INF5180: Software Product- and Process Improvement in Systems Development

Part 09:

Process Assessment

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Spring 2010

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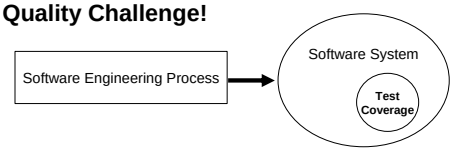
- CMM(I) History and Overview
- Structure
  - Specific and generic goals
  - Specific and generic practices
- Process Areas
- Evaluation
- Continuous Process Improvement
- Dissemination and Results

The Quality Challenge!



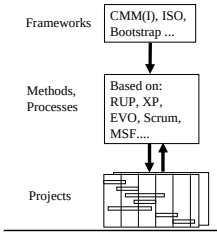
"The quality of a system is highly influenced by the quality of the process used to acquire, develop, and maintain it." (W.Humphrey)

The Software Business ...

- Problems with estimation
  - Budget overruns
  - Time overruns
- Problems with quality
  - Struggle with defect correction instead of avoidance
  - Struggle with unsatisfied customers
- No well-defined process
  - Starting "from scratch" in every project
  - Good practices are sacrificed under stress
- Critical aspects
  - Relying on "heroes"
  - Overtime
  - Fire-fighting

... and this is even more the case for system development

How to Sustain Good Practice?



Maturity/quality frameworks support
- evaluating improvement needs and achievements
- organizational change
- cultural change
- knowledge creation
- measurement

Much good practice is prescribed in explicit process models. But you should **choose right** and **adapt** to your needs

It is important to identify and learn about good practices from within the projects. Update the process model after each project!

Origins of CMM*

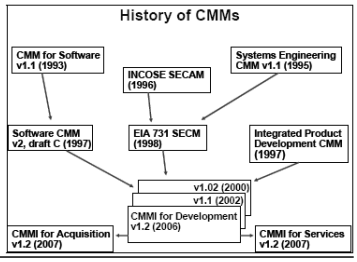
- DoD** decided in the 80s to do something about everything that went wrong in its expensive software projects (often involving suppliers).
  - Ada didn't solve the problems (as many had thought/hoped)
  - Appraisals showed that there was a management problem
- Watts Humphrey left IBM for SEI and began developing CMM in 1986
- *Managing the Software Process* by W. Humphrey published in 1989
- Version 1.1 published in 1993 – is still the most used model
- CMMI first published in 1999, version 1.2 published in 2006.

CMM = Capability Maturity Model
DoD** = Department of Defense

History

Source: CMMI® for Development, Version 1.2 (CMMI-DEV, V1.2), CMU/SEI-2006-TR-008, ESC-TR-2006-008, August 2006

http://www.sei.cmu.edu/cmmi/



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CMMI Family

- 4 different models (with very small differences)
  - **CMMI-SE/SW/IPPD/SS**
  - **CMMI-SE/SW/IPPD**
  - **CMMI-SE/SW**
  - **CMMI-SW**
  - All models have a continuous and staged representation.
- Definitions:
  - SS: Supplier Sourcing
  - IPPD: Integrated Product and Process Development
  - SE: Systems Engineering
  - SW: Software Engineering

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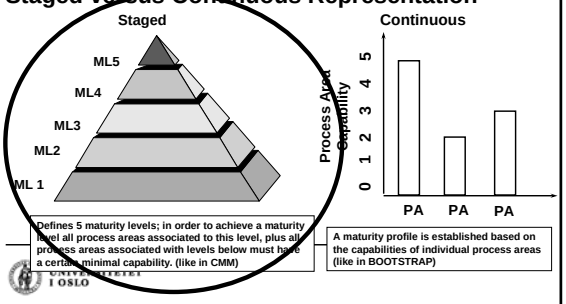
Staged versus Continuous Representation



Defines 5 maturity levels; in order to achieve a maturity level all process areas associated to this level, plus all process areas associated with levels below must have a certain minimal capability. (like in CMM)

A maturity profile is established based on the capabilities of individual process areas (like in BOOTSTRAP)

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Levels and Process Areas (staged)

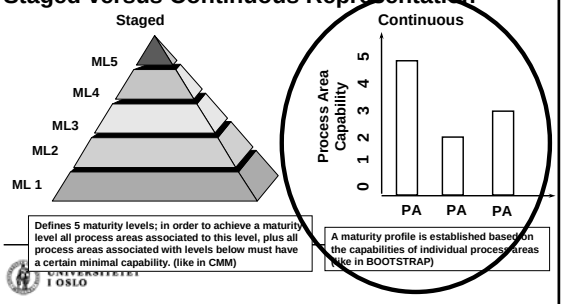
Level	Process Areas
5 Optimizing	Causal Analysis and Resolution Organizational Innovation and Deployment
4 Quantitatively Managed	Quantitative Project Management Organizational Process Performance
3 Defined	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Risk Management Integrated Project Management (for IPPD*) Integrated Teaming* Integrated Supplier Management** Decision Analysis and Resolution Organizational Environment for Integration*
2 Managed	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Performed	

* Integrated Product/Process Development (IPPD) – add-on to the Engineering processes
** Acquisition – add-on to the Engineering processes

CMMI Level 2 – *Managed* means …

- Adhering to organizational policies
- Following established plans and process descriptions
- Providing adequate resources (including funding, people, and tools)
- Assigning responsibility and authority for performing the process
- Training the people performing and supporting the process
- Placing designated work products under appropriate levels of configuration management
- Identifying and involving relevant stakeholders
- Monitoring and controlling the performance of the process against the plans for performing the process and taking corrective actions
- Objectively evaluating the process, its work products, and its services for adherence to the process descriptions, standards, and procedures, and addressing noncompliance
- Reviewing the activities, status, and results of the process with higher level management, and taking corrective action

