

Lecture 8

About Quality and Quality Management Systems

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Content of today's lecture

Two weeks ago we discussed about testing and inspections,

- that are means to improve quality.

Today we

- discuss what is quality anyways, and
- go through quality management systems and quality standards of software engineering.

Learning goals

- Develop a holistic view to SW quality
- Learn basics of "quality management systems" and related standards
- Know what concepts
 - ISO9000 – series
 - CMMI
 - SPICEmean

About our program

| | | Exercise |
|------|--|--|
| 13.1 | Introduction to the course and software engineering | Article: Silver bullet |
| 20.1 | Week | Lecture |
| 27.1 | Project planning | Project management |
| 3.2 | Scrum | Tool: processing |
| 10.2 | Requirement management | Tool: Agilefant |
| 17.2 | Other methods; Lean; Kanban | Article: From Traditional, to Lean, to Agile |
| 24.2 | Improving Quality: review practices, testing and quality assurance | Testing; CTC tool family |
| 3.3 | break | Break |

| Week | Lecture | Exercise |
|------|--|-------------------|
| 10.3 | Quality in general; Quality management systems | Patterns |
| 17.3 | Dependable and safety-critical systems | ISO9001 |
| 24.3 | Work planning; effort estimation | Code inspections |
| 31.3 | Version and configuration management | Effort estimation |
| 7.4 | Role of software architecture; product families; software evolution | ? |
| 14.4 | Specifics of some domains, e.g. web system and/or embedded and real time systems | Break? |
| 21.4 | Easter | Break? |
| 28.4 | Software business, software start-ups | ? |
| 5.5 | Last lecture; summary; recap for exam | ? |

A FEW THOUGHTS ABOUT QUALITY

The next four slides are based on presentation of Esko Hannula (CEO of Qu entinel)

Many different definitions

People

Subjective view on
what is good and
valuable.

