Technische Universität
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software engineering dependability

Quality Management of Software and Systems:
Software Process Assessments

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Software Process Assessments

- Motivation
  - evaluation of providers: not the cheapest competitor is the best choice but the one with the best cost/performance ratio
- Required
  - procedure for the evaluation of the capability ➔ SEI-assessment
  - reference model as measurement standard for comparison ➔ Capability Maturity Model (CMM)
- Entered further application areas
  - proof of qualification ➔ marketing criterion
  - instrument for the targeted improvement of the SW-development process: target and priority determination
- Execution
  - evaluation with the aid of a questionnaire (assessment)

Temporal Development of the CMM and the Assessment Procedure

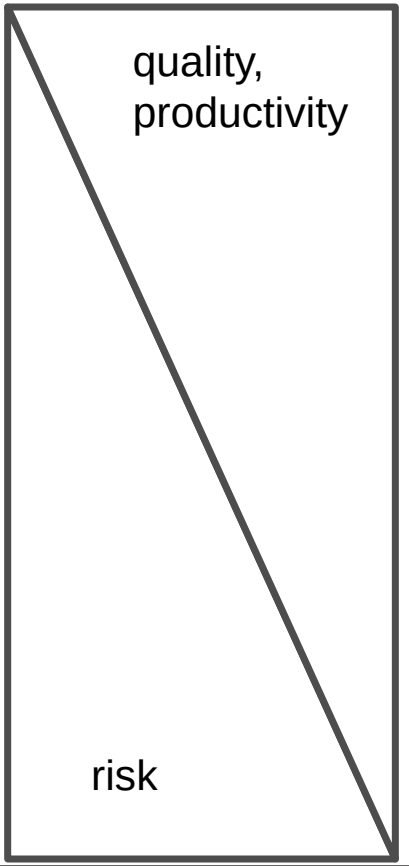
- 1987: first assessment questionnaire of Software Engineering Institute of the Carnegie Mellon University on behalf of the Department of Defense
- 1991: Capability Maturity Model (CMM), Version 1.0, published by SEI as reference model for evaluation procedures
- 1992: Assessment questionnaire as a result of the ESPRIT project BOOTSTRAP
- 1993: Capability Maturity Model, Version 1.1 published by SEI
- In the future: creation and establishment of a flexible standard which integrates existing assessment procedures (SEI, Bootstrap, STD, Healthcheck, Trillium, ...) and related approaches (ISO 9001, Malcolm Baldridge, ...): SPICE

Mature and Immature Processes

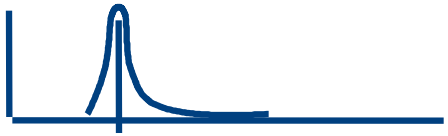
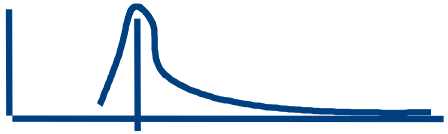
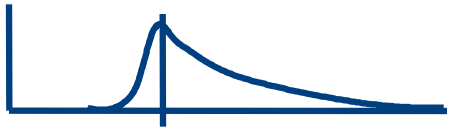
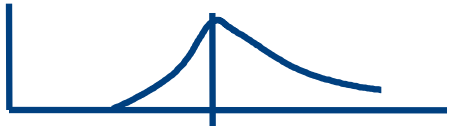
Low stage of maturity	High stage of maturity
Improvised process, not always realized	Appropriate, lived process
Reaction with problems	Avoidance of problems
Costs projections and schedules are normally not met	Better planning due to appropriate prognosis/projection methods
Functionality and quality reduction with time problems	Problems are prognosticated early and avoided
QS-activities are not executed when time problems occur	The process is enhanced continuously

Structure of the Capability Maturity Models
Five Levels of the CMM

Level	Process characteristics
5: Optimizing	The process improvement is an activity executed continuously
4: Managed	The product and the process are under quantitative control
3: Defined	The technical procedures are institutionalized together with the Project Management Practices
2: Repeatable	The Project Management Practices are institutionalized
1: Initial	Informal ad hoc process