Staged versus Continuous Representation



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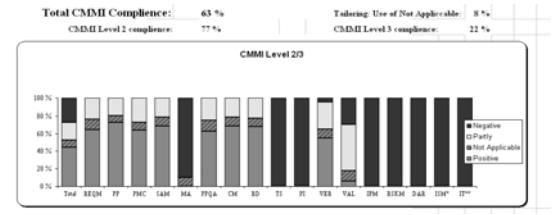
Assessment Results (continuous)



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Research Results at Simula

Headline:
That's why it goes so wrong

On average:
35% cost overrun
25% time overrun

50% of all projects are really bad

Reasons:
Underestimation of complexity and thus
of the risks associated with sw/system development


COMPUTERWORLD
20 år

Derfor går det så galt

Endelig er det vitenskapelig bevist: It-prosjekter blir i snitt 35 prosent dyrere og tar 25 prosent lenger tid enn planlagt. Prosjektene er nesten alltid langt mer komplekse enn antatt, hevder forskere ved Simula-senteret. – Halvparten av alle prosjekter går riktig galt. Som regel på grunn av en sterk undervurdering av risiko, sier professor Magne Jørgensen.

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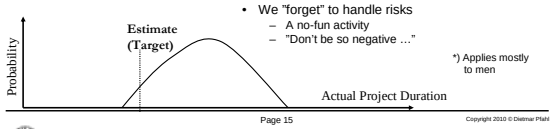
It is human to make mistakes …

Source:
Magne Jørgensen et.al. (2003)
"Better sure than safe?
Overconfidence in judgment based software development effort prediction intervals"

- Overestimating your own skills
  - "Everyone" is an above average driver…*
  - Study at Simula shows similar tendency for developers
- We estimate "internally"
  - Fail to look at the project from outside
    - Which experience was made with similar projects?
    - Have there been done at all similar projects before?
- We "forget" to handle risks
  - A no-fun activity
  - "Don't be so negative …"

*) Applies mostly to men



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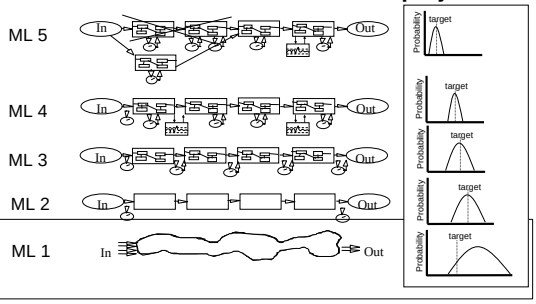
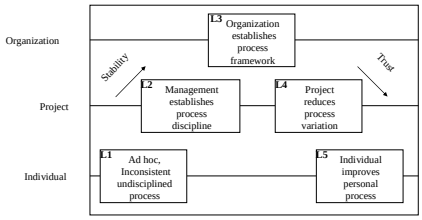
CMMI – How much we now about our projects?



Organizational Changes



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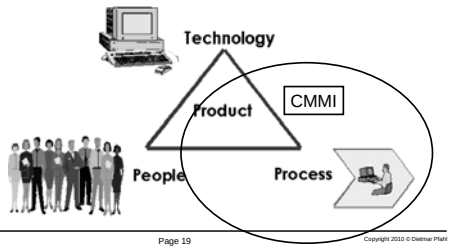
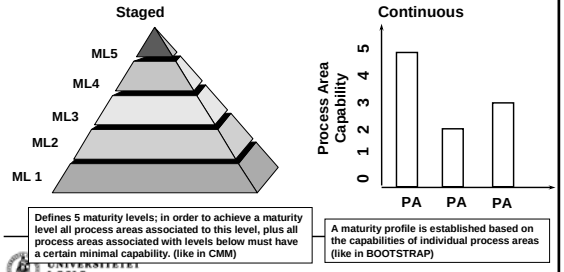
STRUCTURE

CMMI Scope



Staged or Continuous Representation?



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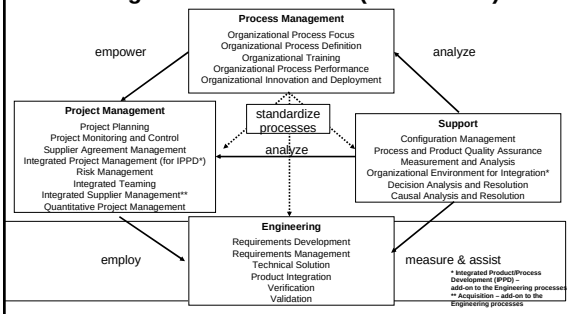
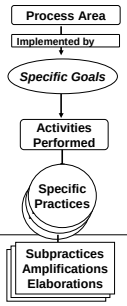
Structuring the Process Areas (continuous)



Implementing the Process Areas



Example: Requirement Management

The purpose of Requirements Management is to manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products.

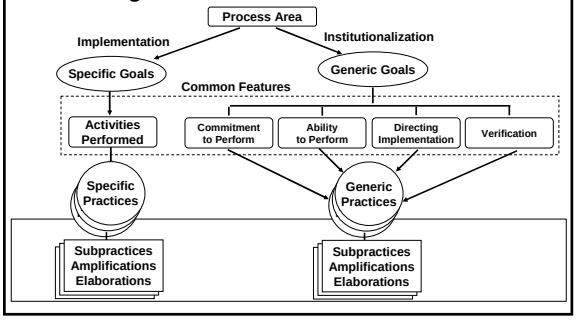
SG1: *Requirements are managed and inconsistencies with project plans and work products are identified.*

SP 1.1 Obtain an Understanding of Requirements

. . . .