Development Engineer

Meeting of the
predefined criteria

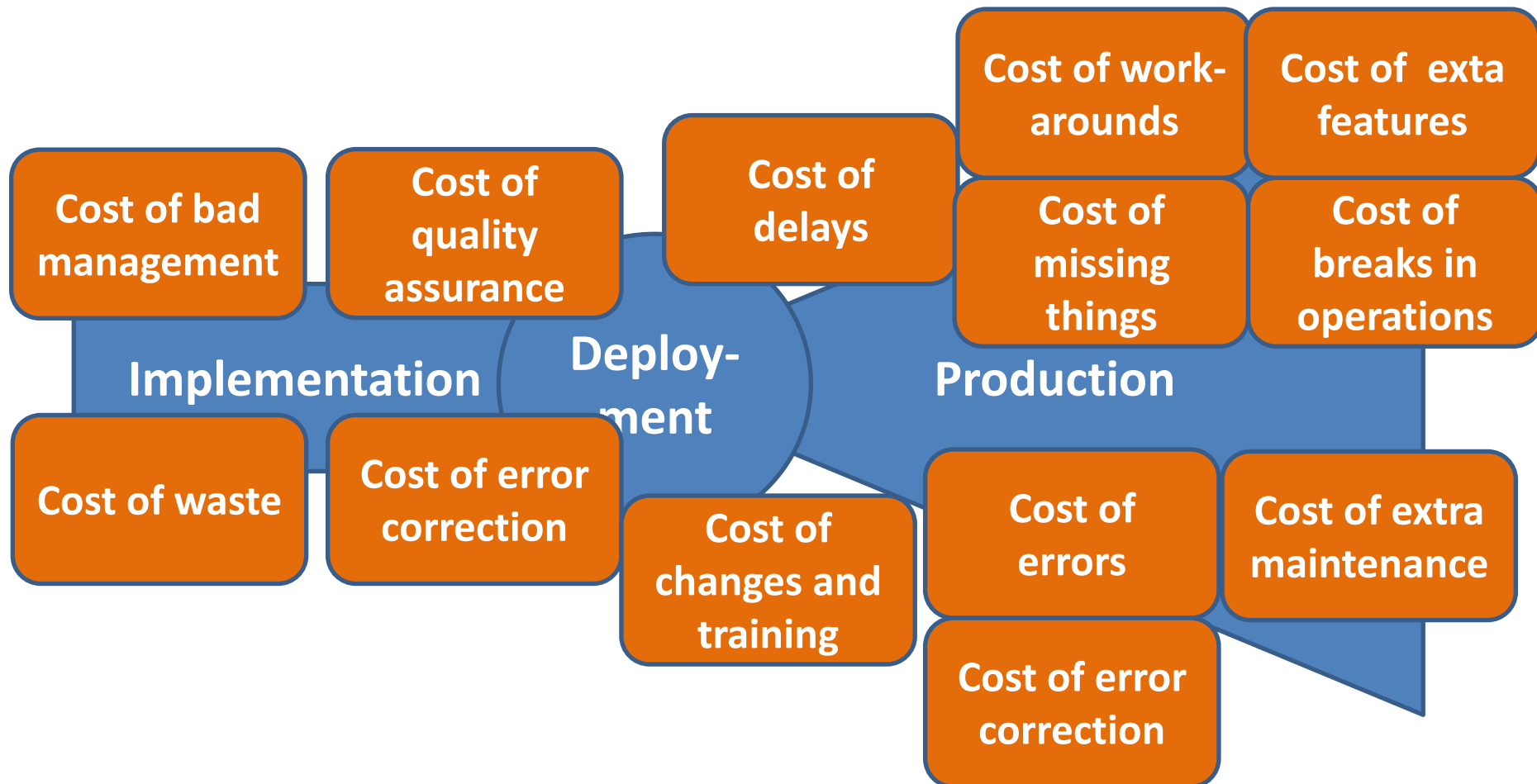
Quality manager

Operation complies
with standardized
quality systems

Production Engineer

How big % of the patch
fulfils the predefined
criteria-

SW Quality defined in terms of problems, deviations, bugs ... **cost**



Stakeholders and quality of software

User

Can perform tasks
- easily
- reliably

CEO

Cash-flow
Revenue
Productivity

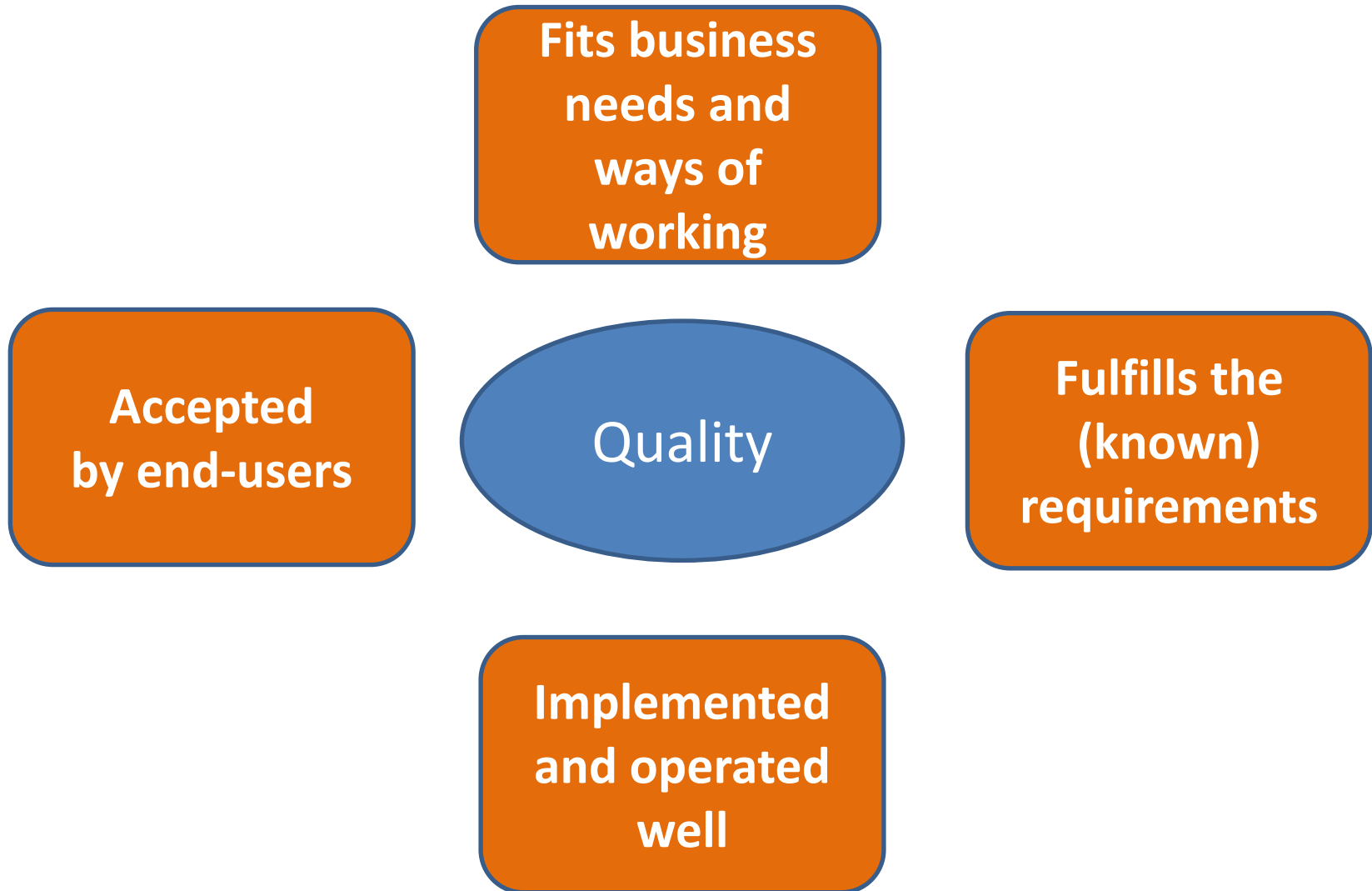
CIO

Maintenance and
operation costs.
User support.
Business complaints.