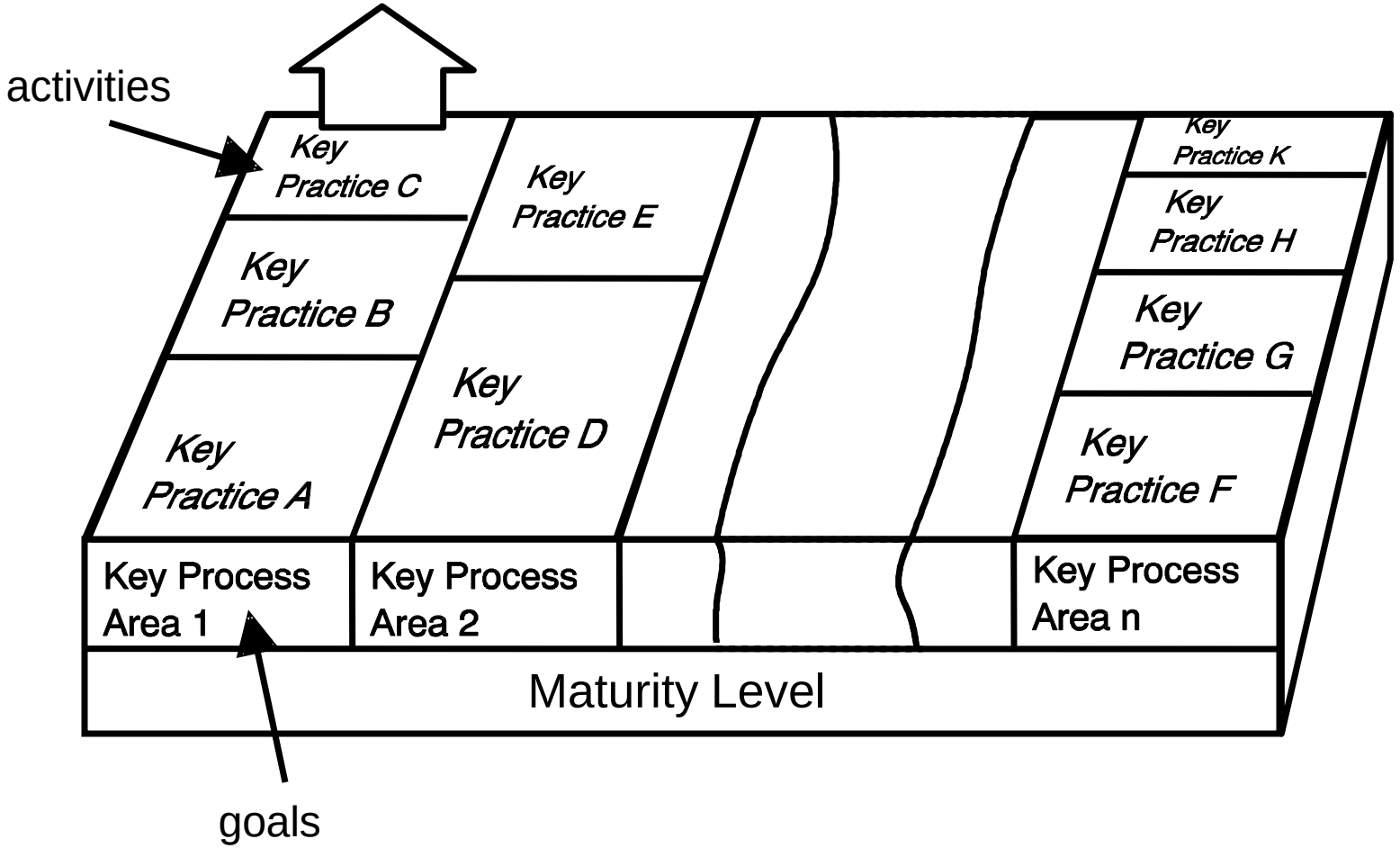


Structure of the Capability Maturity Models
Effects of the CMM Levels

Level	Prognosis quality	Technique/method	People
5: Optimizing		Techniques and process support each other	Problems are prevented, assistants improve actively
4: Managed		Quantitative basis for techniques exists	Comprehension of interrelations exists
3: Defined		Qualitative basis for techniques exists	Process is defined, assistants know and follow it
2: Repeatable		Techniques support some activities	Experienced assistants keep the process alive
1: Initial		Introduction of new techniques is risky	Regular chaos elimination, low efficiency