1. Establish criteria for distinguishing appropriate requirements providers.
2. Establish objective criteria for the acceptance of requirements.

Structuring the Process Areas



Specific versus Generic

- Addresses one process area
- Describes activities used to **implement** the process area

- Addresses all process areas
- Describes activities that **institutionalize** the process area

Example: Requirements Mgmt.

SG 1 Manage Requirements
- SP 1.1 Obtain an Understanding of Requirements
- SP 1.2 Obtain Commitment to Requirements
- SP 1.3 Manage Requirements Changes
- SP 1.4 Maintain Bidirectional Traceability of Requirements
- SP 1.5 Identify Inconsistencies between Project Work and Requirements

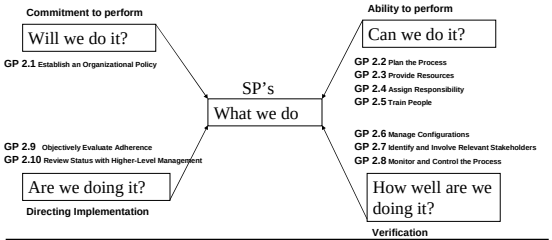
GG 1 Achieve Specific Goals
- GP 1.1 Perform Base Practices

GG 2 Institutionalize a Managed Process
- GP 2.1 Establish an Organizational Policy
- GP 2.2 Plan the Process
- GP 2.3 Provide Resources
- GP 2.4 Assign Responsibility
- GP 2.5 Train People
- GP 2.6 Manage Configurations
- GP 2.7 Identify and Involve Relevant Stakeholders
- GP 2.8 Monitor and Control the Process
- GP 2.9 Objectively Evaluate Adherence
- GP 2.10 Review Status with Higher Level Management

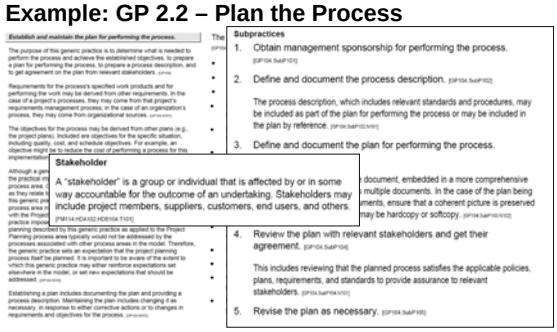
GG 3 Institutionalize a Defined Process
- GP 3.1 Establish a Defined Process
- GP 3.2 Collect Improvement Information

...

Basis for Institutionalization



Example: GP 2.2 – Plan the Process



Establish and maintain the plan for performing the process.

The purpose of this generic practice is to determine what is needed to perform the process and achieve the established objectives, to prepare a plan for performing the process, to prepare a process description, and to get agreement on the plan from relevant stakeholders.

Requirements for the process's specified work products and for performing the work may be derived from other requirements. In the case of a project's processes, they may come from that project's requirements management process. In the case of an organization's process, they may come from organizational sources.

The objectives for the process may be derived from other plans (e.g., the project plans). Included are objectives for the specific situation, including quality, cost, and schedule objectives. For example, an objective might be to reduce the cost of performing a process for this implementation.

Although a ge... the practice impro... process area... as they relate t... this generic pra... process area n... with the Project... practice improv... planning described by this generic practice as applied to the Project Planning process area typically would not be addressed by the processes associated with other process areas in the model. Therefore, the generic practice sets an expectation that the project planning process itself be planned. It is important to be aware of the extent to which this generic practice may either reinforce expectations set elsewhere in the model, or set new expectations that should be addressed.

Establishing a plan includes documenting the plan and providing a process description. Maintaining the plan includes changing it as necessary, in response to either corrective actions or to changes in requirements and objectives for the process.

Stakeholder

A "stakeholder" is a group or individual that is affected by or in some way accountable for the outcome of an undertaking. Stakeholders may include project members, suppliers, customers, end users, and others.

[FM14:HDA102:HDB104:T101]

Subpractices

1. Obtain management sponsorship for performing the process.
2. Define and document the process description.

   The process description, which includes relevant standards and procedures, may be included as part of the plan for performing the process or may be included in the plan by reference.
3. Define and document the plan for performing the process.

   ... document, embedded in a more comprehensive ... multiple documents. In the case of the plan being ... ments, ensure that a coherent picture is preserved ... may be hardcopy or softcopy.
4. Review the plan with relevant stakeholders and get their agreement.

   This includes reviewing that the planned process satisfies the applicable policies, plans, requirements, and standards to provide assurance to relevant stakeholders.
5. Revise the plan as necessary.

All Generic Goals

GG 1	Achieve Specific Goals [CL102:GL101]
	The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.
GG 2	Institutionalize a Managed Process [CL103:GL101]
	The process is institutionalized as a managed process.
GG 3	Institutionalize a Defined Process [CL104:GL101]
	The process is institutionalized as a defined process.
GG 4	Institutionalize a Quantitatively Managed Process [CL105:GL101]
	The process is institutionalized as a quantitatively managed process.
GG 5	Institutionalize an Optimizing Process [CL106:GL101]
	The process is institutionalized as an optimizing process.

