Chapter 25
Process Improvement
Understanding, modeling, and improving the software process

Objectives
- To explain the principles of software process improvement
- To explain how software process factors influence software quality and productivity
- To introduce the SEI Capability Maturity Model and to explain why it is influential. To discuss the applicability of that model
- To explain why CMM-based improvement is not universally applicable

Topics covered
- Process and product quality
- Process analysis and modelling
- Process measurement
- The SEI process maturity model
- Process classification

Process improvement
- Understanding existing processes
- Introducing process changes to achieve organizational objectives which are usually focused on *quality improvement, cost reduction* and *schedule acceleration*
- Most process improvement work so far has focused on defect reduction. This reflects the increasing attention paid by industry to quality.
- Other process attributes, however, can be the focus of improvement as well

Process characteristics
- Understandability
- Visibility
- Supportability
- Acceptability
- Reliability
- Robustness
- Maintainability
- Rapidity

Process improvement stages
- Process analysis
  - Model and analyze (quantitatively if possible) existing processes
- Improvement identification
  - Identify quality, cost or schedule bottlenecks
- Process change introduction
  - Modify the process to remove identified bottlenecks
- Process change training
  - Train staff involved in new process proposals
- Change tuning
  - Evolve and improve process improvements
The process improvement process

- Process
- Model
- Change plan
- Training plan
- Feedback on improvements
- Revised process model

Process and product quality

- 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

- Development technology
- Process quality
  - Cost, time and schedule
- People quality

Quality factors

- For large projects with ‘average’ capabilities, the development process determines product quality
- For small projects, the capabilities of the developers is the main determinant
- The development technology is particularly significant for small projects
- In all cases, if an unrealistic schedule is imposed then product quality will suffer

Process analysis and modelling

- Process analysis
  - The study of existing processes to understand the relationships between parts of the process and to compare them with other processes
- Process modelling
  - The documentation of a process which records the tasks, the roles and the entities used
  - Process models may be presented from different perspectives
Process analysis techniques

- Published process models and process standards
  It is always best to start process analysis with an existing model. People then may extend and change this.
- Questionnaires and interviews
  Must be carefully designed. Participants may tell you what they think you want to hear.
- Ethnographic analysis
  Involves assimilating process knowledge by observation.

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Ethnographic analysis

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Elements of a process model

- Activity (round edged rectangle without shadow)
- Process (round edged rectangle with shadow)
- Deliverable (rectangle with shadow)
- Condition (parallelogram)
- Role (circle with shadow)
- Exception (double-edged box)
- Communication (arrow)

The module testing activity

<table>
<thead>
<tr>
<th>Pre-condition</th>
<th>Process</th>
<th>Post-condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module compiles without syntax errors</td>
<td>Test module</td>
<td>All defined tests run on module</td>
</tr>
<tr>
<td>Module specification</td>
<td>Test engineer</td>
<td>Responsible for</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module specification</td>
<td>Signed-off test record</td>
</tr>
<tr>
<td>Test data</td>
<td></td>
</tr>
</tbody>
</table>

Activities in module testing

- Test data preparation
  - Read module specification
  - Prepare test data according to specification
  - Submit test data for review
  - Review test data

- Module test harness preparation
  - Checklists module
  - Read and understand module specification
  - Prepare test harness for module
  - Compile test harness

- Test execution
  - Incorporate module with test harness
  - Run approved tests on module
  - Record test results for regression testing

- Test reporting
  - Write report on module testing including details of discovered problems
  - Submit report for approval
  - Submit test results to CM
  - Complete test harness

Process exceptions

- Software processes are complex and process models cannot effectively represent how to handle exceptions
  - Several key people becoming ill just before a critical review
  - A complete failure of a communication processor so that no e-mail is available for several days
  - Organizational reorganization
  - A need to respond to an unanticipated request for new proposals
- Under these circumstances, the model is suspended and managers use their initiative to deal with the exception

Process measurement

- Quantitative process data should be collected
  - However, where organizations do not have clearly defined process standards this is very difficult as you don’t know what to measure. A process may have to be defined before any measurement is possible.
- Measurements should be used to assess process improvements
  - But this does not mean that measurements should drive the improvements. The improvement driver should be the organizational objectives.
Class of process measurement

- Time taken for process activities to be completed
  E.g. Calendar time or effort to complete an activity or process
- Resources required for processes or activities
  E.g. Total effort in person-days
- Number of occurrences of a particular event
  E.g. Number of defects discovered

Goal-Question-Metric Paradigm

- Goals
  What is the organization trying to achieve? The objective of process improvement is to satisfy these goals.
- Questions
  Questions about areas of uncertainty related to the goals. You need process knowledge to derive these.
- Metrics
  Measurements to be collected to answer the questions.