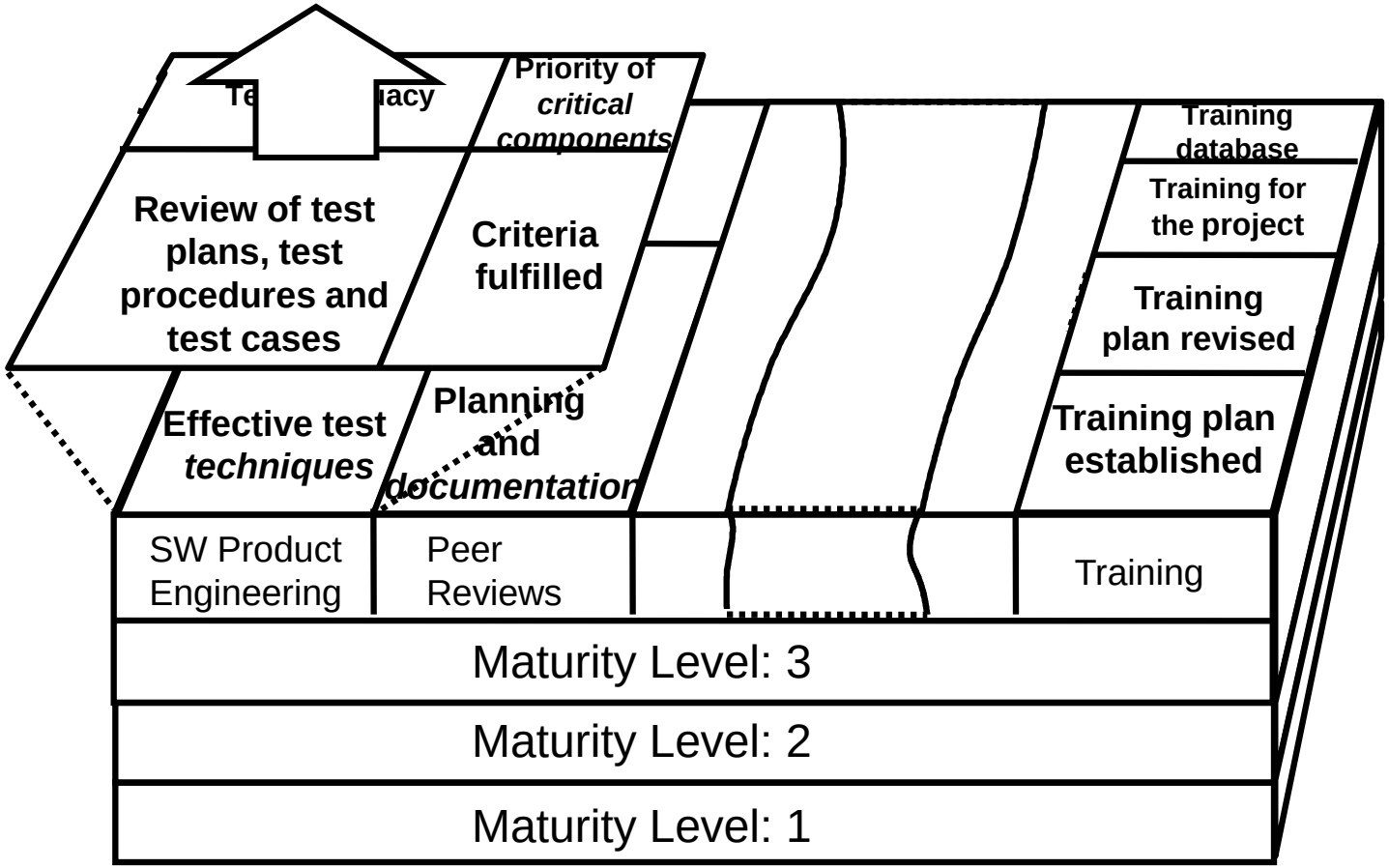
Structure of the Capability Maturity Models

- Key indicator C: Is tested in the form of a question!