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PROCESS AREAS

CMMI Level 2 – *Managed* means …

- Adhering to organizational policies
- Following established plans and process descriptions
- Providing adequate resources (including funding, people, and tools)
- Assigning responsibility and authority for performing the process
- Training the people performing and supporting the process
- Placing designated work products under appropriate levels of configuration management
- Identifying and involving relevant stakeholders
- Monitoring and controlling the performance of the process against the plans for performing the process and taking corrective actions
- Objectively evaluating the process, its work products, and its services for adherence to the process descriptions, standards, and procedures, and addressing noncompliance
- Reviewing the activities, status, and results of the process with higher level management, and taking corrective action

CMMI Level 2

Process Areas

- Requirements Management
- Project Planning
- Project Monitoring and Control
- Supplier Agreement Management
- Measurement and Analysis
- Process and Product Quality Assurance
- Configuration Management

Requirements Management – REQM

Purpose

The purpose of Requirements Management is to manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products.

SG 1 Manage Requirements
Requirements are managed and inconsistencies with project plans and work products are identified.

GG 2 Institutionalize a Managed Process
The process is institutionalized as a managed process.

Requirements Management – REQM

Practices by Goal:

SG 1 Manage Requirements

Requirements are managed and inconsistencies with project plans and work products are identified.

- **SP 1.1-1 Obtain an Understanding of Requirements**
  Develop an understanding with the requirements providers on the meaning of the requirements.
- **SP 1.2-2 Obtain Commitment to Requirements**
  Obtain commitment to the requirements from the project participants.
- **SP 1.3-1 Manage Requirements Changes**
  Manage changes to the requirements as they evolve during the project.
- **SP 1.4-2 Maintain Bidirectional Traceability of Requirements**
  Maintain bidirectional traceability among the requirements and the project plans and work products.
- **SP 1.5-1 Identify Inconsistencies between Project Work and Requirements**
  Identify inconsistencies between the project plans and work products and the requirements.

GG 1 Achieve Specific Goals

The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.

- **GP 2.5 Train People**
  Train the people performing or supporting the process as needed.
- **GP 2.6 Manage Configurations**
  Place designated work products of the process under appropriate levels of configuration management.
- **GP 2.7 Identify and Involve Relevant Stakeholders**
  Identify and involve the relevant stakeholders as planned.
- **GP 2.8 Monitor and Control the Process**
  Monitor and control the process against the plan for performing the process and take appropriate corrective action.
- **GP 2.9 Objectively Evaluate Adherence**
  Objectively evaluate adherence of the process against its process description, standards, and procedures, and address noncompliance.
- **GP 2.10 Review Status with Higher Level Management**
  Review the activities, status, and results of the process with higher level management and resolve issues.

Project Planning – PP

Purpose

The purpose of Project Planning is to establish and maintain plans that define project activities.

SG 1 Establish Estimates
Estimates of project planning parameters are established and maintained.

SG 2 Develop a Project Plan
A project plan is established and maintained as the basis for managing the project.

SG 3 Obtain Commitment to the Plan
Commitments to the project plan are established and maintained.

GG1 & 2

Project Monitoring and Control – PMC

Purpose

The purpose of Project Monitoring and Control is to provide understanding into the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.

SG 1 Monitor Project Against Plan
Actual performance and progress of the project is monitored against the project plan.

SG 2 Manage Corrective Action to Closure
Corrective actions are managed to closure when the project's performance or results deviate significantly from the plan.

GG1 & 2

Supplier Agreement Management – SAM

Purpose

The purpose of Supplier Agreement Management is to manage the acquisition of products and services from suppliers external to the project for which there exists a formal agreement.

SG 1 Establish Supplier Agreements
Agreements with the suppliers are established and maintained.

SG 2 Satisfy Supplier Agreements
Agreements with the suppliers are satisfied by both the project and the supplier.

GG1 & 2

Measurement and Analysis – MA

Purpose

The purpose of Measurement and Analysis is to develop and sustain a measurement capability that is used to support management information needs.

SG 1 Align Measurement and Analysis Activities
Measurement objectives and practices are aligned with identified information needs and objectives.

SG 2 Provide Measurement Results
Measurement results that address identified information needs and objectives are provided.

GG1 & 2

Process and Product Quality Assurance – PPQA

Purpose

The purpose of Process and Product Quality Assurance is to provide staff and management with objective insight into the processes and associated work products.

SG 1 Objectively Evaluate Processes and Work Products
Adherence of the performed process and associated work products and services to applicable process descriptions, standards and procedures is objectively evaluated.

SG 2 Provide Objective Insight
Noncompliance issues are objectively tracked and communicated, and resolution is ensured.

GG1 & 2

Configuration Management – CM

Purpose

The purpose of Configuration Management is to establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.

SG 1 Establish Baselines
Baselines of identified work products are established and maintained.

SG 2 Track and Control Changes
Changes to the work products under configuration management are tracked and controlled.

SG 3 Establish Integrity
Integrity of baselines is established and maintained.

GG1 & 2

CMMI Level 3 – *Defined* means …

- Establish a **standard development process** which is
  - **Well-defined** at the organizational level
  - **in use** on a broad scale
  - the basis for all learning and storing of experience (*best practices*)
  - the starting point for special adjustments (*tailoring*)
- The organization stresses the use of the process:
  - creates process groups ("SEPG")
  - provides experience mechanism ("de-briefing", project evaluation etc)
  - links experience data to the process
  - offers training about the process
  - and ties technical training into the process
  - clearly defines interfaces between groups

CMMI Level 3

Process Areas

- Requirements Development
- Technical Solution
- Product Integration
- Verification
- Validation
- Organizational Process Focus
- Organizational Process Definition
- Organizational Training
- Integrated Project Management
- Risk Management
- Decision Analysis and Resolution

Requirements Development – RD

Purpose

The purpose of Requirements Development is to produce and analyze customer, product, and product component requirements.

