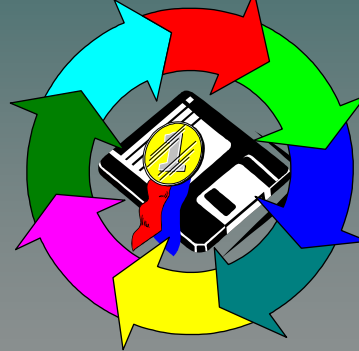


QUALITY: PRODUCT VS PROCESS



PROCESS AND PRODUCT QUALITY

Fernando Brito e Abreu

FCT/UNL

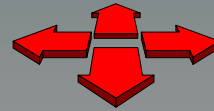
ABSTRACT

- ① *PRODUCT OR PROCESS?*
- ① *INSIDE-OUT VERSUS OUTSIDE-IN*
- ① *PRODUCT QUALITY MODELS*
- ① *PRODUCT EVALUATION PROCESS*
- ① *PROCESS QUALITY - Q.M.S.*
- ① *QUALITY META-MANUAL EXAMPLES*
- ① *SOFTWARE QUALITY ORGANIZATIONS*

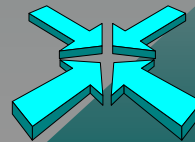
PRODUCT OR PROCESS?

- Increasing competition on the global market makes the evaluation of software product quality characteristics more relevant.
- Two approaches to achieve that:

- Inside-out (product centered)



- Outside-in (process centered)



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INSIDE-OUT APPROACH

- Internal structure is a necessary, but not sufficient, condition for product quality!
- Evaluating the **quality of the final product** and do the required corrections iteratively until it exhibits the required quality level.

- Drawbacks:

- Agreement on which quality characteristics
- Agreement on how to measure them
- Effort involved

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OUTSIDE-IN APPROACH

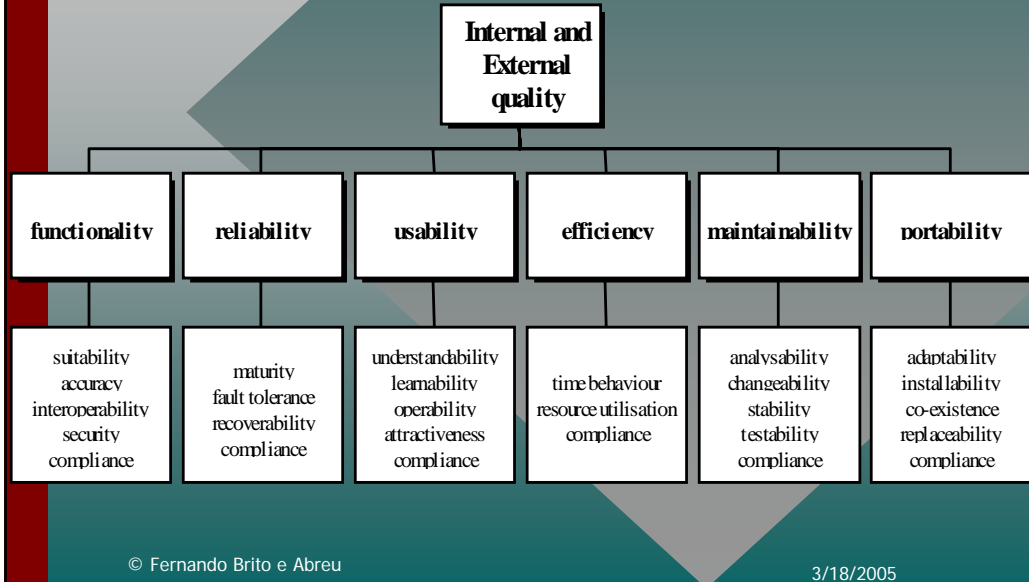


- Organization of the software process is a necessary, but not sufficient, condition for product quality!
- Focus on **quality of the development process**, because that potentially leads to obtaining quality products.
- Drawbacks:
 - An ill-defined process, when followed strictly, will probably lead to the systematic production of bad products!

QUALITY OF PRODUCT

- ISO/IEC 9126 standard proposes a framework with a set of characteristics that allows to characterize product quality.
- The proposed characteristics were chosen with the concern of minimum overlap.
- Those characteristics are decomposed in sub-characteristics according to the following schemas:

ISO9126 Software Internal and External Quality Model



ISO9126 Software Internal and External Quality Model

Functionality - capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions.

Reliability - capability of the software product to maintain a specified level of performance when used under specified conditions

Usability - capability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions.