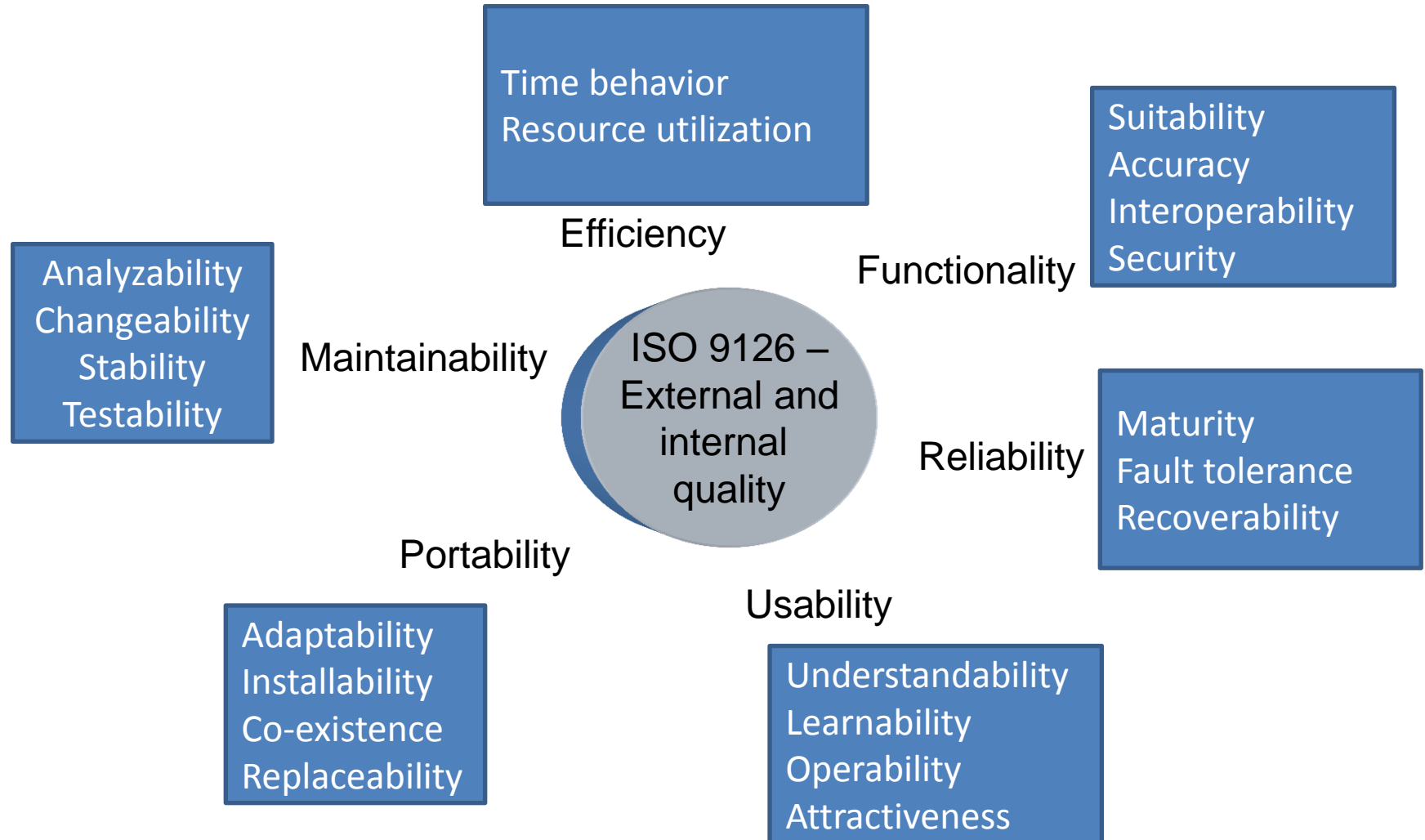
Project manager

Schedule is met
Budget is met

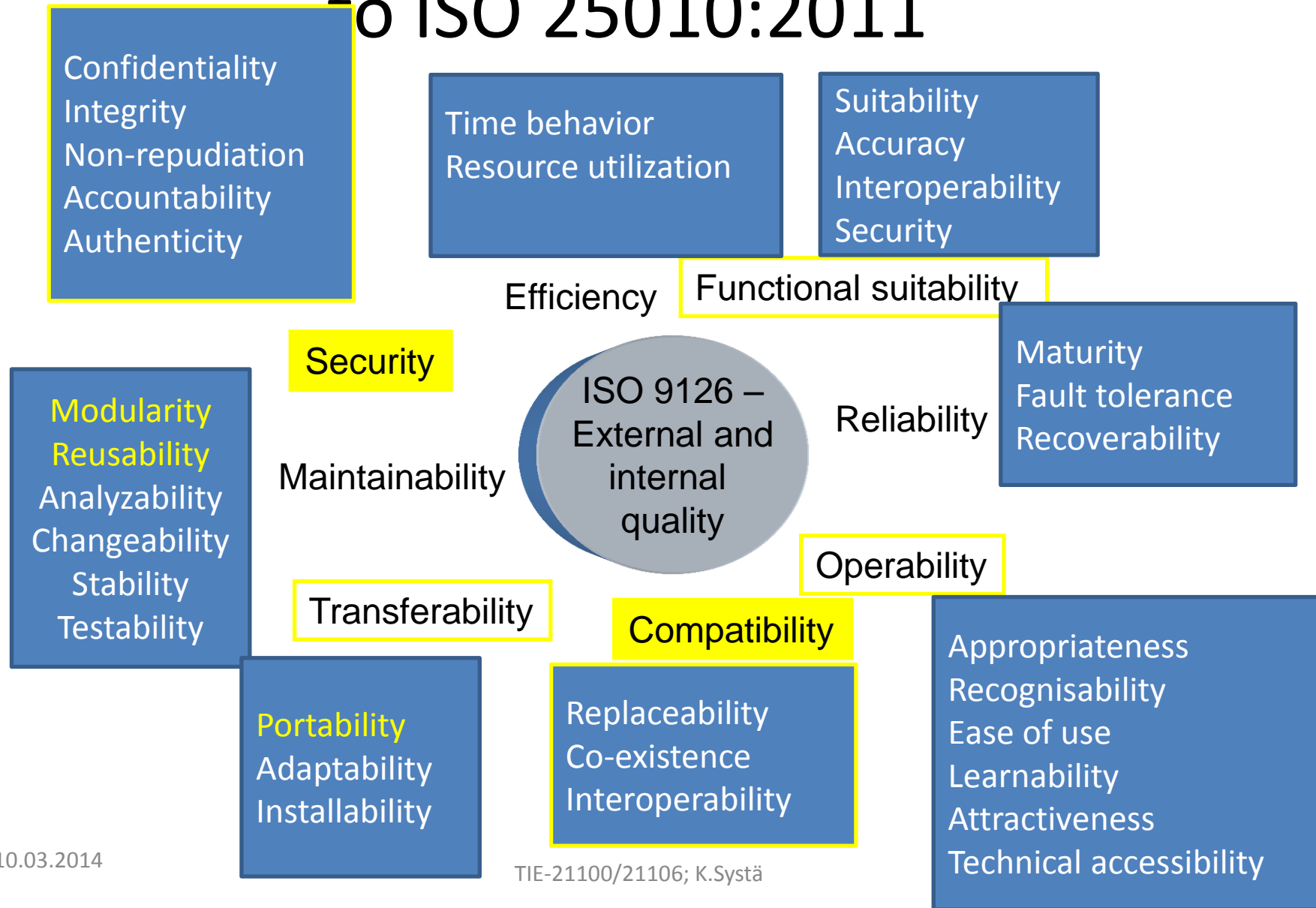
Quality is about value



Software Quality attributes according to ISO 9126 (old standard)