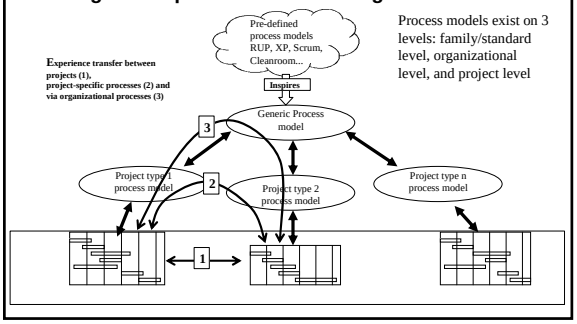
SG 1 Develop Customer Requirements
Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.

SG 2 Develop Product Requirements
Customer requirements are refined and elaborated to develop product and product component requirements for the product life cycle.

SG 3 Analyze and Validate Requirements
The requirements are analyzed and validated, and a definition of required functionality is developed.

GG1-3

Learning and Improvement in SW Organisations



Process models exist on 3 levels: family/standard level, organizational level, and project level

CMMI®

EVALUATION

CMMI Evaluation – How to do it?

Many models, forms and formalisms exist:

- Official *appraisal*: SCAMPI℠ (replaced CBA IPI* and SCE**)
- Company-specific assessments (e.g., Siemens Assessment)
- Light assessments
- Ultra-light assessments
- Self-assessment
- Interim-evaluation / Mini-assessment
- Based on open interviews
- Based on structured interviews
- Based on questionnaires

* CMM-Based Appraisal for Internal Process Improvement
** Software Capability Evaluation

http://www.kt-bits.com/appraisals.htm

CMMI Evaluation – Questionnaire Example

- **Related to Requirements Development**
- Note: This example refers to the SPICE model (cf. lecture Part 10), process ENG.2.2 - Analyze Software Requirements
- Similar questionnaires exist for CMMI (and other process assessment approaches)
- These questionnaires are NOT standardised

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SCAMPI[SM]

- **Standard CMMI Appraisal Method for Process Improvement**
  - Is a group of evaluation methods, both suitable to monitor progress on the way and for reliable benchmarking of organizations
  - Complies with ISO 15504

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The SCAMPI[SM] Family

Name:	Class A[1]	Class B[2]	Class C[3]
Type:	Benchmark	Mini-appraisal	Pulse Taking
Objectiveness:	High	Medium	Low
Evidence required:	Document Review Interviews Instrument	Document Review Interviews Instrument *(pick two)*	Document Review Interviews Instrument *(pick one)*
Rating:	Formal Rating	Not formal	Not formal
Responsible:	Lead Appraiser	Lead Appraiser *(preferred)*	Trained Leader
Team:	Appraisal Team *(large)*	Appraisal Team *(medium)*	Appraisal Team *(small)*

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1: Replaces CMM Based Appraisal for Internal Process Improvement (CBA IPI)
2: Replaces Mini-Assessment
3: Replaces Project Quick Look Assessment (PQLA)

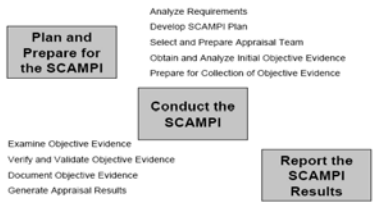
Appraisal Team Members (ATM) – Requirements

- Appraisal Team must
  - have a total of 25 years of field experience with an average of 6 years
  - have a total of 10 years of management experience and at least one ATM with at least 6 years experience as a manager
  - have experience in the life cycles in use by the organizational unit
    - At least two ATMs should have experience as practitioners
- ATMs should
  - not be managers of any of the selected projects
  - not be in the direct supervisory chain of any of the interviewees
  - have good written and oral communication skills
  - have the ability to facilitate the free flow of communication
  - have the ability to perform as team players and negotiate consensus
  - have participated (at least 50%) in a previous process appraisal
  - be perceived by the appraisal sponsor as credible

Practice Implementation Indicator Descriptions

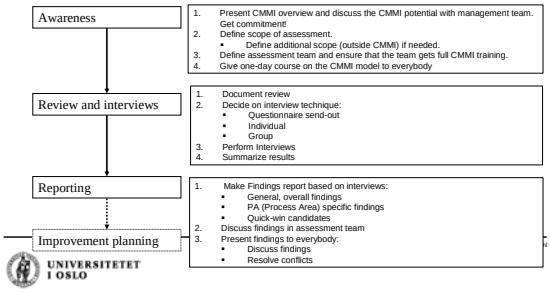
PIID Type	Description	Examples
Direct	Tangible output resulting directly from implementation of a practice	Typical work products
Indirect	Artifacts that are a side-effect or indicative of performing a practice	Typical work products, meeting minutes, reviews, logs, reports
Affirmation	Oral or written statements confirming or supporting implementation of the practice	Interviews, questionnaires, briefings, demonstrations