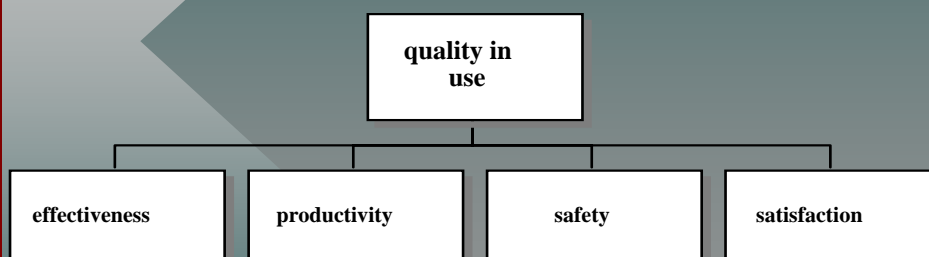
ISO9126 Software Internal and External Quality Model

Efficiency - capability of the software product to provide appropriate performance, relative to the amount of resources used, under stated conditions.

Maintainability - capability of the software product to be modified. Modifications may include corrections, improvements or adaptation of the software to changes in environment, and in requirements and functional specifications.

Portability - capability of the software product to be transferred from one environment to another.

ISO9126 Software Quality in Use Model



ISO9126 Software Quality in Use Model

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Effectiveness - capability to enable users to achieve specified goals with accuracy and completeness in a specified context of use.

Productivity - capability to enable users to expend appropriate amounts of resources in relation to the effectiveness achieved in a specified context of use.

Safety - capability to achieve acceptable levels of risk of harm to people, software, equipment or the environment in a specified context of use.

Satisfaction - capability to satisfy users in a specified context of use.

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Other Quality Models

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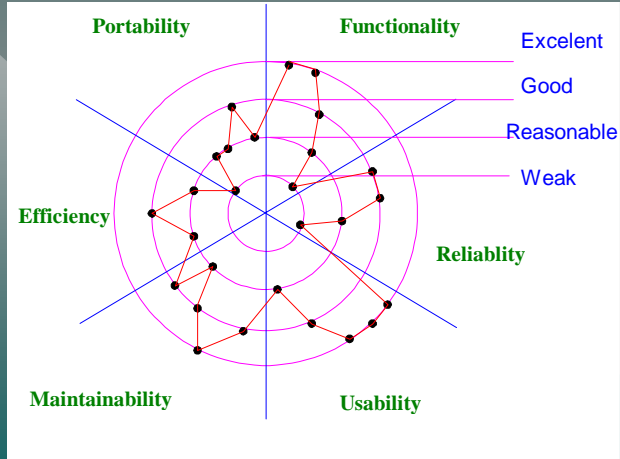
- *J.A. McCall, General Electric / Rome Air Develop. Center (USAF) [McCall77; Cavano78; McCall94]*
- *Barry Boehm, TRW, creator of COCOMO model [Boehm78]*
- *Lowell Arthur [Arthur85]*
- *Robert Grady, Hewlett-Packard, [Grady87]*
- *Bertrand Meyer, Interactive Software Engineering, creator of Eiffel language [Meyer95; Meyer97]*
- **Conclusion: More than 2 decades of software quality models proposals! More to come ...**

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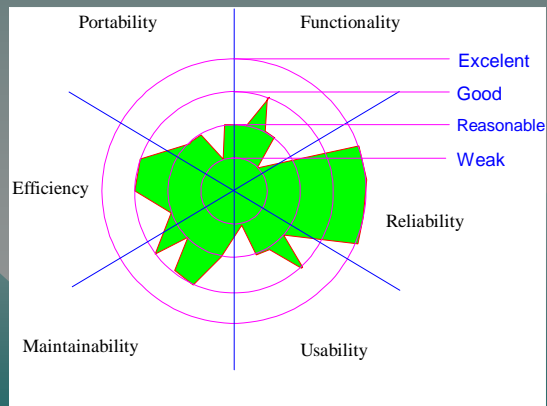
Representation of Product Quality

We can obtain a suggestive perception of the quality characteristics set by using a Kiviati diagram :



Relative importance of product quality characteristics

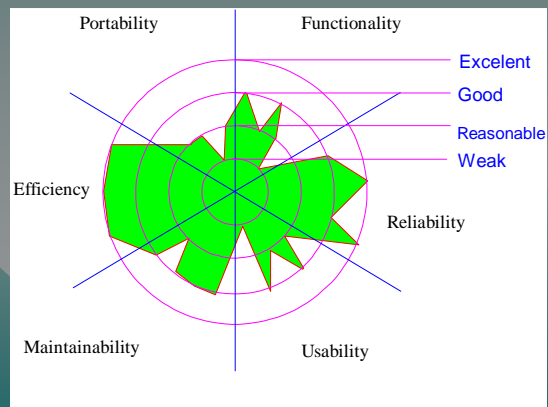
- Software controlling critical systems:
 - Nuclear power plant
 - Pace-maker
 - Air-traffic control
 - Railway switching