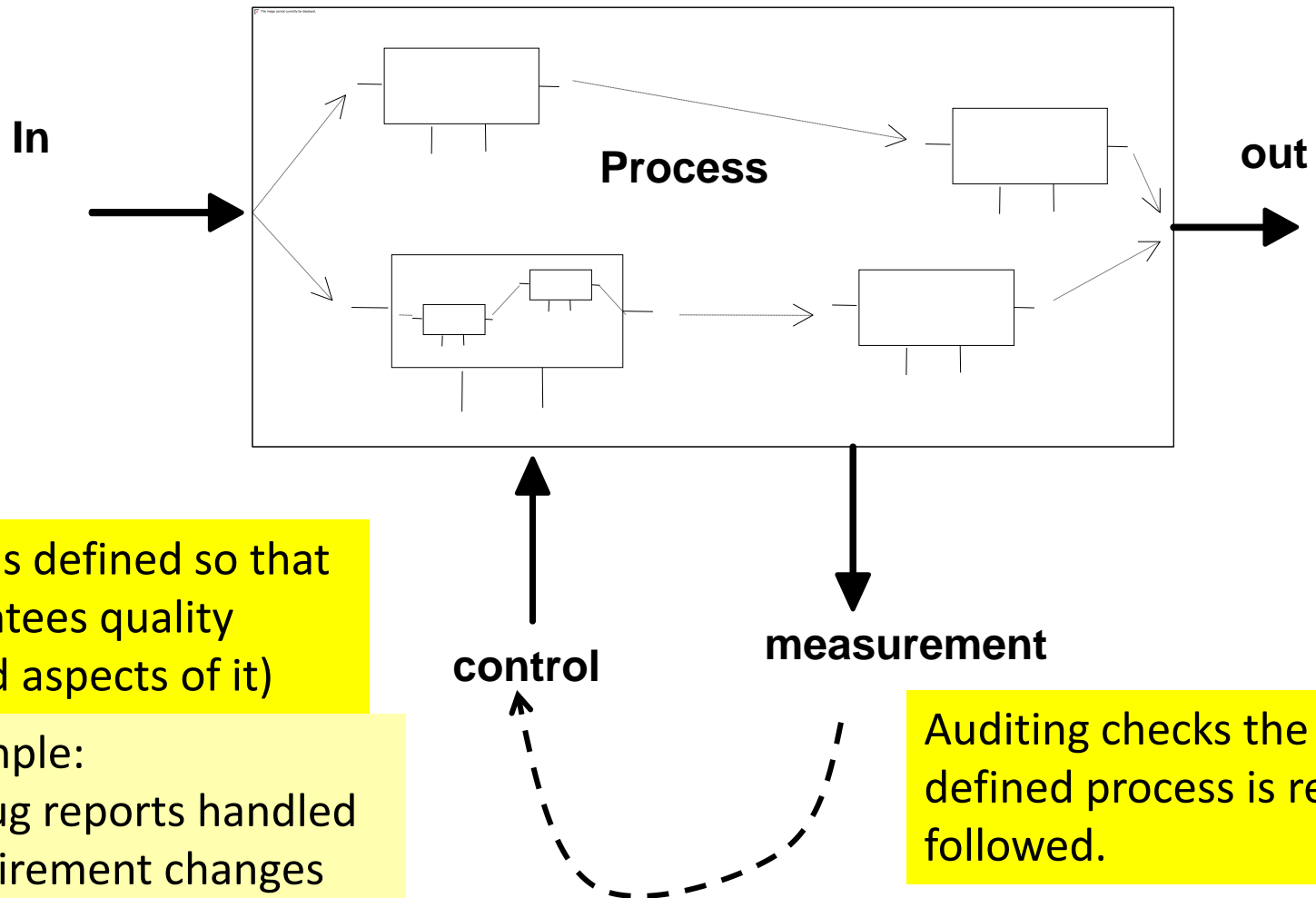


Software Quality attributes according to ISO 25010:2011

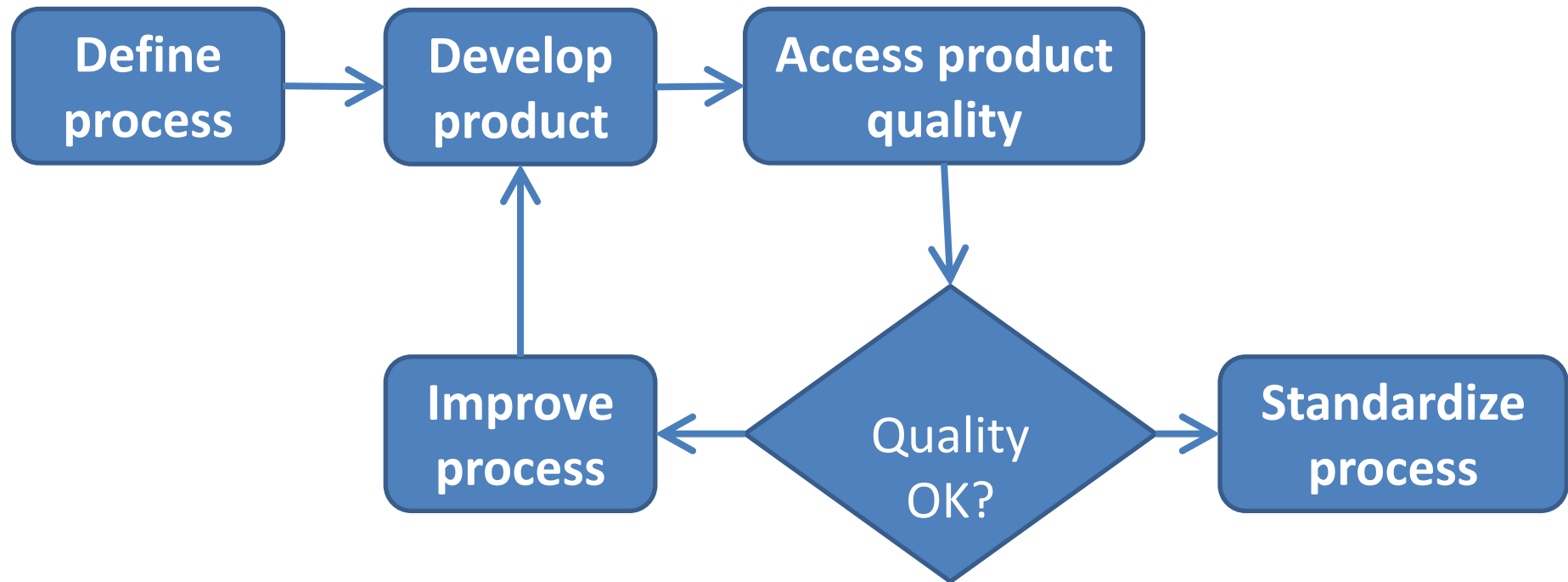


QUALITY MANAGEMENT SYSTEMS

Process view to SW development



Process-based quality improvement (figure 24.3 in Sommerville)



Question:

Why the focus is on process and not in product (SW)?

Quality management systems (Laatujärjestelmät)

- Documented description of the development process
- Aim is to provide predictable and sustainable quality
- Customer may be interested in this
- Can be audited by a neutral body

ISO9000 Standards

- Standard used to develop quality management systems
- Targets to all industries – including software
- Revisions
 - 1987: had the same structure as the UK Standard BS 5750 and influence from US Military standards
 - 1994: emphasized quality assurance via preventive actions, instead of just checking final product
 - 2000: placed the concept of [process management](#) front and center ("Process management" was the monitoring and optimisation of a company's tasks and activities, instead of just inspection of the final product)
 - 2010: introduced clarifications to the existing requirements of ISO 9001:2000
 - Forthcoming 2015 version
(http://www.iso.org/iso/home/news_index/news_archive/news.htm?refid=Ref1633)

Series of standards

- ISO 9001:2008 - sets out the requirements of a quality management system
- ISO 9000:2005 - covers the basic concepts and language
- ISO 9004:2009 - focuses on how to make a quality management system more efficient and effective
- ISO 9011:2011 - sets out guidance on internal and external audits of quality management systems.