The SCAMPI Process



TeraQuest

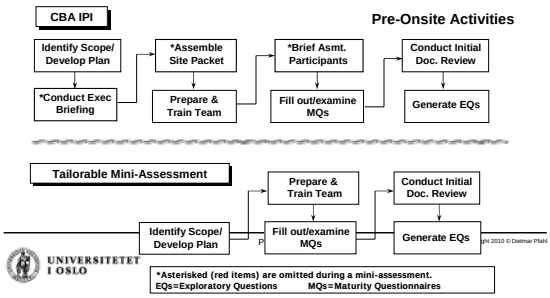
A Simple Assessment-Process



Mini-Assessment Method

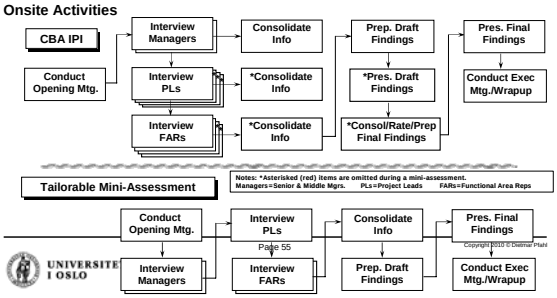
- An informal review of an organization's current software process based on:
  - A review of 3-4 key projects
    - responses to SEI's MQ (Maturity Questionnaire)
    - discussions with senior managers, project leaders, middle managers, and practitioners
    - document review
- Uses a tailored and streamlined version of the SEI's CBA IPI method
  - Cost and resource impacts reduced
    - less time, fewer participants, some sessions combined or deleted, less formality
  - No ratings
  - Focuses on global strengths and high priority issues
    - primarily weaknesses at the KPA level

CBA IPI & Mini-Assessment Comparison



CBA IPI & Mini-Assessment Comparison

Onsite Activities



Mini-Assessment Status Chart (optional)

SOFTWARE PROJECT PLANNING

	Commitment to Perform	Ability to Perform	Activities Performed				Measurement & Analysis	Verifying Implementation
			1	2	3	4		

Common Feature Definitions:

Commitment to Perform:	documented policy, senior management commitment demonstrated, responsibilities assigned
Ability to Perform:	adequate resources (tools, staff, $) to perform the practices, role/function in place, trained personnel
Activities Performed:	1. processes/template documented & used 2. estimates, commitments, & schedules generated/documented 3. project plans complete & documented, 4. risks (technical & program) identified
Measurement & Analysis:	process metrics collected & analyzed
Verifying Implementation:	process activities reviewed by senior management, middle management, & SQA

Compliance Legend:

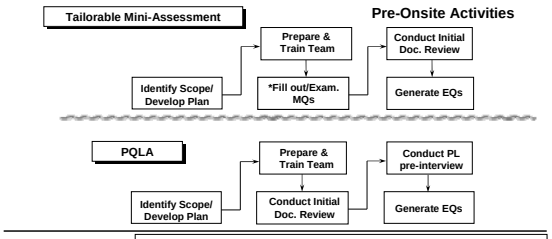
	Practices implemented and institutionalized (in place on all assessed projects)
	Some practices implemented. Or practices performed only some projects (inconsistent across the organization).
	Little or no evidence of practices in place (on the assessed projects).

Project Quick Look Assessment Method

- An informal review of a single project's current software process based on:
  - Discussions with Project Lead and practitioners
  - Document review
- Uses a tailored and streamlined version of the mini-assessment method
  - Cost and resource impacts greatly reduced
    - minimal time, fewer participants, some sessions combined or deleted, informal discussions and briefing
  - Reduced scope
    - single project only; no organizational practices evaluated
  - Interview questions more direct and interactive
  - No ratings
  - Focuses on high priority issues at the KPA level

PQLA approach developed and successfully used at General Dynamics

Mini-Assessment & PQLA Comparison



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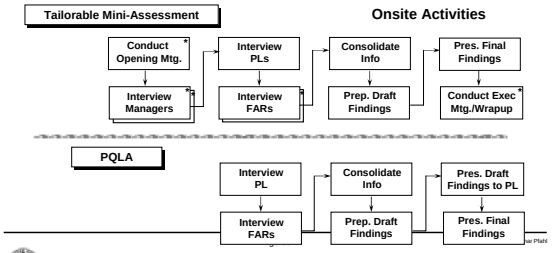
*Asterisked (red items) are omitted during a PQLA
EQs=Exploratory Questions MQs=Maturity Questionnaires PL=Project Lead

Mini-Assessment & PQLA Comparison



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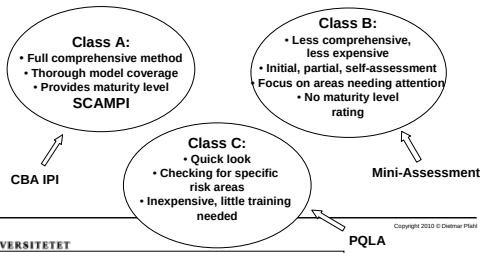
Notes: *Asterisked (red) items are omitted during a PQLA.
Managers=Senior & Middle Mgrs. PLs=Project Leads FARs=Functional Area Reps

CMMI[sm] Classes of Assessment Methods

Comparison with CMM Assessment Methods



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SCAMPI = Standard CMMI Assessment Method for Internal Process Improvement.
[sm] CMM Integration and CMMI are service marks of Carnegie Mellon University.

Assessment Method Comparisons

	CBA IPI	Mini-asmt.	PQLA
*Resources:			
- # team members	6-8	4-6	4
- team member time (plan, prep, conduct)	110-130 hrs.	48-60 hrs.	14-20 hrs.
- # participants	50-60	30-40	8-10
- participant time (prep, conduct)	4-8 hrs.	2-5 hrs.	1-3 hrs.
Team training (CMM and assessment method)	5 days	1.5-2 days	4-6 hrs.
Pre On-Site schedule (wall time)	2-3 months	3-4 weeks	1 week
On-Site schedule (consecutive days)	7-9 days	4-5 days	1.5-2 days
Formality (briefings, plans, reports, paperwork)	• Formal • Maximum doc. review	• Informal • Moderate doc. review	• Very informal • Minimal doc. review

*Resources are per person; Typical figures for an organization with size 100 SW staff, covering Levels 2 & 3. Total time includes planning, preparing, and conducting.