Relative importance of product quality characteristics

15

- Software controlling real-time systems:
 - Telecom switching
 - Communic. protocols
 - Operating systems
 - DBMS



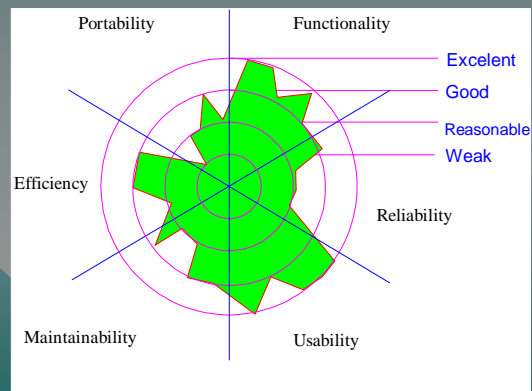
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Relative importance of product quality characteristics

16

- Front-office systems:
 - Word processor
 - Accounts current
 - Tourist information
 - Entertainment package



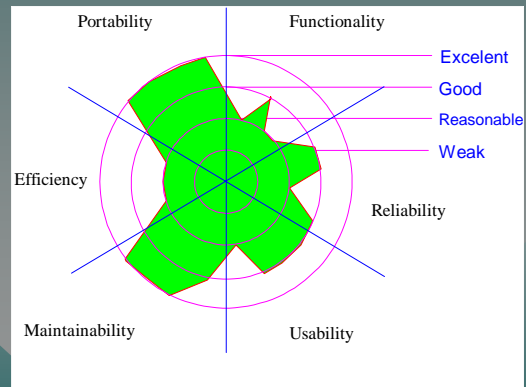
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Relative importance of product quality characteristics

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- Long lifecycle system:
 - Banking system
 - Air reservation system
 - Assurances system



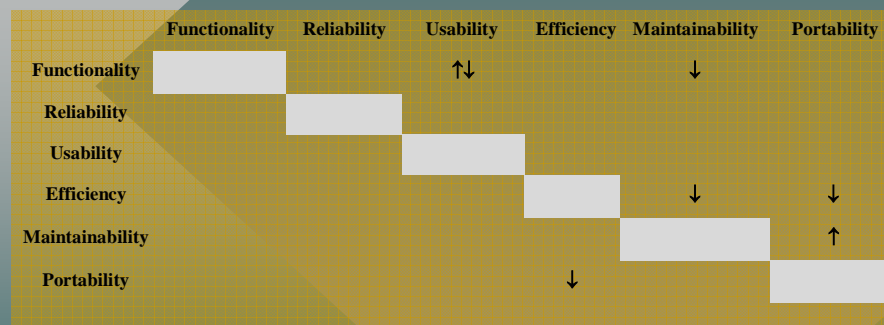
- Project manager must consider a weighted blend!

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Interdependent Characteristics

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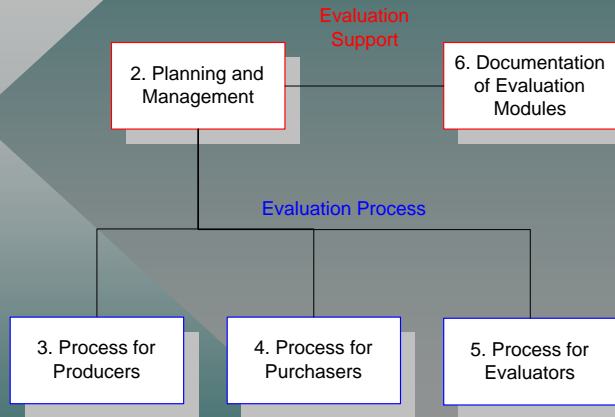