Principles behind ISO9000 series

(http://www.iso.org/iso/qmp_2012.pdf)

- Principle 1 – Customer focus
- Principle 2 – Leadership
- Principle 3 – Involvement of people
- Principle 4 – Process approach
- Principle 5 – System approach to management
- Principle 6 – Continual improvement
- Principle 7 – Factual approach to decision making
- Principle 8 – Mutually beneficial supplier

An example from [http qmp_2012.pdf](http://qmp_2012.pdf) (process approach)

Key benefits

- Lower costs and shorter cycle times
- through effective use of resources
- Improved, consistent and predictable results
- Focused and prioritized improvement opportunities.

Means:

- Systematically defining the activities necessary to obtain a desired result
- Establishing clear responsibility and accountability for managing key activities
- Analysing and measuring of the capability of key activities
- Identifying the interfaces of key activities within and between the functions of the organization
- Focusing on the factors – such as resources, methods, and materials – that will improve key activities of the organization
- Evaluating risks, consequences and impacts of activities on customers, suppliers and other interested parties.

ISO 9001 core processes

Product delivery

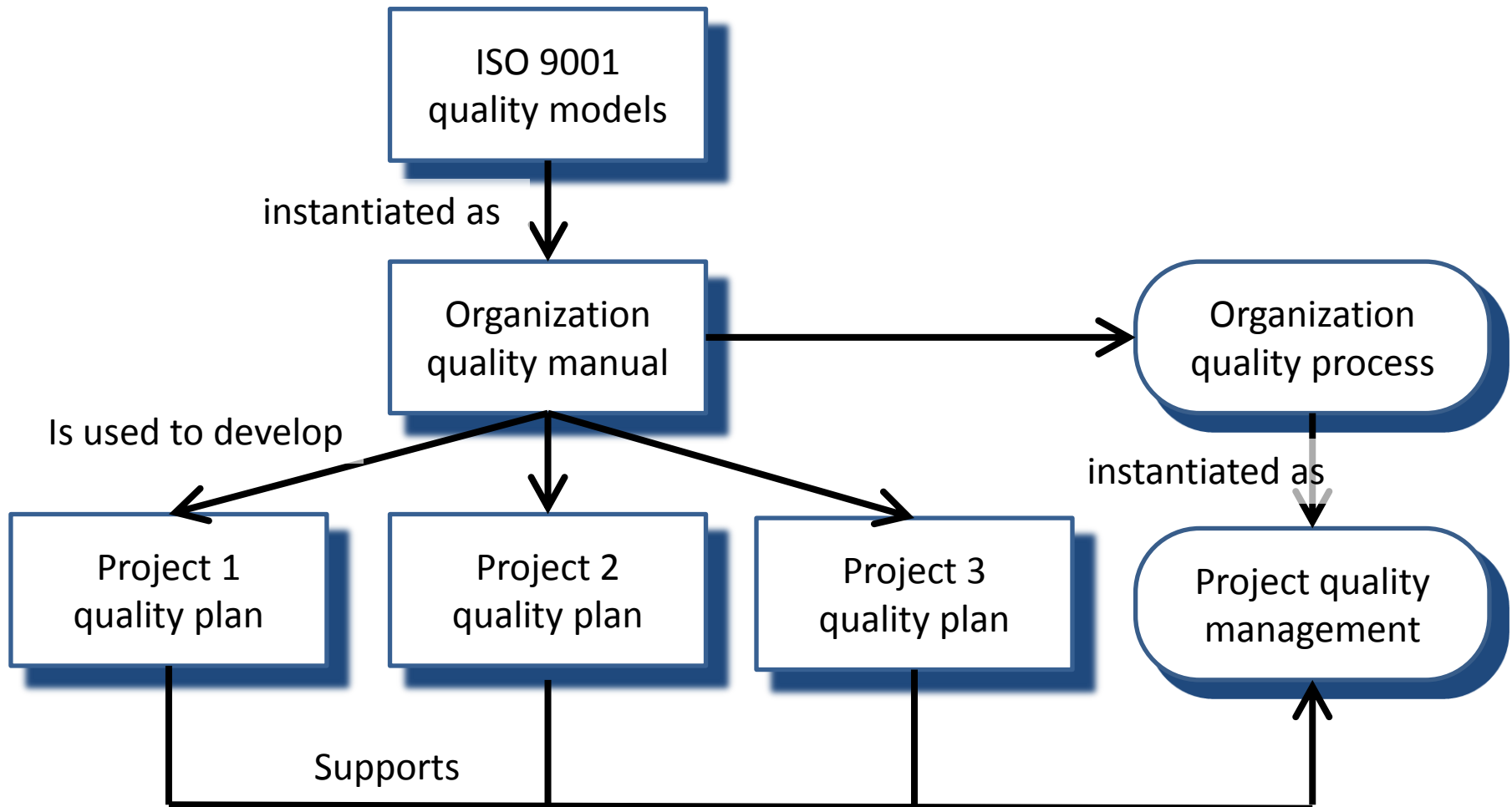
- Business acquisition
- Design and development
- Test
- Production and Delivery
- Service and Support

Supporting processes

- Business management
- Supplier management
- Inventory management
- Configuration management

ISO9001 and quality management

(figure 24.5 in Sommerville)



Auditing and certification

An organization must perform internal audits to check how its quality management system is working. An organization may decide to invite an independent **certification** body to verify that it is in conformity to the standard, but there is no requirement for this. Alternatively, it might invite its clients to audit the quality system for themselves.

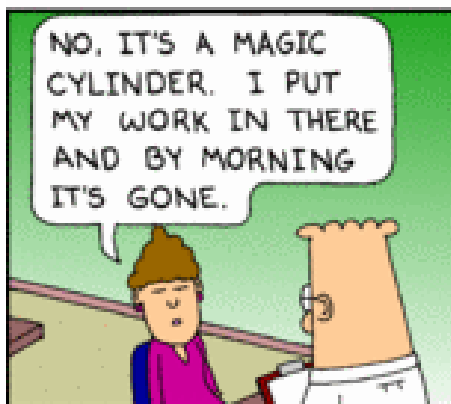
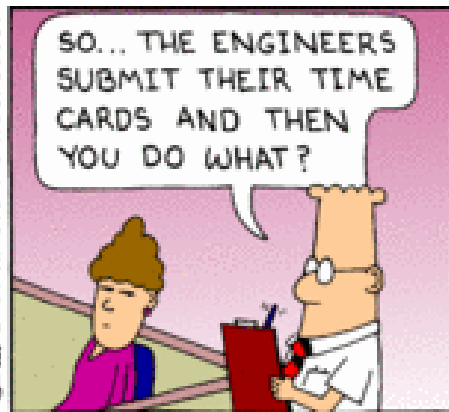
Certification is not requirement, but certification may:

- be a contractual or regulatory requirement
- be necessary to meet customer preferences
- fall within the context of a risk management programme, and
- help motivate staff by setting a clear goal for the development of its management system.