Assessment Method Comparisons (cont.)

	CBA IPI	Mini-assessment	PQLA
Outputs	• Findings briefing: · Global findings · KPA findings (strengths & weaknesses) · Maturity Level · KPA ratings • Final Report • Data/results to SEI	• Findings briefing: · Global findings · KPA findings (strengths & weaknesses) • Color chart (opt)	• Findings briefing: · Global findings · KPA weaknesses
Pros	• Very comprehensive / accurate • Supports detailed action plan	• Comprehensive • Reliable predictor of CBA IPI results • Less time, $, participants, tension	• Minimal time, $, participants • Participants more at ease; interactive
Cons	• Expensive • Time consuming • Schedule difficulties • Tension due to ratings	• Schedule difficulties	• Some weaknesses may be missed • Does not provide organizational view

Interim Evaluation – CMM-Mini

- A light weight evaluation for projects and line organization – developed by KDA
- Tool: a spreadsheet that lists all relevant KPAs with its practices
- All practices are given a score:
  - y – Yes
  - p – Partly
  - n – Not
  - na – Not Applicable
- Assumes that mapping to procedures and documents (PIIDs) has been done in advance.
- Project:
  - All KPAs and all practices which are relevant for the project (all in level 2 plus a selection in level 3)
  - Are implemented regularly (every or every other month)
  - Are based on 1 full review (< 8 hours), while the other is focused (< 2 hours)
- Line: A selection of KPAs on level 3 where the responsibility is centralized.

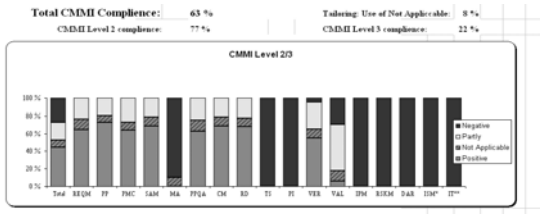
Example: Requirement Management

Requirements Management

Goals for the RM Key Process Area:
Goal 1: System requirements allocated to software are controlled to establish a baseline for software engineering and management use.
Goal 2: Software plans, products and activities are kept consistent with the system requirements allocated to software.

Key practices	Values		Assess the status in the "Values" column; y=yes, p=partly, n=no	How is it handled within the project?	Solutions provided from the line organization	Action required to achieve compliance?
1	y		The project follows a written organizational policy for managing the allocated system requirements.		*KDA Quality Manual, part I* *SE-process and INS 0234*	
20	y		For each project, responsibility is established for analysing the system requirements and allocating them to HW, SW, and other system components	*Responsibility (Role) defined and allocated to a person or group.*	*KDA Roles: the «manager» responsible for allocating requirements to SW, HW etc. SW architect responsible for writing the SRS*	
21	y		The allocated requirements are documented.	*Technical, Non-technical requirements and acceptance criteria are defined and documented*	*SE-process:* *User Requirement specification (URS), System Segment Specification (SSS), Interface requirement specification (IRS), Software Requirement Specification (SRS), Hardware development specification (HDS), Statement of Work (SOW)* *INS 0234*	
48	y		Adequate resources and funding are provided for managing the allocated requirements.	*An agreement written between the line and project for the allocated RM resources. Hours for RM planned, Budget planned for RM*	*A2DS tool: Rational Requisite Pro*	
49	y		Members of the engineering group and other related groups are trained to perform their requirements management activities.	*Training in RM activities both technical, application, methods and tools. Example Database training.*		
51	y		The engineering group reviews the allocated requirements before they are incorporated into the project.		*PRO-0047 Review Process. SRS checklist in PRO-0018, A2DS Requirements to project: Requirements handling.*	
50	y		The engineering group uses the allocated requirements as the basis for plans, work products, and activities.		*Project management process, Initial planning PRO-0015 Software Engineering Management, Plan the SW development uses SRSs as input to planning.* *A2DS Task descriptions?*	

CMM-Mini Results (project)



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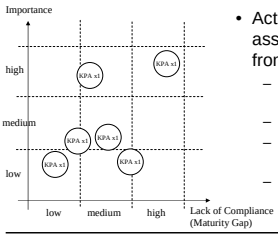
Assessment Follow-On Activities



- Action plan – generated by SEPG, assessment team, and key personnel from organization/projects
  - Address findings (how to address weaknesses)
  - Strategy for addressing additional KPAs
  - Detailed actions, responsibilities, budget, and schedule
  - Reviewed/approved by management

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and ...

CONTINUOUS PROCESS IMPROVEMENT

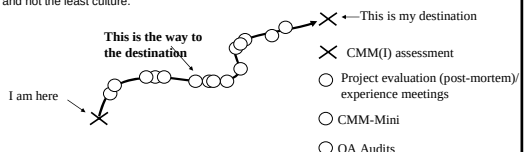
SEI Slogan

"The Capability Maturity Model for Software (CMM) is a framework that describes the elements of an effective software process.