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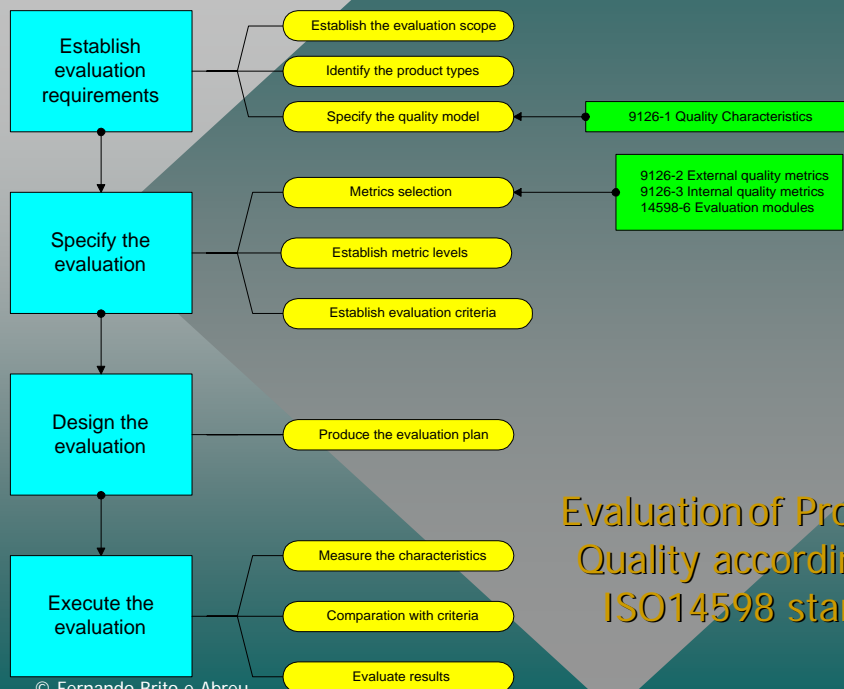
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Evaluation of Product Quality according to Standard ISO14598

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Legend – Relation among the parts relative to the evaluation process and those of evaluation support



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Evaluation of Product Quality according to ISO14598 standard

Evaluation of Product Quality according to Standard ISO14598 21

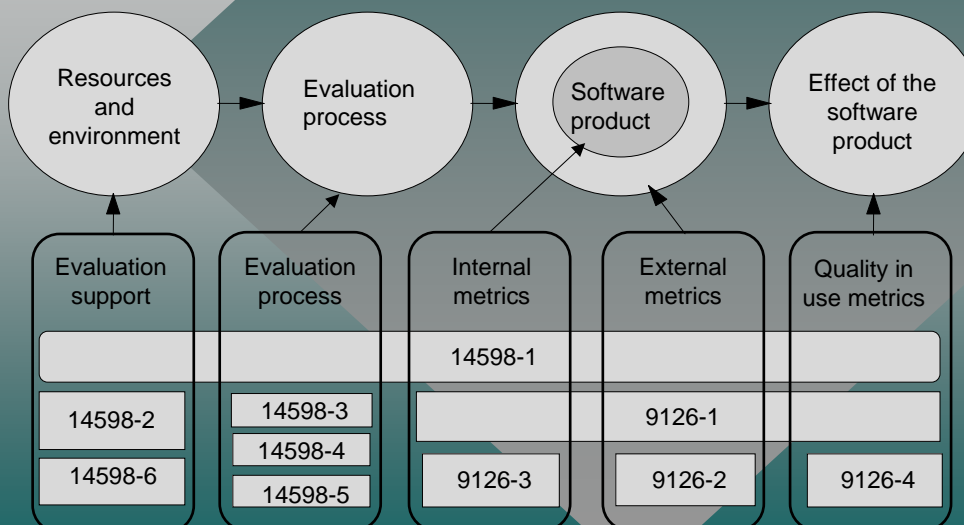
- *Meta-guide ("template") for the construction of a Plan of Quantitative Evaluation*

	Chapter
1.	Introduction
2.	Evaluation Objectives
3.	Applicable quality characteristics
4.	List of priorities
5.	Quality objectives
6.	Schedule
7.	Definition of responsibilities
8.	Categories of measurement
9.	Data analysis
10.	Results disclosure
11.	Other requirements

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Relationship between ISO/IEC 9126 and 14598 standards 22



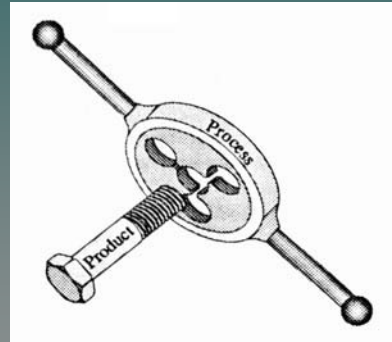
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PROCESS QUALITY

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- Outside-in approach to Software Quality (revisited...) :
 - Organization of the software process is a necessary, but not sufficient, condition for product quality!
 - Process quality has a big influence on product quality ...



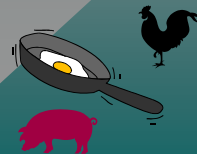
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PROCESS QUALITY

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- Development process quality depends on the adoption of a set of systematized activities - the **Quality Management System (QMS)**
- The QMS must:
 - be perfectly defined and documented - **Quality Manual**.
 - clearly identify the management commitment
 - include a definition of strategies to develop
 - detailing the steps to fulfil
- Commitment vs Involvement (bacon with eggs)!

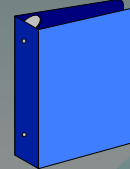


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What must be in a Quality Manual?