The CMM and the Assessment Questions

- Are test cases submitted to formal reviews?



Key Process Areas of the CMM

5	Defect Prevention, Process Change Management, Technology Innovation
4	Process Measurement and Analysis, Quality Management
3	Process Focus, Process Definition, Training, Integrated SW Management, Product Engineering, Intergroup Coordination, Peer Reviews
2	Requirements Management, Quality Assurance, Project Tracking and Oversight, Project Planning, Subcontract Management, Configuration Management
1	None

Assessment as a Basis for Process Improvement

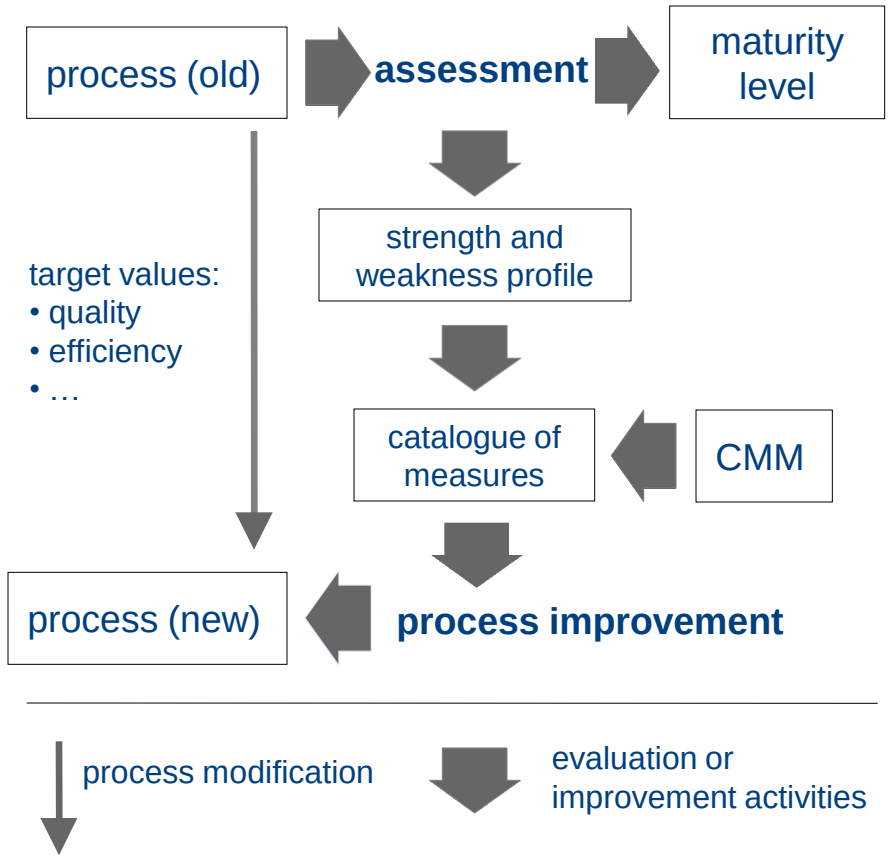
- The mechanical ticking of the questionnaire is no appropriate procedure for the execution of an assessment
  - An assessment requires preparation
  - It is useful to evaluate the process definition as well as the realization in practice
  - Representatives of the management, development, quality assurance etc. should be surveyed
  - The survey should be done in the form of an open interview. The sole answering of the questions leads to unreliable, incomplete results
  - The evaluations of the questions have to be discussed with the interviewed persons to avoid misunderstandings
- Preparation
  - Inform the relevant people about CMM, assessments and their role
  - If necessary thorough training of persons of the concerned organizational unit
  - Create atmosphere of trust

