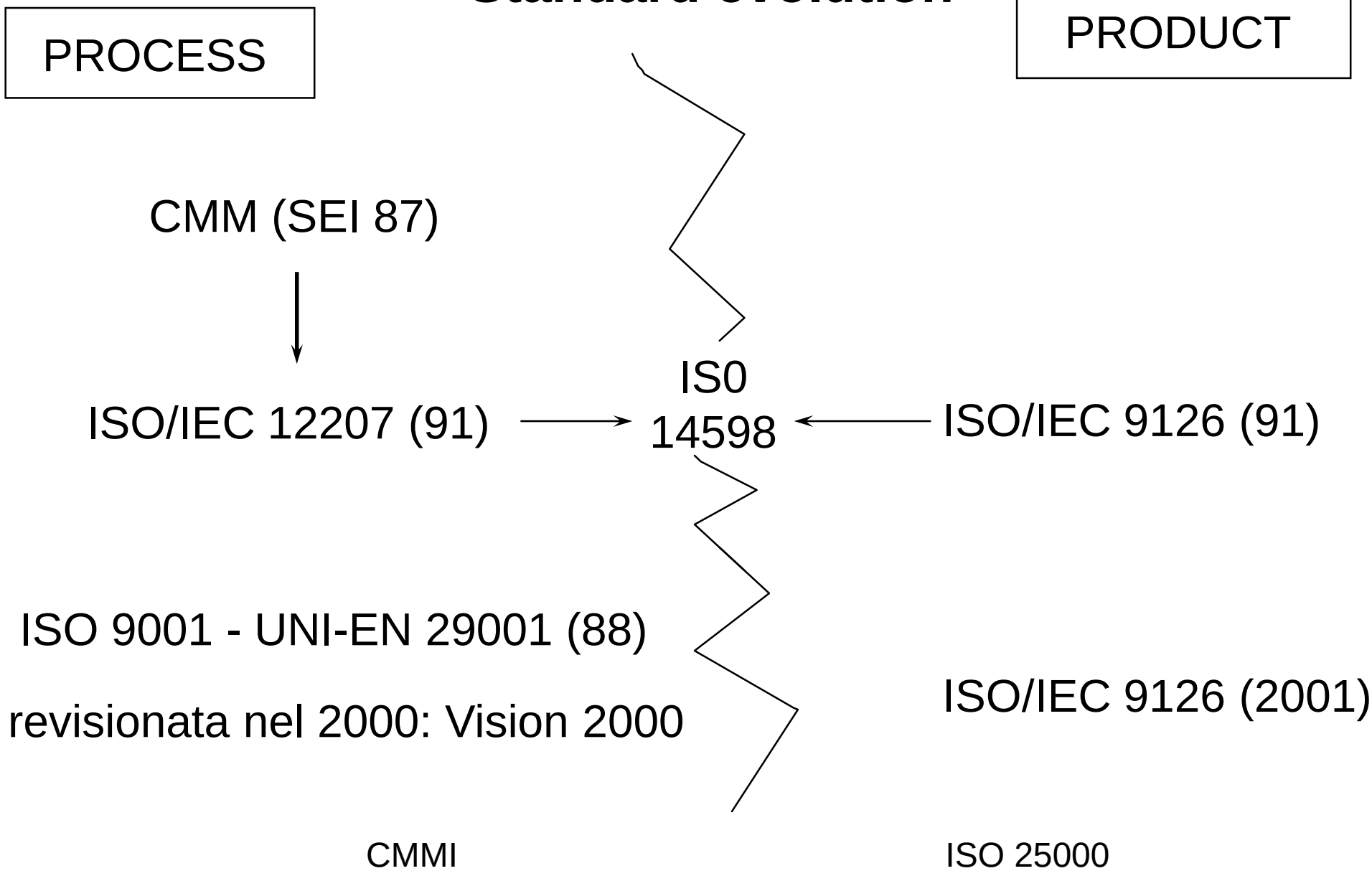
Acronyms

- ISO International Organization for Standardization
- IEC International Electrotechnical Commission
- CEN Comitato Europeo di Normazione (sigla sui documenti EN)
- CENELEC Comitato Europeo di Normazione Elettrotecnica (sigla sui documenti EN HD)
- UNI Ente Nazionale Italiano di Unificazione
- CEI Comitato Elettrotecnico Italiano

- Non European National ISO:

- ANSI American National Standard Institute, United States;
- JISC Japan Industrial Standards Committee, Japan;
- SA Standards Australia, l'Australia;
- SCC Standard Council of Canada, Canada.

Standard evolution



Exercise

- A little city is installing some self service systems to by train tickets. The system has an interface through touch-sensitive screen and allows the user to specify the trip and to pay cash or with a credit card. Indicate two quality requirements that are relevant to the application in accompanying each one with a metric:
- measuring procedure
- scale
- type of measure
- internal/external/in use
- direct, indirect, indicator
- size, time of occurrence and their possible combination

Usability

- **Learnability** Learning effort for different users, i.e. novice, expert, casual etc.

- **Metric:** mean/ standard deviation time for completing a transaction (threshold? Mean about a minute ?)
  - measuring procedure: Log analysis
  - scale: ratio scale
  - In use
  - indicator
  - time/count

Usability

- **Operability** Ability of the software to be easily operated by a given user in a given environment

- **Metric** : mean/ standard deviation time for completing each subtask (selecting stations, time, payment)
  - measuring procedure: Log analysis
  - scale: ratio scale
  - In use
  - indicator
  - time/count

Usability

- **Operability** Ability of the software to be easily operated by a given user in a given environment

- **Metric** : mean/ standard deviation of errors (?) during each subtask (selecting stations, time, payment)
  - measuring procedure: Log analysis(?)
  - scale: ratio scale
  - In use
  - indicator
  - count/time