- Any Software Quality Manual must include, at least, the following themes:
 - Definition of **development life-cycle** and documents to produce in each phase
 - Organizational structure of projects
 - Tasks distribution (responsibility assignment)
 - Execution schedules and resource management
 - **Configuration management**
 - Risks identification and contingency plans
 - Mechanisms of **verification and validation (V&V)**



What is Verification and Validation (V&V) ?

- **Verification - "Do the Job Right"**
 - evaluation of correction and consistency of a product, in a given phase, face to the products and standards that are an input to that phase.
- **Validation - "Do the Right Job"**
 - evaluation of conformity of a given product with the requirements specified for it.
- Two basic techniques of V&V:
 - **Reviews**
 - **Tests**



What is Configuration Management?

- Set of mechanisms and activities to identify and organize the software components as well as the development environment.
- These components can be:
 - requirements specification documents,
 - source code modules
 - test batteries
 - user or installation manuals
 - executable programs
 - ...

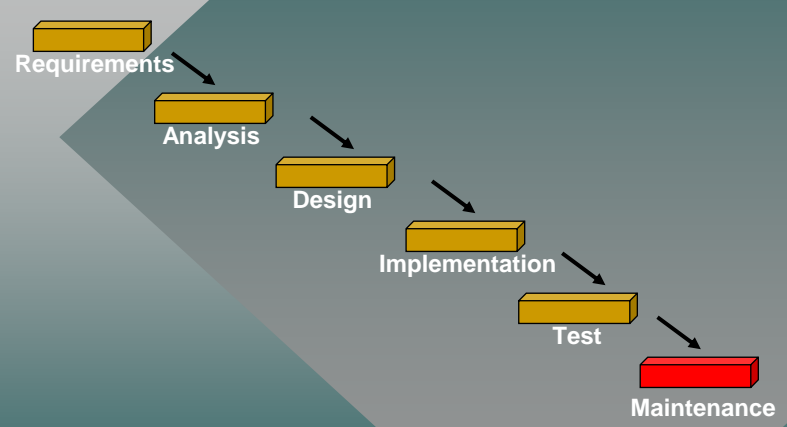
What is Config.Management? (continued)

- The main mechanisms are:
 - **Identification Mechanisms** - explicit naming convention (may be automated) for:
 - components
 - product versions
 - components versions
 - **Versions Control** - mechanism that turns the modification of components (creation of new versions) a controlled activity

What is a SW Life-cycle Model?

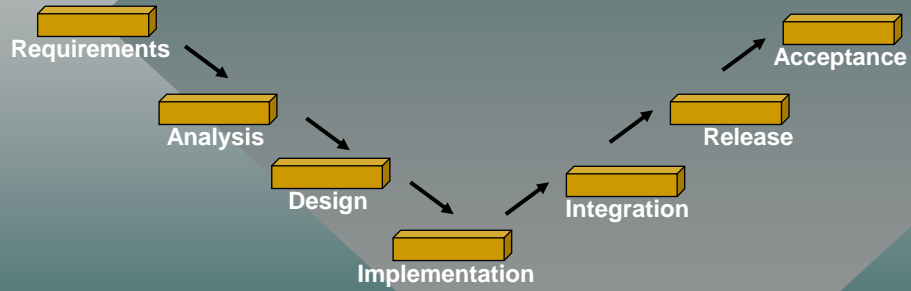
- It is a model of the generic activities associated with a given software product throughout its lifetime
- It usually includes the definition of deliverables such as:
 - requirements specification
 - design model
 - source code module
 - test battery
 - user manual
 - executable program
 - installation guidelines
 - ...

SW Life-cycle: Waterfall Model



SW Life-cycle: V Model

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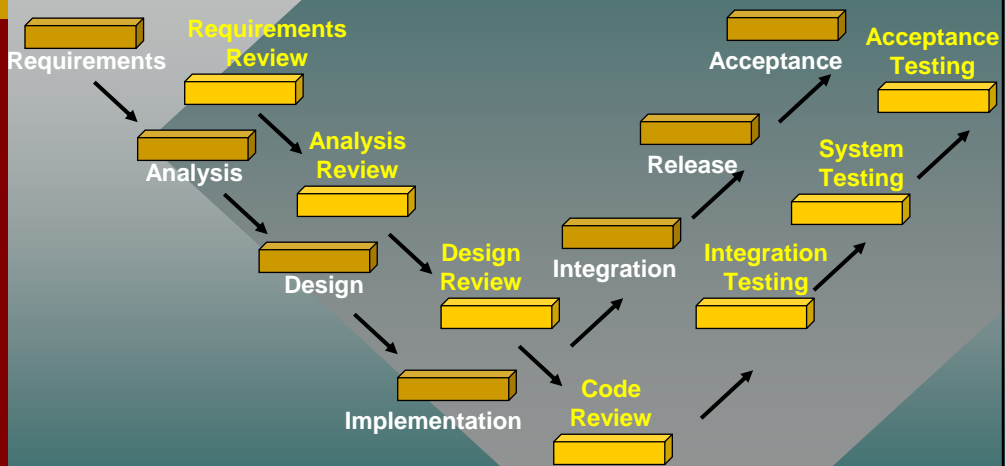
[Schultz89] Arno Schultz, "Software-Lifecycle und Vorgehensmodelle", Angewandte Informatik, n.4, 1989.