Certification – the provision by an independent body of written assurance (a certificate) that the product, service or system in question meets specific requirements.

Accreditation – the formal recognition by an independent body, generally known as an accreditation body, that a certification body is capable of carrying out certification.

Some Dilbert humor



And more



CMMI

<http://cmmiinstitute.com/>

- A framework developed by Software Engineering Institute (SEI) of Carnegie-Mellon University (CMU)
- CMMI (or Capability Maturity Model Integration) is a proven approach to performance management with decades of results showing it works.
- Organizations using CMMI have predictable cost, schedule, and quality—business results that serve as discriminators among their competitors.
- CMMI is built with practices and goals seen in thousands of real organizations worldwide. Use these practices and goals to evaluate your own performance and decide what to improve for your own business reasons.

CMMI and ISO9000-series

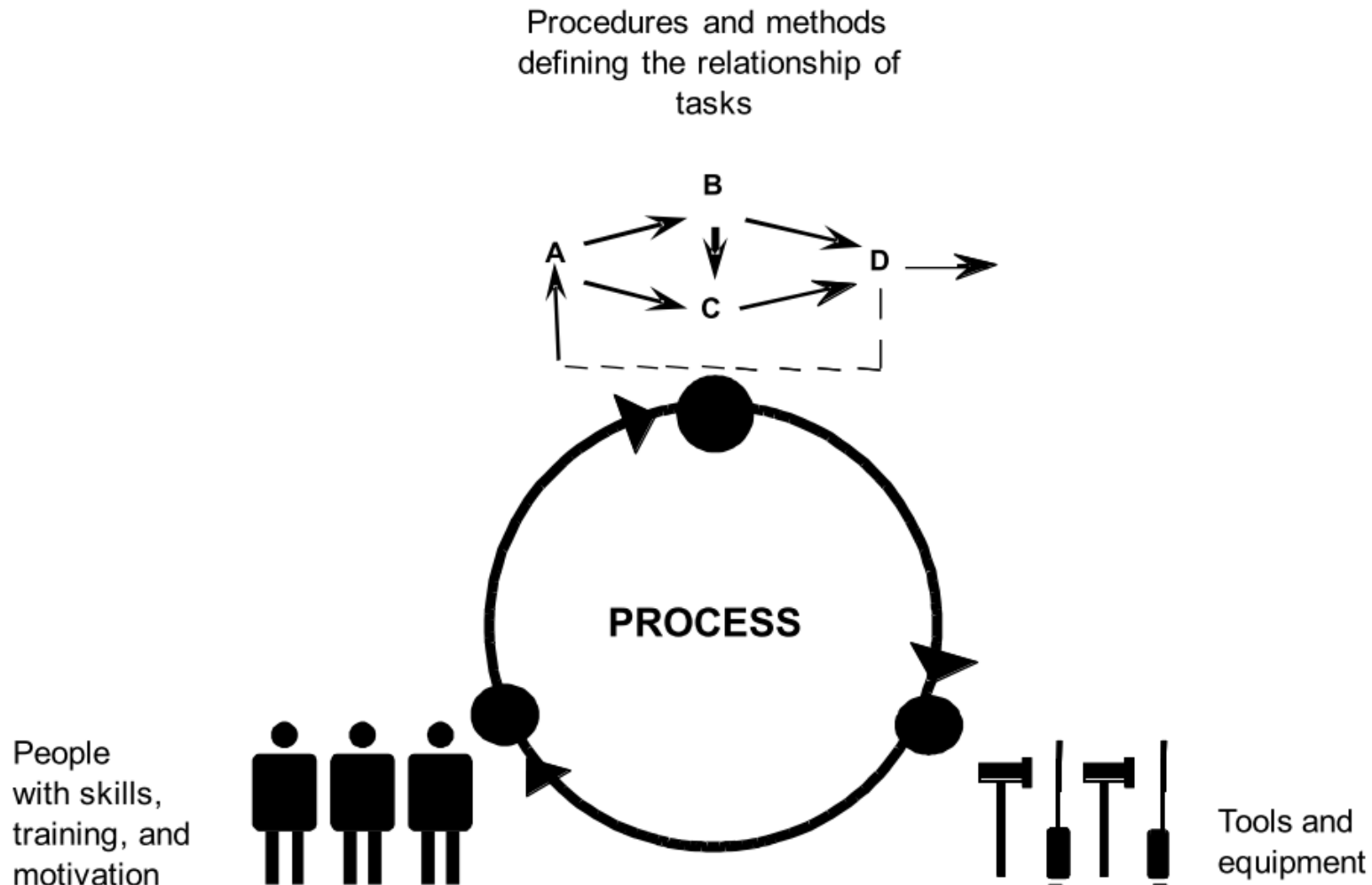
- CMMI is a set of best practices
ISO9000 set of standards
- CMMI is about software
ISO9000 is for all industries