The CMM describes an evolutionary path
from an ad hoc, chaotic process,
to a mature disciplined process"

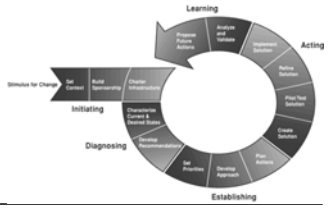
CMMI as a Roadmap

- It is not difficult to come up with a long list with good proposals for improvements.
- It is more difficult to prioritize the most important and to make a realistic progress plan.
- The most difficult of all is to manage the necessary changes in the organization – work pattern and not the least culture.



Process Improvement: IDEAL

The Process Improvement Process of SEI:



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CMM and QIP

- CMM is well suited to be used with Quality Improvement Paradigm on the organizational level

1. **Conduct a CMM-assessment. Combine the results with business goals and identified problems.**
2. **Use "Findings" from the assessment to define improvement goals**
3. Choose measures which are supposed to help achieve the objectives
4. Implement one or more projects with the new models, tools and methods. Collect data on the way
5. Collect lessons learnt from the projects
6. Update standard process model and experience database

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PROFES –

Product-Focused Process Improvement in Software Engineering

Phases and steps of the PROFES improvement methodology

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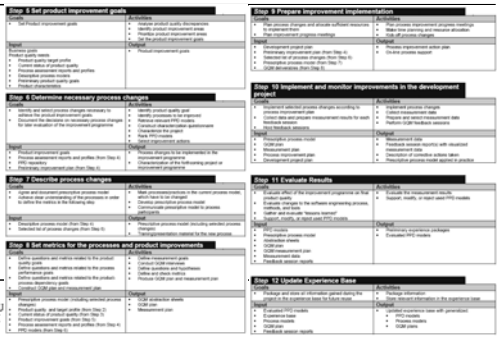


Different Process Improvement Approaches

- Most users of CMM(I) today use it internally as a improvement framework – i.e. they don't intend to use assessment results for marketing purpose.
- The most active CMM advocates (Mark Paulk and Bill Curtis) strongly warn against following the model blindly. *Use the model with common sense, coupled with understanding one's own needs and problem areas.*

Model-less SPI (e.g. GQM) — CMM(I) used as guideline (combined with GQM/QIP or similar) — "Hard-core CMM" (SCAMPI)

Use Common Sense...

- Mark Paulk, SEI:

Common Sense \ Process Discipline	Yes	No
Yes	Quality	Creative Chaos
No	Mindless Bureaucracy	Mindless Chaos

DISSEMINATION and RESULTS

Improvements According to SEI Data

Performance Results of CMMI®-Based Process Improvement

The quantitative performance results in Table 2 are from a total of 35 organizations, some of which are enterprises with more than one constituent organization. 30 of them have results that can be expressed as change over time. These results are expressed either as percentage change from an earlier baseline prior to the CMMI-based process improvement or as ratios of return on investment (ROI). The results are summarized by the six performance categories discussed in Section 2 of this document: cost, schedule, productivity, quality, customer satisfaction and return on investment. Most of the organizations have provided multiple results, sometimes several in the same performance category.

TECHNICAL REPORT
CMU/SEI-2006-TR-004
ESC-TR-2006-004

Table 2: CMMI Performance Results Summary

Performance Category	Median Improvement	Number of Data Points	Lowest Improvement	Highest Improvement
Cost	34%	29	3%	87%
Schedule	50%	22	2%	95%
Productivity	61%	20	11%	329%
Quality	48%	34	2%	132%
Customer Satisfaction	14%	7	-4%	55%
Return on Investment	4.0 : 1	22	1.7 : 1	27.7 : 1

Note: The performance results in this table express change over varying periods of time.

Motorola GSG China

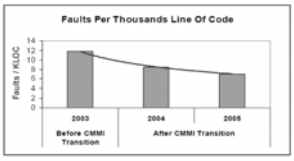
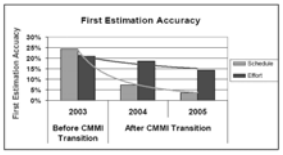


Figure 24: In Process Faults per Thousand Lines of Code



Raytheon Network Centric Systems

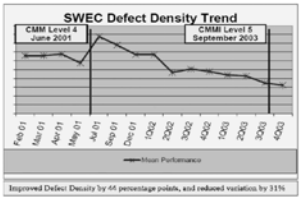


Figure 40: Defect Density

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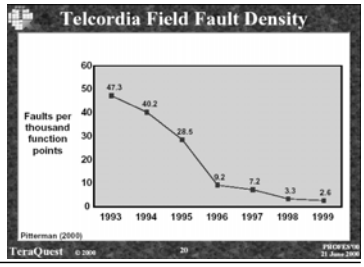
Telcordia (CMM)



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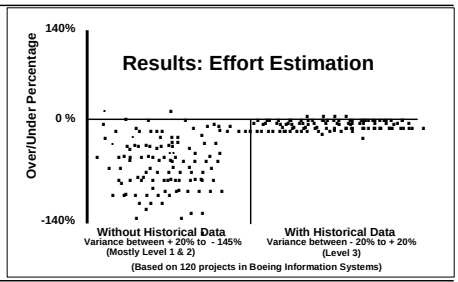
Boeing



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Reference: John D. Vu. "Software Process Improvement Journey:From Level 1 to Level 5." 7th SEPG Conference, San Jose, March 1997.

Status and Spread of CMMI

- **SCAMPI v1.1 Class A appraisals conducted since its April 2002 release and reported to the SEI by July 2004**
  - 367 **appraisals**
  - 333 **organizations**
  - 176 **participating companies**
  - 28 **reappraised organizations**
  - 1.368 **projects**
  - 46,2 % **Non-USA organizations**