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SW Life-cycle: W Model

32

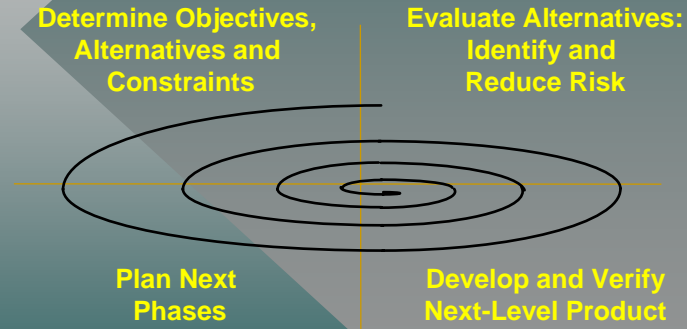


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Example 4: Spiral Model

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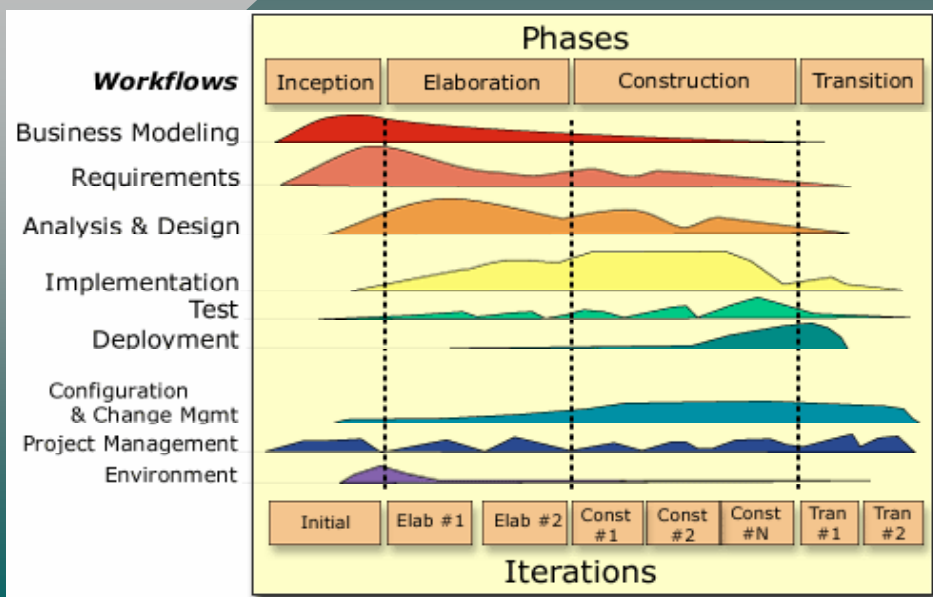
[Boehm88] Barry W. Boehm, "A Spiral Model of Software Development and Enhancement", IEEE Computer, 21(5), May 1988.

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Example 5: The RUP Model

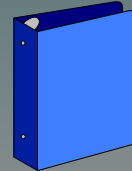
34



A Q.M.S. Framework: the ISO 9000-3 Standard

35

- "Guidelines for the Application of ISO 9001 to the Development, Supply and Maintenance of Software":
 - Scope
 - Related standards
 - Quality System - Framework
 - Management responsibilities
 - Quality System
 - Internal Audits to the Quality System
 - Corrective actions



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ISO 9000-3 Standard (continued)

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- "Guidelines for the Application of ISO 9001 to the Development, Supply and Maintenance of Software":
 - Quality System -Activities of the life-cycle
 - Contractual revisions
 - Purchaser requirements specification
 - Development planing
 - Quality planing
 - Design and Implementation
 - Test and Validation
 - Acceptation
 - Maintenance

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ISO 9000-3 Standard (continued)

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- "Guidelines for the Application of ISO 9001 to the Development, Supply and Maintenance of Software":
 - Quality System -Support activities
 - Configuration Management
 - Documentation Control
 - Quality Registers
 - Measurement
 - Rules, Practices and Conventions
 - Tools and Techniques
 - Acquisitions
 - Included Software Products (third party)
 - Training