The Software Engineering Institute

- US Defense Dept. funded institute associated with Carnegie Mellon University
- Mission is to promote software technology transfer particularly to defense contractors
- Maturity model proposed in mid-1980s, refined in early 1990s.
- Work has been very influential in process improvement

The SEI process maturity model

<table>
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<tr>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>Level 1</td>
<td>Initial</td>
</tr>
<tr>
<td>Level 2</td>
<td>Repeatable</td>
</tr>
<tr>
<td>Level 3</td>
<td>Defined</td>
</tr>
<tr>
<td>Level 4</td>
<td>Managed</td>
</tr>
<tr>
<td>Level 5</td>
<td>Optimizing</td>
</tr>
</tbody>
</table>

Maturity model levels

- Initial: Essentially uncontrolled
- Repeatable: Product management procedures defined and used
- Defined: Process management procedures and strategies defined and used
- Managed: Quality management strategies defined and used
- Optimising: Process improvement strategies defined and used

Key process areas
SEI model problems

- It focuses on project management rather than product development.
- It ignores the use of technologies such as rapid prototyping.
- It does not incorporate risk analysis as a key process area
- It does not define its domain of applicability

The CMM and ISO 9000

- There is a clear correlation between the key processes in the CMM and the quality management processes in ISO 9000
- The CMM is more detailed and prescriptive and includes a framework for improvement
- Organizations rated as level 2 in the CMM are likely to be ISO 9000 compliant

Capability assessment

- An important role of the SEI is to use the CMM to assess the capabilities of contractors bidding for US government defence contracts
- The model is intended to represent organizational capability, not the practices used in particular projects
- Within the same organization, there are often wide variations in processes used
- Capability assessment is questionnaire-based

The capability assessment process

- Select projects for assessment
- Distribute questionnaires
- Analyse responses
- Clarify responses
- Identify issues for discussion
- Interview project managers
- Interview engineers
- Interview managers
- Brief managers and engineers
- Present assessment
- Write report

Process classification

- Informal
  - No detailed process model. Development team chose their own way of working
- Managed
  - Defined process model which drives the development process
- Methodical
  - Processes supported by some development method and CASE tools
- Improving
  - Processes that have inherent improvement objectives

Process applicability

- Informal process: Prototypes, Short-lifetime products, 4GL business systems
- Managed process: Large systems, Long-lifetime products
- Methodical process: Well-understood application domains, life-engineered systems
Process choice

- Process used should depend on type of product which is being developed
  - For large systems, management is usually the principal problem so you need a strictly managed process. For smaller systems, more informality is possible.
- There is no uniformly applicable process which should be standardized within an organization
  - High costs may be incurred if you force an inappropriate process on a development team

Process tool support

<table>
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<th>Managed process</th>
<th>Methodical process</th>
<th>Improving process</th>
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<td>Generic tools</td>
<td>Configuration management tools</td>
<td>Project management tools</td>
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Key points

- Process improvement involves process analysis, standardization, measurement and change
- Process models include descriptions of tasks, activities, roles, exceptions, communications, deliverables and other processes
- Measurement should be used to answer specific questions about the software process used
- The three types of process metrics which can be collected are time metrics, resource utilization metrics and event metrics

Key points (continued)

- The SEI model classifies software processes as initial, repeatable, defined, managed and optimising. It identifies key processes which should be used at each of these levels
- The SEI model is appropriate for large systems developed by large teams of engineers. It cannot be applied without modification in other situations
- Processes can be classified as informal, managed, methodical and improving. This classification can be used to identify process tool support