CMMI

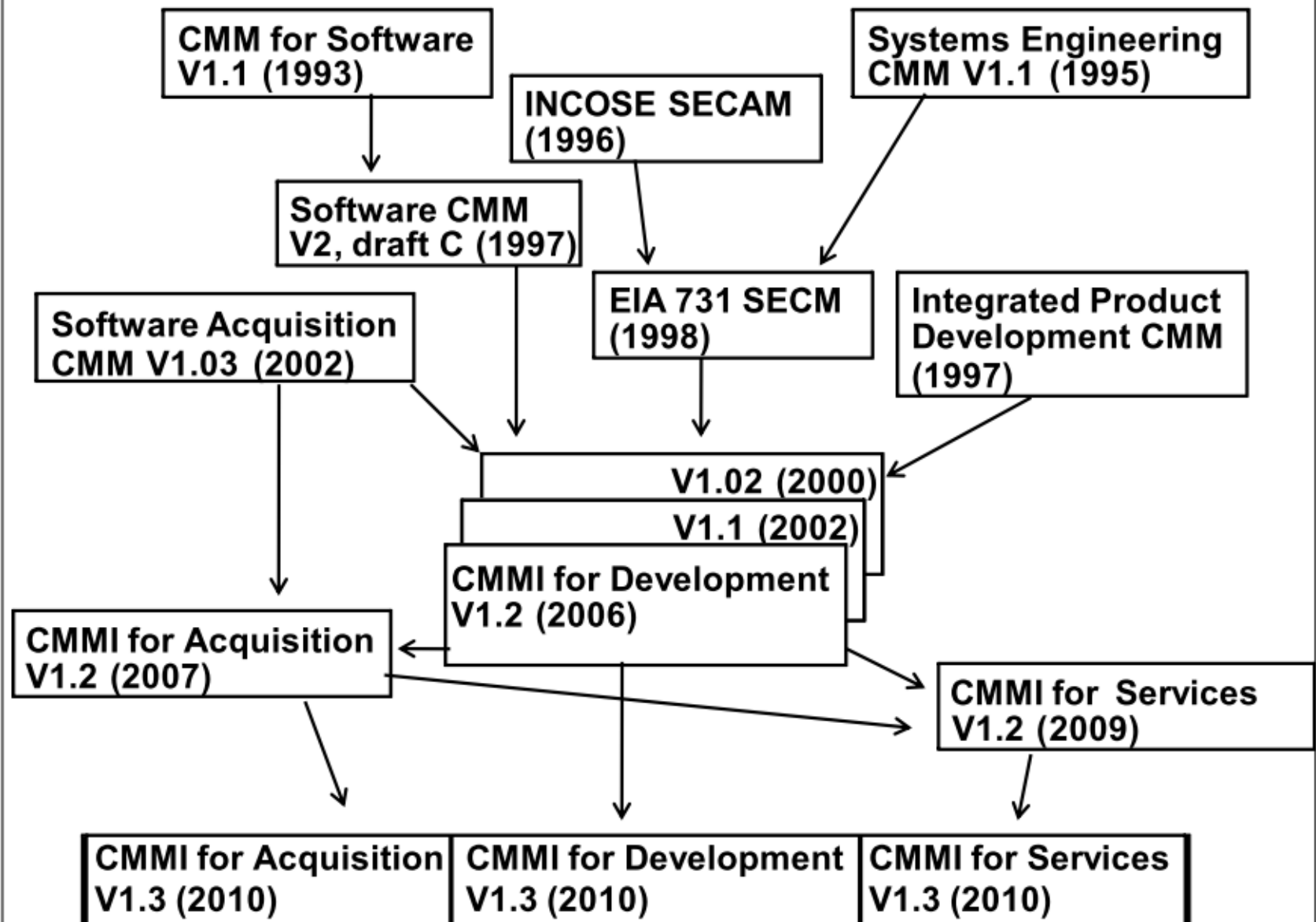
- Sources
 - Haikala&Mikkonen:
 - <http://www.sei.cmu.edu/reports/10tr033.pdf> (chapter 1)
- Old version CMM (1987-1997) listed 5 maturity levels
 1. Initial
 2. Repeatable process
 3. Defined process
 4. Quantitatively Manged Process
 5. Optimizing Process
- New version is called CMMI defines two models for process impovement
 - Staged
 - Continuous

Software Process improvement

(<http://www.sei.cmu.edu/reports/10tr033.pdf>)



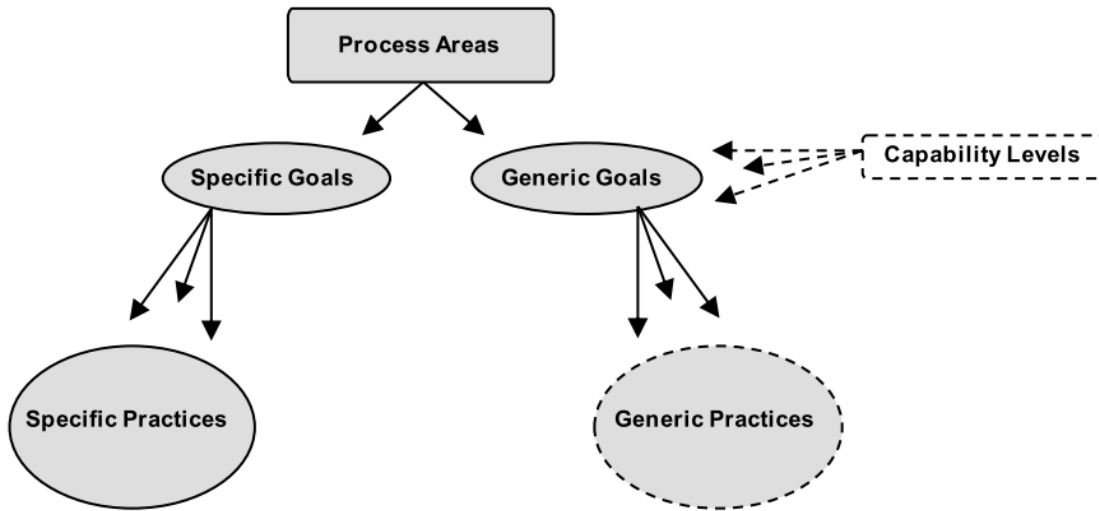
History of CMMs



Basic concepts of CMMI

- **Capability levels** apply to an organization's process improvement achievement in individual process areas. These levels are a means for incrementally improving the processes corresponding to a given process area.
 - Continuous representation
- **Maturity levels** apply to an organization's process improvement achievement across multiple process areas. These levels are a means of improving the processes corresponding to a given set of process areas.
 - For staged representation

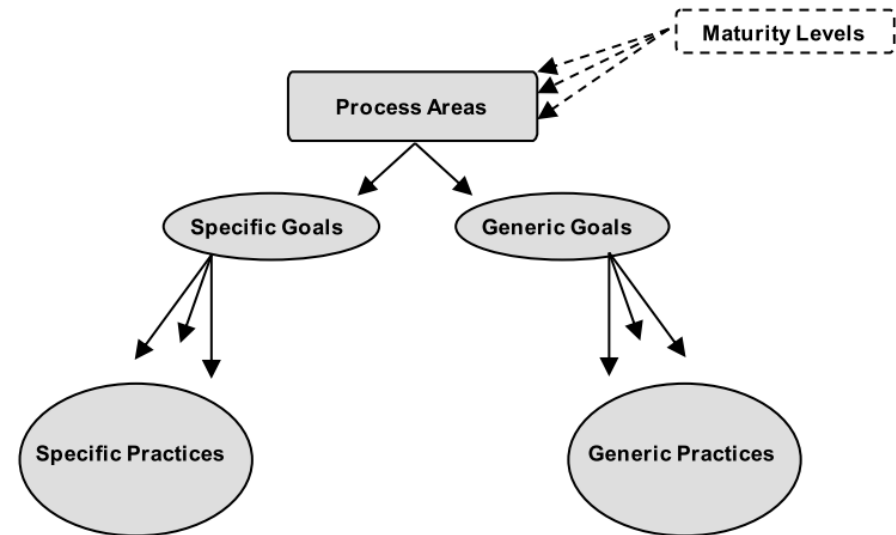
Continuous Representation



Capability levels apply to an organization's process improvement achievement in individual process areas. These levels are a means for incrementally improving the processes corresponding to a given process area.