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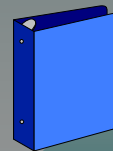
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1st Example of a Quality Meta-Manual

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"MSQH-Modeling a SW Quality Handbook"

- Work funded by the Nordic Fund for Technologic and Industrial Development
- Developed by the Inter-Nordic Normalization Group in Information Technologies:
 - Icelandic Council for Normalization (STRÍ) - Iceland
 - Dansk Standardiseringsrad (DS) - Denmark
 - Finnish Standards Organization (SFS) - Finland
 - Norsk Verkstadindustri Standardisering (NVS) - Norway
 - Informationsteknologisk Standardisering (SIS-ITS) - Sweden



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MSQH (continued)

- Objective: help **small to medium sized software-houses** to introduce (or reorganize) a Quality Management System
- Based in standards ISO9001 and ISO 9000-3, ISO9004 (services), ISO9126 and ISO10011 (auditing).
- Includes cross references to paragraphs of ISO9000-3 and ISO9001.
- Stresses that the introduction of a Quality System is only possible with management commitment.

MSQH (continued)

- For each of the activities of the life-cycle it describes:
 - tasks involved
 - objectives
 - responsibilities
 - documents to produce.
- The MSQH includes a set of recommendations, that must be tailored for each company in particular.
- Is written in english and can be obtained through:
 - *Icelandic Council for Standardization (STRÍ)*
 - *Iontæknistofnun Íslands, Keldnaholti, IS-112 Reykjavík, Iceland*
 - *Telefax: +354-1-687409*

MSQH (continued)

The required activities of the life-cycle are:

– **Basic activities :**

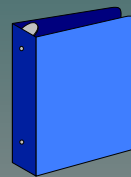
- Contract
- Requirements specification
- Plan of development and of quality
- Design
- Implementation
- Test and validation
- Acceptation plan
- Maintenance
- Services

– **Complementary support activities :**

- Configuration management
- Control of documentation
- Quality registers
- Measurement of software quality
- Evaluation and incorporation of third party software
- Training

2nd Example of a Quality Meta-Manual

"Recomendaciones para la Preparación de Planes de Calidad del Software para las Industrias de Defensa"



<http://www.aec.es>

"... Preparación de Planes de Calidad del Software..." (continued) ⁴³

- Based in standards:
 - AQAP 150, "Requirements for Quality Management of Software Development", Allied Quality Assurance Publication, May 1990
 - PECAL-13, "Exigencias para un Sistema de Control Total de la Calidad del Software", Publicaciones Españolas de Calidad
- Objective: help companies that develop military software to prepare Quality Plans:
 - to achieve contractual compromises (PECAL-13)
 - to improve the quality of their processes de development and final products
 - make the work of the quality assurance responsible easier, through the systematic control of the required activities

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"... Preparación de Planes de Calidad del Software..." (continued) ⁴⁴

Distinct Quality Plan / Manual for each project to develop.
The proposed structure is the following:

- Introduction
 - Objective
 - Scope
 - Revision of the Quality Plan
 - Applicable and reference documentation
 - Relation with other plans
 - Definitions
 - Identifiers and Abbreviators

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"... Preparación de Planes de Calidad del Software..." (continued) 45

The proposed structure (continued) ...

- Description of the project
 - Overview of the project
 - Constraints
 - Products to deliver
- Development of the project
 - Organizational structure of the project
 - Task distribution
 - Schedule of execution
 - Project resources

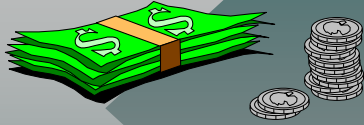
"... Preparación de Planes de Calidad del Software..." (continued) 46

The proposed structure (continued) ...

- Control of subcontracting
- Risk management
- Notifications of non-conformities and corrective actions
- Documentation of quality and support means
 - Methods, procedures, standards, techniques
 - Documentation of software development
 - Library of software development
- Use, storage, reproduction, delivery and distribution of software
- Verification and validation
- Configuration management

QUALITY COSTS AND BENEFITS

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- Draw cost & benefit curves over time ...