Assessment as a Basis for Process Improvement

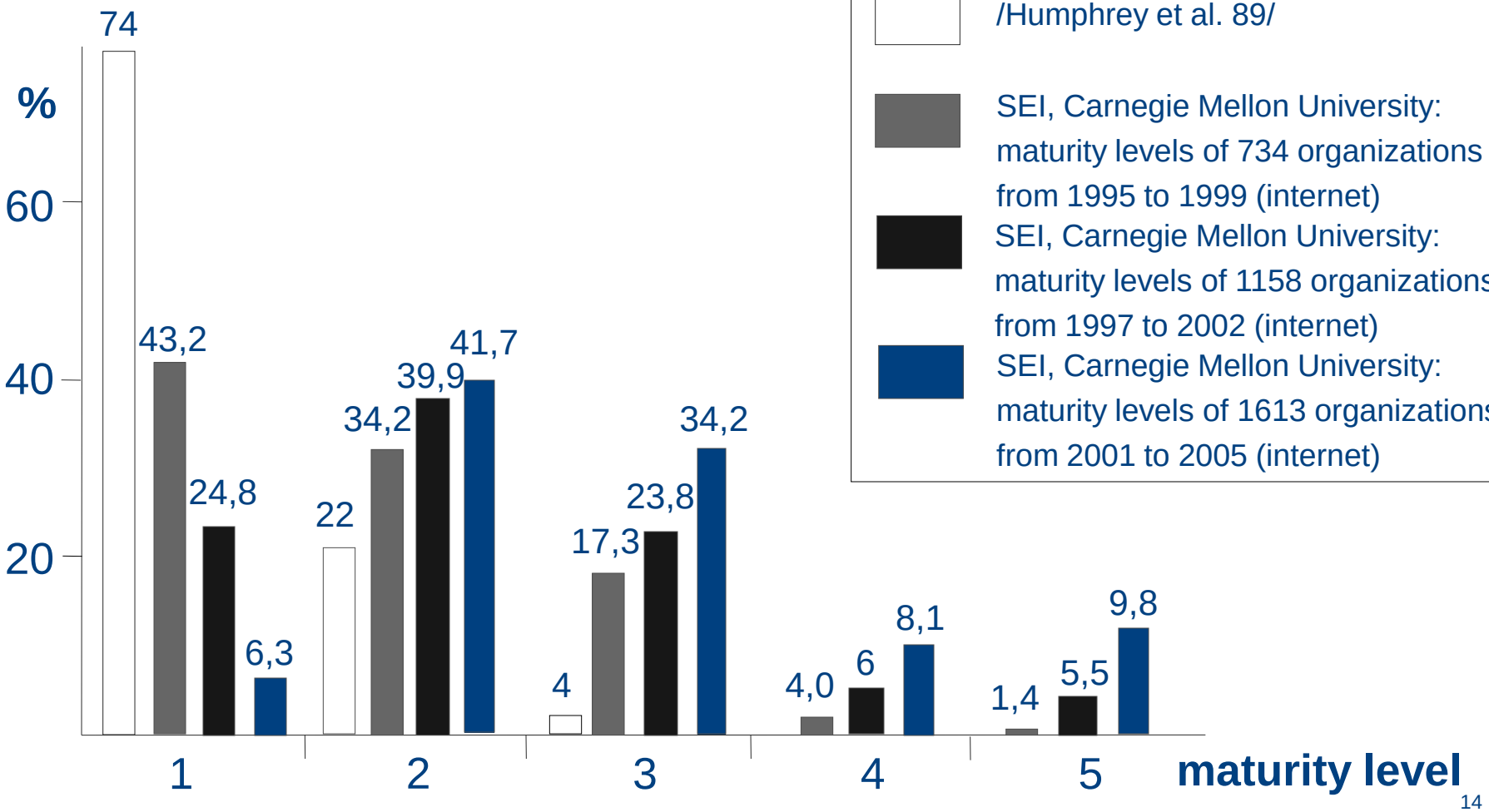
- Execution
  - Survey of different groups of persons (management, developers, QS)
  - Evaluation of the process description (projects) and the actual situation
  - Ask open questions: How is the quality and applicability of the test cases determined? Instead of: Are test cases submitted to formal reviews?
  - Evaluation of the questions due to the answers to the open questions, if necessary ask additional questions
  - Rough taking of notes of essential statements as important information for the strengths and weaknesses profile and as a basis for proposals of improvements
  - Discussion of the questions evaluation with the interviewed persons immediately afterwards to avoid misunderstandings: I have evaluated the question “Are test cases submitted to formal reviews” with no because ... Did I understand you right?
- Wrap-up
  - Show state of the process definition, the realization of this definition and the improvement potential
  - Determine detailed strengths and weaknesses profile according to theme complexes (e.g. development phases)