Continuous representation focuses on process area capability as measured by capability levels and the **staged representation** focuses on overall maturity as measured by maturity levels.

Staged Representation



Maturity levels apply to an organization's process improvement achievement across multiple process areas. These levels are a means of improving the processes corresponding to a given set of process areas

Capability and Maturity Models

| Level | Continuous Representation Capability Levels | Staged representation Maturity Levels |
|-------|--|--|
| 0 | Incompetete | |
| 1 | Performed | Initial |
| 2 | Managed | Managed |
| 3 | Defined | Defined |
| 4 | | Quantitatively Managed |
| 5 | | Optimizing |

What are the capability levels

Capability Level 0: Incomplete

An incomplete process is a process that either is not performed or is partially performed. One or more of the specific goals of the process area are not satisfied and no generic goals exist for this level since there is no reason to institutionalize a partially performed process.

Capability Level 1: Performed

A capability level 1 process is characterized as a performed process. A performed process is a process that accomplishes the needed work to produce work products; the specific goals of the process area are satisfied.

Although capability level 1 results in important improvements, those improvements can be lost over time if they are not institutionalized. The application of institutionalization (the CMMI generic practices at capability levels 2 and 3) helps to ensure that improvements are maintained.

Capability Level 2: Managed

A capability level 2 process is characterized as a managed process. A managed process is a performed process that is planned and executed in accordance with policy; employs skilled people having adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description.

The process discipline reflected by capability level 2 helps to ensure that existing practices are retained during times of stress.

Capability Level 3: Defined

A capability level 3 process is characterized as a defined process. A defined process is a managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has a maintained process description; and contributes process related experiences to the organizational process assets.

A critical distinction between levels 2 and 3 is the scope of standards, process descriptions, and procedures. At level 2, the standards, process descriptions, and procedures can be quite different in each specific instance of the process (e.g., on a particular project). At level 3, the standards etc are tailored from the organization's set of standard processes to suit a particular project or organizational unit and therefore are more consistent,

Maturity levels

Maturity Level 1: Initial

At maturity level 1, processes are usually ad hoc and chaotic. The organization usually does not provide a stable environment to support processes. Success in these organizations depends on the competence and heroics of the people in the organization and not on the use of proven processes. In spite of this chaos, maturity level 1 organizations often produce products and services that work, but they frequently exceed the budget and schedule documented in their plans.

Maturity level 1 organizations are characterized by a tendency to overcommit, abandon their processes in a time of crisis, and be unable to repeat their successes.

Maturity Level 2: Managed

At maturity level 2, the projects have ensured that processes are planned and executed in accordance with policy; the projects employ skilled people who have adequate resources to produce controlled outputs; involve relevant stakeholders; are monitored, controlled, and reviewed; and are evaluated for adherence to their process descriptions. The process discipline reflected by maturity level 2 helps to ensure that existing practices are retained during times of stress. When these practices are in place, projects are performed and managed according to their documented plans.

Also at maturity level 2, the status of the work products are visible to management at defined points (e.g., at major milestones, at the completion of major tasks). Commitments are established among relevant stakeholders and are revised as needed. Work products are appropriately controlled. The work products and services satisfy their specified process descriptions, standards, and procedures.

Maturity Level 3: Defined

At maturity level 3, processes are well characterized and understood, and are described in standards, procedures, tools, and methods. The organization's set of standard processes, which is the basis for maturity level 3, is established and improved over time. These standard processes are used to establish consistency across the organization. Projects establish their defined processes by tailoring the organization's set of standard processes according to tailoring guidelines. (See the definition of "organization's set of standard processes" in the glossary.)

A critical distinction between maturity levels 2 and 3 is the scope of ... (as capability level 3 in continuous representation)

Maturity Level 4: Quantitatively Managed

At maturity level 4, the organization and projects establish quantitative objectives for quality and process performance and use them as criteria in managing projects. Quantitative objectives are based on the needs of the customer, end users, organization, and process implementers. Quality and process performance is understood in statistical terms and is managed throughout the life of projects.

For selected subprocesses, specific measures of process performance are collected and statistically analyzed. When selecting subprocesses for analyses, it is critical to understand the relationships between different subprocesses and their impact on achieving the objectives for quality and process performance.

Maturity Level 5: Optimizing

At maturity level 5, an organization continually improves its processes based on a quantitative understanding of its business objectives and performance needs. The organization uses a quantitative approach to understand the variation inherent in the process and the causes of process outcomes.

Maturity level 5 focuses on continually improving process performance through incremental and innovative process and technological improvements.

A critical distinction between maturity levels 4 and 5 is the focus on managing and improving organizational performance. At maturity level 4, the organization and projects focus on understanding and controlling performance at the subprocess level and using the results to manage projects. At maturity level 5, the organization is concerned with overall organizational performance using data collected from multiple projects.

SPICE (ISO 15504)

- E.g. http://en.wikipedia.org/wiki/ISO/IEC_15504
- ISO/IEC 15504 is the reference model for the maturity models (consisting of capability levels which in turn consist of the process attributes and further consist of generic practices) against which the assessors can place the evidence that they collect during their assessment, so that the assessors can give an overall determination of the organization's capabilities for delivering products (software, systems, and IT services)
- Very similar to Continuous Representation of CMMI (when considered in detailed level discussed in this course)

What does this matter

- These SPI approached are not very popular at the moment,
 - But used in some companies
- Young software engineers do not need to be experts, but MSc in Software Engineering must have some idea what they are

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Material

Sommerville Chapter 26

Haikala&Mikkonen Chapter 11

- Quality Management Principles:
http://www.iso.org/iso/qmp_2012.pdf
- ISO 9000 standard family:
http://www.iso.org/iso/iso_9000
- CMMI: <http://cmmi.institute.com/>
<http://www.sei.cmu.edu/reports/10tr033.pdf>