CMMI® V1.1 Tutorial

(Excerpted and augmented by R. Bubacz
for use in SE 450 Software Process & Product Metrics Course)

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Quality Leverage Points

Everyone realizes the importance of having a motivated, quality work force but ...

- ...even our finest people can’t perform at their best when the process is not understood or operating “at its best.”

Major determinants of product cost, schedule, and quality
Why Process Improvement?

• Good software engineering practice increases the chance of delivering quality software products on time and on budget

• So, improving the software process improves the software product and the business

• Stable, repeatable software processes reduce the variability and risk in development
Underlying Premise of Process Improvement

“The quality of a product is largely determined by the quality of the process that is used to develop and maintain it.”

Based on TQM principles as taught by Shewhart, Juran, Deming and Humphrey.
## Immature Versus Mature Organizations

### Immature
- Software Process, though specified, is not followed/enforced
- Reactionary (Fire-Fighting)
- Software processes are generally improvised by practitioners and managers during the course of the project.
- Schedules and Budgets keep constantly changing
- No objective basis for judging product quality or for solving product or process problems

### Mature
- Software process is accurately communicated to staff and work activities are carried out according to the planned process.
- Process improvements are developed through controlled pilot-tests and/or benefit analysis
- Schedules and Budgets are based on historical performance.
- There is an objective, quantitative basis for judging product quality and analyzing problems with the product and process
The Five Levels of Software Process Maturity

- A maturity level is a well-defined evolutionary plateau towards achieving a mature process.

- Each level has a set of goals.

- Achieving each level:
  - Establishes a different component in the software process.
  - Increases the process capability of the organization.
Process Capability & Performance Prediction

- As Maturity increases, the difference between targeted results and actual results decreases.
- Higher maturity ➞ a better way to run a business.
Key Process Areas by Maturity Level

- Achieving each level
  - Establishes a different component in the software process
  - Increases the process capability of the organization
## Continuous Organization of Process Areas

<table>
<thead>
<tr>
<th>Category</th>
<th>Process Area</th>
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<tbody>
<tr>
<td>Project Management</td>
<td>Project Planning</td>
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<td>Project Monitoring and Control</td>
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<td></td>
<td>Supplier Agreement Management</td>
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<td></td>
<td>Integrated Project Management (IPPD)</td>
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<td>Integrated Supplier Management (SS)</td>
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<td>Integrated Teaming (IPPD)</td>
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<td>Risk Management</td>
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<td>Quantitative Project Management</td>
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<td>Support</td>
<td>Configuration Management</td>
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<td>Process and Product Quality Assurance</td>
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<td>Measurement and Analysis</td>
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<td>Causal Analysis and Resolution</td>
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<td>Decision Analysis and Resolution</td>
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<td>Organizational Environment for Integration (IPPD)</td>
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<td>Engineering</td>
<td>Requirements Management</td>
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<td>Requirements Development</td>
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<td>Technical Solution</td>
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<td>Product Integration</td>
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<td>Verification</td>
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<td>Validation</td>
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<td>Process Management</td>
<td>Organizational Process Focus</td>
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<td>Organizational Process Definition</td>
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<td>Organizational Training</td>
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<td>Organizational Process Performance</td>
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<td>Organizational Innovation and Deployment</td>
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</table>
The Maturity Levels (Staged Representation)

• Level 1 – Initial Level
  – Ad Hoc processes, ineffective planning and reaction-driven systems
  – Crisis – abandon planned procedures & revert to coding and testing
  – Schedules, Budget, Functionality, Product Quality: Unpredictable
  – Software Process Capability: Unpredictable

• Level 2 – Repeatable Level
  – Basic Software Management controls
  – Planning/Managing new projects is based on successes with similar projects
  – Realistic project commitments based on empirical knowledge
  – Project managers track software costs, schedules and functionality
  – Projects standards are defined and followed
  – Software Process Capability: Disciplined

