- Process Assessment
  - Capability Maturity Model (CMM) (Section 3 from SEI TR) and follow-up CMMI (Chapter 28)
  - Assessment process

Capability Maturity Model

- Developed by the Software Engineering Institute (SEI) with DoD funding
- Designed for large organizations doing routine development
- Assessment AND evaluation
  - What's the difference?
- Five levels of maturity
- Key processes

Levels

- Level 1: Initial
  - Instable; dependent on individuals
- Level 2: Repeatable
  - Policies; use of experience in planning; discipline
- Level 3: Defined
  - Documented process; process group; readiness and completion criteria
- Level 4: Managed
  - Quantitative goals; data collection
- Level 5: Optimized
  - Continuous process improvement

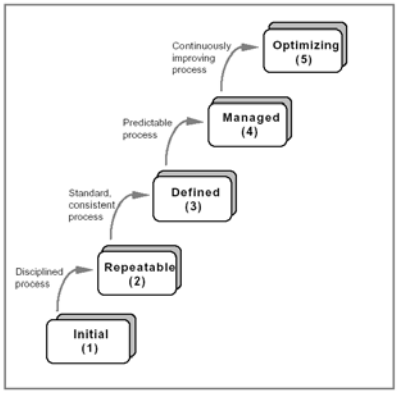
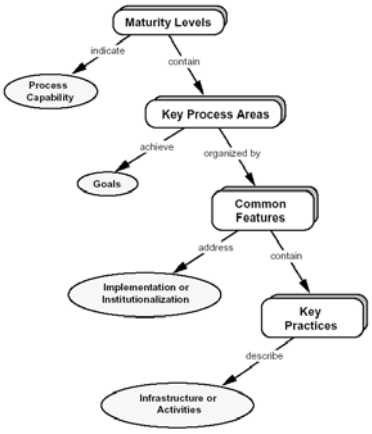
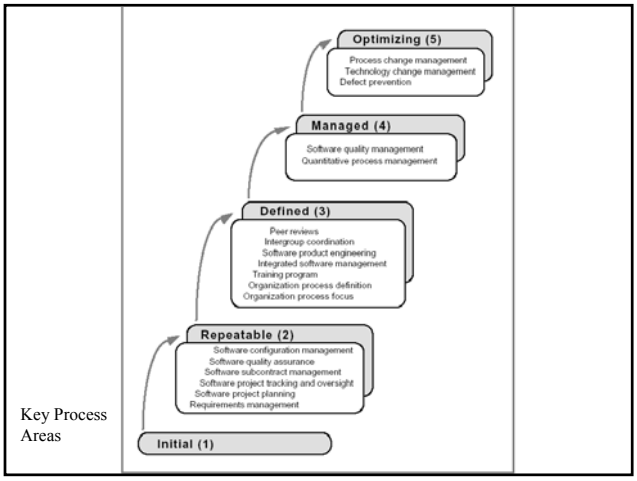


Figure 2.1 The Five Levels of Software Process Maturity





Level I – Initial Process

- Ill-defined inputs; cost and schedule overruns
- Undefined process; no repeatability
- Simple metrics of size, staff effort
- Baseline for later comparison

Level II – Repeatable Process

- Identified process inputs, outputs, and constraints
- No knowledge of how outputs are produced
- Measures of size:
  - Lines of code (LOC), function points, object and method counts
- Requirements volatility
- Extent of personnel experience determines success
  - Domain / applications, development architecture, tools / methods, overall years of experience, turnover
- Key areas
  - Requirements, management, project planning, project tracking, subcontract management, QA, CM
- Called *Managed* in CMMI staged

Level III – Defined Process

- Activities with definitions and entry / exit criteria
- Measures of requirements complexity, design modules, code complexity, test paths, pages of documentation
- Software Engineering Process Groups (SEPGs)
- Quality metrics
  - Defects discovered, error density for each activity area
- Key areas
  - Organizational process definition, training program, integrated management, product engineering, intergroup coordination, peer reviews

Level IV – Managed Process

- Feedback from early activities is used to set priorities for later stages
- Data collected
  - Process type, extent of reuse (production and consumption), when are defects detected, testing completion criteria, use of configuration management, change control, traceability links, module completion rate
- Key areas
  - Process measurement and analysis, quality management

Level V – Optimized Process

- Measures of activities are used to change the process
- Analogy with Statistical Process Control (SPC)
- Key Areas
  - Defect prevention, technology innovation, process change management