Assessment as a Basis for Process Improvement Measures for Improvements

- Formulation of a detailed catalogue of measures and a plan for the introduction
- Installation of a competent Process Improvement Team which coordinates the realization of measures
- Revision of measures in teams with technical and applied knowledge (e.g. specialist for software testing with competent testers)
- Support concerning the realization of measures
- Show successes
- Ensure realistic expectations: successful improvements require time as well as financial and personal costs



State of the Practice
Maturity Level of US-Companies



Costs and Benefit of Assessments

- Hughes Aircraft (IEEE Software, July 1991)
  - 1987: level 2 ➔ after assessment improvement on level 3 (1990)
  - Costs of the Assessments: 45,000 US $
  - Costs for two years process improvement: 400.000 US $
  - Caused annual savings/reduction of costs: approx. 2,000,000 US $
- Raytheon (IEEE Software, July 1993)
  - Process improvement from level 1 (beginning of 1988) to level 3 (end of 1991)
  - Return on Investment factor: 7.7
  - Double productivity

Problem Areas of the CMM and the Assessments

- No guaranteed interrelation between high CMM-level and successful software production
- Rather technology-oriented than staff oriented
- Weak in level 4 and 5 (few assured findings)
- The interrelation between the questionnaire and the CMM is not always visible
- Model prescribes certain activities independently of their utility. Experiences concerning successes are not considered
- To reach a high level it is necessary to meet all requirements of the lower levels
- Not optimally appropriate for technical application areas

CMM - Summary

- It may be expected that the CMM provides a systematic opportunity for the increase of quality and productivity in the software development
- By applying process assessments, the gaps that need improvement are found
- Some published surveys show a good costs-benefit balance
- Many companies concentrating on tool and technology activities have neglected the process. Here a potential for improvements exists
- The CMM and the assessment methodology have to be improved in some essential parts and for particular application areas. Activities with this aim are executed

CMMI

- The **C**apability **M**aturity **M**odel **I**ntegration is the result of an enhancement made to the CMM in 2008.
- The purpose was to develop a framework supporting a set of integrated models:
  - Model dedicated to the software development processes (CMMI-DEV 1.2)
  - Model for the acquisition of software (CMMI-ACQ 1.2)
  - Model focusing on services (CMMI_SVC 1.3)
- The CMMI differentiates 22 process areas, which are divided into 4 groups:
  - Project Management
  - Engineering
  - Process Management
  - Support

CMMI

- Each CMMI process area describes goals that should be achieved:
  - **Specific Goals:** describe what should be done to satisfy a specific process area**.** Should be achieved by conducting the processes related to this process area.
  - **Generic Goals:** are universally defined goals that apply to all process areas.

- The CMMI has two representations:
  - **Continuous:** any process area can be evaluated:
    - A capability level for this process area is determined
    - There are 6 capability levels: “0: Incomplete”, “1: Performed”, “2: Managed”, “3: Defined”, “4: Quantitatively Managed”, “5: Optimizing”
    - The result of the assessment is a comb-shaped profile of the process
  - **Staged:** the complete organization is evaluated:
    - A maturity level is assigned to the organization.
    - There are 5 maturity levels: “1: Initial”, “2: Managed”, “3: Defined”, “4: Quantitatively Managed”, “5: Optimizing”
    - To achieve a maturity level, an organization has to determine if the process areas corresponding to this level fulfill a predefined capability level.

Literature

- CMMI: http://www.sei.cmu.edu/cmmi/
- Rout T.P., SPICE: A Framework for Software Process Assessment, in: Software Process - Improvement and Practice, Vol. 1, No. 1, August 1995, pp. 57-66
- SPICE: ISO/IEC 15504