CMMI®: The Good News and Bad News about Supporting Maturity Concepts

Suzanne Garcia, SEI
# Report Documentation Page

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

<table>
<thead>
<tr>
<th>1. REPORT DATE</th>
<th>2. REPORT TYPE</th>
<th>3. DATES COVERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAY 2006</td>
<td></td>
<td>00-00-2006 to 00-00-2006</td>
</tr>
</tbody>
</table>

## 4. TITLE AND SUBTITLE
CMMI: The Good News and Bad News about Supporting Maturity Concepts

## 6. AUTHOR(S)

## 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA, 15213-3890

## 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

## 12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

## 13. SUPPLEMENTARY NOTES
See also ADM002184. Presented at the Air Force Research Laboratory Seminar/Workshop on Multi-Dimensional Assessment of Technology Maturity in Fairborn, OH on 9-11 May 2006. U.S. Government or Federal Rights License

## 14. ABSTRACT

## 15. SUBJECT TERMS

## 16. SECURITY CLASSIFICATION OF:

<table>
<thead>
<tr>
<th>a. REPORT</th>
<th>b. ABSTRACT</th>
<th>c. THIS PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>unclassified</td>
<td>unclassified</td>
<td>unclassified</td>
</tr>
</tbody>
</table>

## 17. LIMITATION OF ABSTRACT
Same as Report (SAR)

## 18. NUMBER OF PAGES
27

## 19. NAME OF RESPONSIBLE PERSON

---

Standard Form 298 (Rev. 8-98)
Prepared by ANSI Std Z39-18
Capability Maturity Model® (CMM®) Evolution in a Nutshell

Software CMM® initially developed by the Software Engineering Institute (circa 1987)

• Characterized organizational software process capability in terms of “maturity” as evidenced by the widespread use of desirable practices
  - Widely accepted by Government and industry
  - Used both for evaluation and self assessment
  - Improvements in quality and productivity reported

A plethora of discipline-specific CMM®’s emerge in the 90’s

• System Engineering, Integrated Product/Process Dev, Software Acquisition, Security, People and more

CMMI® v1.1 issued January 2001

• Adoption of CMMI has been more widespread, and faster, than SW-CMM or any other of the predecessor models
  - Case study data shows, when implemented appropriately, significant cost, schedule, defect reduction benefit
The Bottom Line

SEI has almost 20 years experience supporting various approaches to supporting and evaluating process “maturity”

- Some approaches work better than others
- No approach is perfect
- Stakeholder acceptance (both acquirers and suppliers) is a continual challenge for new concepts
Good news: Case Studies supports Positive Correlation between Process Maturity and Project Factors*

Mean Defect Density by Phase

Defects per Size (Page or KSLOC)

Baseline 1.0 - All Historical Projects 99/09
Baseline 2.0 - Level 4/5 Projects 99/12
Baseline 2.2 - Level 4/5 Projects 00/06

Source: Northrop Grumman Information Technology

*IF improvement efforts are taken seriously and applied consistently
Model Representations

Staged
...for a pre-defined set of process areas across an organization

- Maturity Level 5
  - OID, CAR

- Maturity Level 4
  - OPP, QPM

- Maturity Level 3
  - RD, TS, PI, VER, VAL, OPF, OPD, OT, IPM, RSKM, DAR, OEI, IT, ISM

- Maturity Level 2
  - REQM, PP, PMC, MA, PPQA, CM, SAM

- Maturity Level 1
  - Initial: Process Unpredictable, Poorly Controlled, and Reactive

Continuous
...for a single process area or Selected set of process areas

- 5 Optimizing: Focus on Continuous Improvement
- 4 Quantitatively Managed: Process Measured and Controlled
- 3 Defined: Process Characterized for the Organization and Is Proactive
- 2 Managed: Process Characterized for Projects and Is Often Reactive
- CL0 (Incomplete)
- CL1 (Initial)
- CL2
- CL3
- CL4
- CL5

Essentially the Same Content but Organized in a Different Way.
Institutionalization is the Difference Between CMMI and Other Frameworks

The Process Capability dimension of CMMI enables the application of a set of *generic* practices to any process of interest:
- This amplifies the utility of the practices and goals expressed in the Specific Processes dimension
- When several pre-defined Process Areas are improved along the Process Capability dimension in concert, changes in behavior are observed that lead to a judgment of increasing organizational maturity.
  - “High maturity” organizations are sought after by customers due to their lower process risk for executing projects
    - But, lower process risk doesn’t necessarily mean lower risk overall
    - Process is only one dimension of risk that should be accounted for
How “Mature” is CMMI?

Using draft TRLs for Practice-based Technologies, CMMI could be argued as a TRL of 7 or 8:

7:
• Actual system prototype in operational environment
• Implementation needs of mainstream users identified and integrated into the prototype,
• Operational use by relevant users demonstrated across the community

8:
• Final form proven to work in operational environment
• Technology picked-up for wide-spread rollout across the community
CMMI Transition Status – 1/31/05

Training
Introduction to CMMI – 43,758 trained
Intermediate CMMI – 1,923 trained
Introduction to CMMI Instructors – 390
SCAMPI Lead Appraisers – 604 trained
SCAMPI B&C-Only Team Lead -- 29

Authorized
Introduction to CMMI V1.1 Instructors – 302
SCAMPI V1.1 Lead Appraisers – 407
SCAMPI B&C Team Leads -- 400
How does that help?