• Level 3 – Defined Level
  – Standard Process for developing and maintaining software is documented
  – Organization-wide training program: to ensure that staff and managers have knowledge and skills to fulfill their assigned roles
  – Projects tailor the Standard Process to develop their own well-defined process for their unique project requirements
  – Schedules, Budget, Functionality, Product Quality: Under Control and Tracked
  – Software Process Capability: Standard and Consistent
The Maturity Levels (Staged) (continued)

• Level 4 – Managed Level
  – Quantitative quality goals for products and processes
  – Organizational Measurement Program for important software process activities
  – Variation in process performance is controlled to be within acceptable range
  – Software Process Capability: Predictable

• Level 5 – Optimizing Level
  – Focus on Continuous Process Improvement
  – Identify weakness and strengthen the process proactively
  – Perform cost benefit analyses of new technologies and proposed changes to the organization’s software process
  – Analyze defects to determine their causes – evaluate the software process accordingly
  – Software Process Capability: Continuous Improving
Comparing Model Representations

. . .for an established set of process areas across an organization

. . .for a single process area or a set of process areas
Remember

• A model is not a process.

• The model shows what to do, NOT how to do it or who does it.
CMMI in a Nutshell

• A CMMI model provides a structured view of process improvement across an organization

• CMMI can help
  – set process improvement goals and priorities
  – provide guidance for quality processes
  – provide a yardstick for appraising current practices
The Bottom Line

• Improvement means different things to different organizations:
  – What are your business goals?
  – How do you measure progress?

• Improvement is a long-term, strategic effort:
  – What is the expected impact on the bottom line?
  – How will impact be measured?
Categories of Process Improvement Benefits

- Process improvement benefits fall into one of eight general categories:
  - improved schedule and budget predictability
  - improved cycle time
  - increased productivity
  - improved quality (as measured by defects)
  - increased customer satisfaction
  - improved employee morale
  - increased return on investment
  - decreased cost of quality
Improved Schedule and Budget Predictability

Results: Boeing Effort Estimation

Without Historical Data
Variance between +20% to -145%
(Mostly Level 1 & 2)

With Historical Data
Variance between -20% to +20%
(Level 3)

(Based on 120 projects in Boeing Information Systems)

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

Project Cycle Times

Source: Software Engineering Div., Hill AFB, Published in Crosstalk May 1999
Increased Productivity

Man-hours per LOC

Source: Software Engineering Div., Hill AFB, Published in Crosstalk May 1999
Increased Productivity and Quality

Productivity Rate and Quality Performance

* For Software Programs

Error Rate Per KLOC  \[\text{Productivity Rate} \]

SLOC per Person Day

Level 2  \[\text{Level 3} \]

Level 4

Productivity Increased By 80% As Error Rates Decreased

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Process Areas

• *Process Areas* (PAs) are a cluster of related practices.

• They are the major building blocks in establishing process capability.

• Example PA: “Requirements Management”
The Capability Dimension

• The values on this axis describe how well you perform a process (called Capability Levels).

- Process performed well and continuously improved
- Process not performed
# The Capability Levels

Capability levels are cumulative – a higher capability level includes the attributes of the lower levels.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>5</td>
<td>Optimizing</td>
</tr>
<tr>
<td>4</td>
<td>Quantitatively Managed</td>
</tr>
<tr>
<td>3</td>
<td>Defined</td>
</tr>
<tr>
<td>2</td>
<td>Managed</td>
</tr>
<tr>
<td>1</td>
<td>Performed</td>
</tr>
<tr>
<td>0</td>
<td>Incomplete</td>
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An Example Process Area Capability Profile
## Alignment of Metrics & Quality Practices with Process Areas

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<th>Metrics/Quality Practices</th>
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<td>Project Mgmt Metrics, Activity Metrics, Basic Quality Tools</td>
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<td>Process Management</td>
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<td>In-Process Metrics, Project Mgmt Metrics, Basic Quality Tools</td>
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Summary

• CMMI models were developed with broad participation and review.

• Process Areas identify “what you do.”

• Capability Levels identify “how well you do it.”

• The CMMI model should be applied using intelligence, common sense, and professional judgment.

• Metrics and quality practices are an integral part of achieving process maturity.