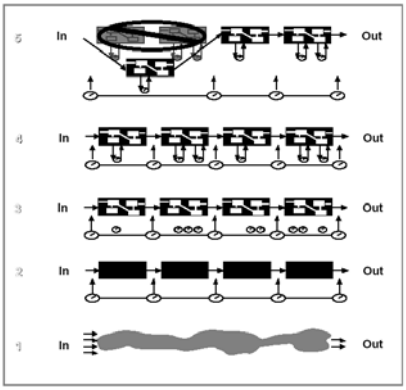
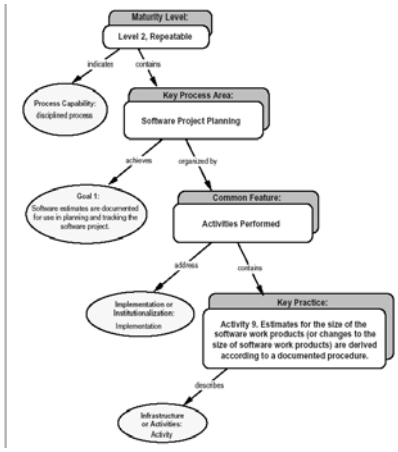


Figure 2.3 A Management View of Visibility Into the Software Process at Each Maturity Level



Assessment process

- Selection of assessment team
- Management commitment
- Assessment agreement
- Preparation
  - Training, survey questionnaire
- Assessment
  - Questionnaire analysis; discussions with projects and functional area representatives; findings; feedback; presentation
- Report
- Follow Up
  - Action plan, reassessment after 18 months

Assessment Details

- Assessment team has 6-8 members
  - some internal, some external
  - Either SEI or a vendor
- Team members have > 10 years experience; team leader has > 20 years experience
- Assessment itself takes 3-5 days
- Four or five projects are examined per organization
- Interviews with 8-10 functional area representatives (FARs) from each area
  - QA, integration testing, coding and unit test, requirements and design
- Implementation process takes 12-18 months
- Follow-up at the end of this time

Questionnaire

2.3 Data Management and Analysis

- Data management deals with the gathering and retention of process metrics. Data management requires standardized data definitions, data management facilities, and a staff to ensure that data is promptly obtained, properly checked, accurately entered into the database and effectively managed. Analysis deals with the subsequent manipulation of the process data to answer questions such as, "Is there a relatively high correlation between error densities found in test and those found in use?" Other types of analyses can assist in determining the optimum use of reviews and resources, the tools most needed, testing priorities, and needed education.

- 2.3.1 Has a managed and controlled process database been established for process metrics data across all projects?
- 2.3.2 Are the review data gathered during design reviews analyzed?
- 2.3.3 Is the error data from code reviews and tests analyzed to determine the likely distribution and characteristics of the errors remaining in the product?
- 2.3.4 Are analyses of errors conducted to determine their process related causes?
- 2.3.5 Is a mechanism used for error cause analysis?
- 2.3.6 Are the error causes reviewed to determine the process changes required to prevent them?
- 2.3.7 Is a mechanism used for initiating error prevention actions?
- 2.3.8 Is review efficiency analyzed for each project?
- 2.3.9 Is software productivity analyzed for major process steps?

CMM and CMMI

- Integrated CMMI (CMMI)
  - staged and
  - continuous
- Continuous model permits different maturity levels in different process areas
  - DoD software focus on improvements in system specification, verification and validation
  - Web development company focus on customer-related processes

SEI TR on CMM

- Software process assessments focus on identifying improvement priorities within an organization's own software process. Assessment teams use the CMM to guide them in identifying and prioritizing findings. These findings, along with guidance provided by the key practices in the CMM, are used (by a software engineering process group, for example) to plan an improvement strategy for the organization.

- Software capability evaluations are focused on identifying the risks associated with a particular project or contract for building high-quality software on schedule and within budget. During the acquisition process, software capability evaluations may be performed on bidders. The findings of the evaluation, as structured by the CMM, may be used to identify the risks in selecting a particular contractor. Evaluations may also be performed on existing contracts to monitor their process performance, with the intent of identifying potential improvements in the software process of the contractor.
- Software process assessments and software capability evaluations differ in motivation, objective, outcome, and ownership of the results….

Case Study – Hughes Aircraft

- 500 people in part of one division
- 1987: Level 2; 1990: Level 3
- $45K assessment cost; $400K improvement cost; $2M savings; 2% increased overhead; 18 months implementation (78 staff months); 5x improvement in expenditure estimation
- Major 1987 recommendations
  - Central data repository, process group, more involvement in requirements process, technology transition organization
- Major 1990 recommendations
  - More division-wide data analysis; opportunities for automation

CMM Benefits

- Level 2 leads to superior product quality
- CMM encapsulates industry best practices
- DOD sponsorship has enforced process improvement throughout Defense community
- Quality movement has led to CMM being quite widely used in other sectors
- Enhanced understanding of the development process
- Increased control and risk reduction
- Migration path to a more mature process
- More accurate cost estimation and scheduling
- Objective evaluations of changes in tools and techniques
- Standardized training
- Marketing

CMM Criticism

- Lots of room for interpretation of assessment rules
- Purpose and potential misuse of model
  - Originally for self-assessment and organizational learning
  - Increasingly used by DoD for contractor evaluation and qualification
- Tends to ignore different needs of different development environments
  - Emphasis on DoD contractual development
  - Emphasis on big, mission-critical projects
- Deemphasis of design risk
- Deemphasis on satisfaction of customer requirements