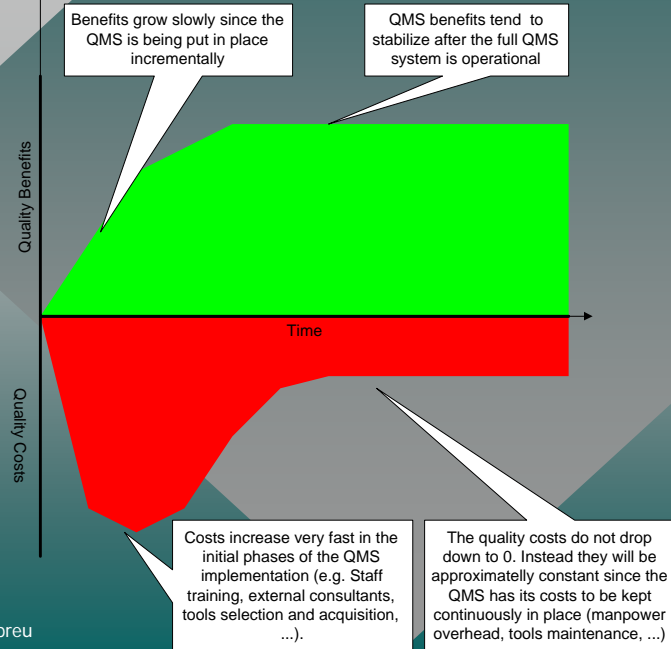


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Quality Costs and Benefits:

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SOFTWARE QUALITY ORGANIZATIONS

Comissão Sectorial
para as



CS/03 **Tecnologias da
Informação e Comunicações**

50

- **Criação:** 1993
- **Missão:** Promover e dinamizar a Qualidade no planeamento, desenvolvimento e exploração das TICs, designadamente ao nível dos processos, sistemas, produtos e serviços
- **Direcção:** um Presidente e dois Vice-Presidentes
- **Membros:** mais de 30 organizações (*software-houses*, operadores, consultoras, banca, serviços, associações de empresas, universidades, etc)
- **Reuniões:** mensais, no IPQ (Monte da Caparica)
- **Realizações:** QUATIC'94 e QUATIC'95 (Lx), QUATIC'98 (Guimarães), QUATIC'2001 (Lx), QUATIC'2004 (Porto)

SOFTWARE ENGINEERING INSTITUTE

- Sponsored by the Department of Defense (**DoD**)
- Installed inside the **Carnegie-Mellon University**
- Mission: promote the adoption of "good" Software Engineering techniques through:
 - production of pedagogic materials (books, manuals, papers, technical reports, films)
 - training, consulting and certification activities
 - promotion of events (conferences, workshops, ...)
- More information: <http://www.sei.cmu.edu>



EUROPEAN SOFTWARE INSTITUTE

- Financed by the E.C.
- Located in Bilbao, Spain
- Mission: promotion of best practices in Software Engineering (european counterpart to the S.E.I.)
- Founding members (around 20): Matra (France), Olivetti SPA (Italy), ESA, ...
- Partner in several initiatives :
 - SPICE (ISO SC7/WG10) - ISO/IEC 15504
 - ESSI (European Software Systems Initiative)
 - ESPRIT (European Strategic Program of Research on Information Technologies).
- Offers access (to its members) to training courses, technical publications, etc.
- More information: <http://www.esi.es>



QUALITY STANDARDS

ISO 9000 SERIES OF STANDARDS

ISO 9000 : "Quality Management and Quality Assurance Standards"

Part 1: Guidelines for selection and use

Part 2: Guidelines for the application of ISO 9001, 9002 and 9003

Part 3: Guidelines for the application of ISO 9001 to the development, supply and maintenance of software

ISO 9001 - "Quality Systems - Model for Quality Assurance in Design / Development, Production, Installation and Servicing"

ISO 9002 - "Quality Systems - Model for Quality Assurance in Production and Installation"

ISO 9003 - "Quality Systems - Model for Quality Assurance in Control and Final Tests"

ISO 9004 - "Quality Management and Quality System Elements - Guidelines"

Part 2 : "Guidelines for Services"

Part 6 : "Configuration Management"

ISO 9126 : "Software Product Evaluation - Quality Characteristics and Guidelines for Their Use"

Part 1: "Quality Characteristics and Sub-characteristics"

Part 2: "External Metrics"

Part 3: "Internal Metrics"

OTHER RELEVANT STANDARDS

ANSI/IEEE Std 730 : "Standard for Software Quality Assurance Plans"

ANSI/IEEE Std 983 : "Guide for Software Quality Assurance Planning"

ISO 8402 : "Quality - Vocabulary"

ISO 10006 : "Guidelines to Quality in Project Management"

ISO14598 : "Software Product Evaluation"

Part 1 - "General Overview / General Guide"

Part 2 - "Planning and Management / Manager's Guide"

Part 3 - "Process for Developers / Developer's (and Maintainers) Guide"

Part 4 - "Process for Acquirers / Buyer's Guide"

Part 5 - "Process for Evaluators / Evaluator's Guide"

Part 6 - "Evaluation Modules"

DoD Mil Std 2168 : "Software Quality Program"

NATO AQAP 13 : "Software Quality Control System Requirements"

NATO AQAP 150 : "Requirements for Quality Management of Software Development"