Chapter 28

Process Improvement
Objectives

- To explain the principles of software process improvement
- To explain how process factors influence quality and productivity
- To explain the notion of process capability and the CMMI process improvement model
Topics covered

- Process attributes
- The process improvement cycle
- Process and product quality
- The SEI’s CMMI framework

(Read chapter introduction + sections 28.1 and 28.6)
Topics covered

- Process attributes
- The process improvement cycle
- Process and product quality
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(Read chapter introduction + sections 28.1 and 28.6)
Process attributes (too!)

- Most process improvement work has focused on (product) defect reduction. (This reflects the increasing attention paid by industry to quality since the early ’80’s.)
- However, *process attributes* themselves can also be the focus of improvement…
Process attributes (cont’d)

**Understandability**: Is the process *explicitly defined* and *easy to understand*?

**Visibility**: Do process activities culminate in *clear results* and is the *progress* being made *visible externally*?

**Supportability**: Can **CASE tools** be used to support process activities?

**Acceptability**: Is the process acceptable to and usable by engineers responsible for producing the product (as well as others…)?

(cont'd)
Process attributes (cont’d)

**Reliability:** Can *process errors* be avoided or trapped before they result in *product errors*?

**Robustness:** Can the process continue despite unexpected problems?

**Maintainability:** Can the process *evolve* to reflect changing organizational requirements or to make process improvements?

**Rapidity:** How fast can the process be completed?
Topics covered

- Process attributes
- The process improvement cycle
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The process improvement cycle
Process improvement stages

- **Process measurement**
  - Attributes of the current process are measured. (Provides a baseline for assessing improvements.)

- **Process analysis**
  - Bottlenecks and weaknesses are identified.
  - Changes aimed at improving measures are identified.

- **Process change**
  - Changes are introduced.
Topics covered

- Process attributes
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What is the relationship between process and product quality?

- Obviously, *process* quality and *product* quality are *closely related*…
- A “good process” is *usually required* to produce a “good product.”
- For *manufactured goods*, process is the *principal quality determinant*.
- For *design-based activity*, *other factors are also involved* (especially the capabilities of the designers)…
Principal product quality factors

- Product quality
- Development technology
  (tool support)
- Process quality
- People quality
- Cost, time and schedule
More quality generalizations...

- For *large projects* with “average” *people capabilities*, *process* determines *product quality*.
- For *small projects*…
  - *people capabilities* tend to be more important; but
  - *development technology* (tool support) is also important.
- In *all cases*, an *unrealistic schedule* can cause *product quality* to suffer.
Topics covered

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Software Engineering Institute (SEI)

- DoD-funded organization established in 1984 at CMU to assess and improve the capabilities of the US software industry.
- Developed the influential 5-level “Software Capability Maturity Model” (CMM) in early ’90’s.
  - To assess extent to which an organization’s processes follow best practices.
  - Others have extended or adapted the model (e.g., SPICE, Bootstrap) for use in a wider range of companies.
SEI Software CMM maturity levels

1. **Initial**: essentially uncontrolled
2. **Repeatable**: product management procedures defined and used
3. **Defined**: process management procedures and strategies defined and used
4. **Managed**: quality management strategies defined and used
5. **Optimizing**: process improvement strategies defined and used
The Software CMM was followed by the development of more specialized CMMs:

- Systems Engineering CMM
- People CMM
- Integrated Product & Process Development CMM
- Software Acquisition CMM
- Systems Security Engineering CMM

Each had different structures, terms, and ways of measuring maturity.

(cont'd)
Software Engineering Institute (SEI) (cont’d)

- This *caused confusion*, especially when using more than one model at a time.
- They were *difficult to integrate* into a combined improvement program.
- Also difficult to use in supplier selection and sub-contracting.
The CMMI project

- The **Capability Maturity Model Integration** (CMMI) project was begun in 2001 to:
  - build an initial set of *integrated* models
  - improve best practices from existing CMM models
  - establish a framework to enable integration of future models
  - create an associated set of appraisal and training products

(cont'd)
The CMMI project (cont’d)

- Collaborative endeavor (over 100 people from nearly 30 industry/government organizations were involved)
- See [www.sei.cmu.edu/cmmi/](http://www.sei.cmu.edu/cmmi/) for more info.
CMMI framework

- Models support four “bodies of knowledge”:
  - Software Engineering (SW)
  - Systems Engineering (SE)
  - Integrated Product and Process Development (IPPD)
  - Supplier Sourcing (SS)

- Two instantiations:
  - *Staged*: the model is expressed in terms of 5 capability *levels*;
  - *Continuous*: a capability *rating* is computed.
CMMI process areas

- 24 process areas relevant to process capability and improvement are identified.
- Organized into 4 groups:
  - Process management
  - Project management
  - Engineering
  - Support
- Each area has associated goals and (advisory) practices
## CMMI process areas (cont’d)

<table>
<thead>
<tr>
<th>Process management</th>
<th>Organisational process definition</th>
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<td>Organisational process focus</td>
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<td>Organisational training</td>
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<td>Organisational process performance</td>
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<td>Organisational innovation and deployment</td>
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<td>Project management</td>
<td>Project planning</td>
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<td>Project monitoring and control</td>
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<td>Supplier agreement management</td>
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<td>Integrated teaming</td>
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<td>Quantitative project management</td>
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**CMMI process areas (cont’d)**

<table>
<thead>
<tr>
<th>Engineering</th>
<th>Support</th>
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<tbody>
<tr>
<td>Requirements management</td>
<td>Configuration management</td>
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<td>Requirements development</td>
<td>Process and product quality management</td>
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<tr>
<td>Technical solution</td>
<td>Measurement and analysis</td>
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<tr>
<td>Product integration</td>
<td>Decision analysis and resolution</td>
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<tr>
<td>Verification</td>
<td>Organisational environment for integration</td>
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<tr>
<td>Validation</td>
<td>Causal analysis and resolution</td>
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CMMI process assessment

- Examines processes used and assesses organizational capability relative to each of the 24 process areas.
- Based on a 6-point “capability level” scale:
  0. Not performed (“Incomplete”)
  1. Performed
  2. Managed
  3. Defined
  4. Quantitatively managed
  5. Optimizing
The **staged** CMMI model

- Comparable to the 5-level Software CMM.
- Each level has process areas and goals.
- For example, process areas associated with Level 2 ("**Managed**") include:
  - Requirements management
  - Project planning
  - Project monitoring and control
  - Supplier agreement management
  - Measurement and analysis
  - Process and product quality management
Staged CMMI model maturity levels

1. Level 1: Initial
   - "Repeatable" in CMM
2. Level 2: Managed
3. Level 3: Defined
   - "Managed" in CMM
4. Level 4: Quantitatively managed
5. Level 5: Optimizing

5 “Maturity Levels”
The **continuous** CMMI model

- A finer-grain model that considers individual or groups of practices and assesses their use.
- The maturity assessment is a set of “capability values” (based on the 6-point “capability level” scale described earlier) in each area.
- The **advantage** of a continuous approach is that organizations can pick and choose process areas to improve according to their local needs.
A process capability profile

- Project monitoring and control
- Supplier agreement management
- Risk management
- Configuration management
- Requirements management
- Verification
- Validation
Key points

- The process improvement cycle involves process **measurement**, process **analysis** and process **change**.
- Process measurement should be used to answer specific process questions based on improvement goals.

(cont’d)
Key points (cont’d)

- SEI’s CMMI framework provides a common, *integrated* vision of improvement for all elements of an organization.
- Process improvement in the CMMI framework is based on reaching a set of goals related to good engineering practices from *multiple disciplines*. 
Chapter 28

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