Even less “ready” adopters should be able to find support for a reasonable implementation of CMMI

Increasing adopter readiness

Increasing technology readiness

High Risk

Low Risk

???
Lessons Learned in using Maturity Concepts
Any model that supports implementing new practices supports assessment

Maturity is an attractive concept to customers
  • Implies wisdom, “seasoning”, trustworthiness

Frameworks that support improving the adoption of “best practices” are attractive to organizations seeking operational efficiency
  • They don’t have to invent and learn internally about new practices if other organizations have already paved the way

For lots of reasons, these kinds of models lead toward a strong assessment/evaluation viewpoint of compliance to the model/framework

Following slides with adoption/appraisal statistics are from “CMMI Today” presentation which is publicly available and updated 2-3 times per year:

https://bscw.sei.cmu.edu/pub/bscw.cgi/0/395854
Number of SCAMPI vX Class A Appraisals Conducted by Year by Model Representation

Reported as of 31 January 2006

*Where Representation is reported

- Staged
- Continuous
Reporting Organizational Types

- Commercial/In-house: 64.0%
- Contractor for Military/Government: 31.3%
- Military/Government Agency: 4.7%

Based on 878 organizations

© 2003 by Carnegie Mellon University
Maturity Profile by All Reporting Organizations

Based on most recent appraisal of 878 organizations

9/30/05
Maturity Profile by All Reporting USA and Non-USA Organizations

Based on 355 USA organizations and 523 Non-USA organizations

© 2003 by Carnegie Mellon University

Version 1

Smg GAO Mtg 3/25/03 page 15
The Good News About Strong Assessment Focus

From the model steward’s point of view:
• You’re careful in assuring that the model is as objective and context-free as possible
• You invest in defining and supporting appraisal methods that include authorization/certification of qualified individuals to perform the assessments
• You seek widespread participation by the stakeholders in the community

If you know you will be one of the “assessed” and you’re serious about improvement
• You use the model as leverage to get the resources needed for a robust improvement effort
• You participate in the model development/review to ensure that it doesn’t include elements that are irrelevant to your context
The Bad News About Strong Assessment Focus

From the model steward’s point of view:

• If you get strong adoption, you’ll have a hard time keeping quality of assessor pool high
  - Training and experience requirements will cause delays in getting qualified assessors into the community

• There will always be organizations who “go for the Level” without adopting the behaviors that typically result in actual improvement
  - Educating the customers who demand assessment is one of the ways to reduce over-reliance on assessments to meet goals they were not intended for
Summary

Models and frameworks that address maturity concepts can be very powerful, but they require strong stewardship and significant adoption support.

If a rating *can* be assigned, it *will* be assigned.
- If you’re the developer/steward, the choice you have is to try to support assessments productively, or let them happen without controls on the assessor community.

Often customer education is a productive path to reduce issues related to inappropriate use of assessment results.
Backup Slides/Additional Information

Sponsored by the U.S. Department of Defense
© 2003 by Carnegie Mellon University
### CMMI® Maturity Level 2 (Managed) - Process Area List

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PA Acronym</th>
<th>PA Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements Management</td>
<td>REQM</td>
<td>Manage the requirements of the project's products and product components and identify inconsistencies between those requirements and the project's plans and work products</td>
</tr>
<tr>
<td>Project Planning</td>
<td>PP</td>
<td>Establish and maintain plans that define project activities</td>
</tr>
<tr>
<td>Project Monitoring and Control</td>
<td>PMC</td>
<td>Provide understanding into the project’s progress so that appropriate corrective actions can be taken when the project’s performance deviates significantly from the plan</td>
</tr>
<tr>
<td>Supplier Agreement Management</td>
<td>SAM</td>
<td>Manage the acquisition of products and services from suppliers external to the project for which there exists a formal agreement</td>
</tr>
</tbody>
</table>
## CMMI® Maturity Level 2 (Managed) - Process Area List

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PA Acronym</th>
<th>PA Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process and Product Quality Assurance</td>
<td>PPQA</td>
<td>Provide staff and management with objective insight into the processes and associated work products</td>
</tr>
<tr>
<td>Configuration Management</td>
<td>CM</td>
<td>Establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits</td>
</tr>
<tr>
<td>Measurement and Analysis</td>
<td>M&amp;A</td>
<td>Develop and sustain a measurement capability that is used to support management information needs</td>
</tr>
</tbody>
</table>
CMMI® Maturity Level 3 (Defined) - Process Area List

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PA Acronym</th>
<th>PA Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational Process Focus</td>
<td>OPF</td>
<td>Establish and maintain an understanding of the organization's processes and process assets, and to identify, plan, and implement the organization's process improvement activities</td>
</tr>
<tr>
<td>Organizational Process Definition</td>
<td>OPD</td>
<td>Establish and maintain a usable set of organizational process assets</td>
</tr>
<tr>
<td>Organizational Training</td>
<td>OT</td>
<td>Develop the skills and knowledge of people so they can perform their roles effectively and efficiently</td>
</tr>
<tr>
<td>Risk Management</td>
<td>RSKM</td>
<td>Identify potential problems before they occur, so that risk-handling activities may be planned and invoked as needed across the life cycle to mitigate adverse impacts on achieving objectives</td>
</tr>
</tbody>
</table>
CMMI® Maturity Level 3 (Defined) - Process Area List

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PA Acronym</th>
<th>PA Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Project Management</td>
<td>IPM</td>
<td>Establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization’s set of standard processes</td>
</tr>
<tr>
<td>Requirements Development</td>
<td>RD</td>
<td>Produce and analyze customer, product, and product component requirements</td>
</tr>
<tr>
<td>Technical Solution</td>
<td>TS</td>
<td>Develop, design, and implement solutions to requirements; solutions, designs and implementations encompass products, product components, and product related processes either singly or in combinations as appropriate</td>
</tr>
</tbody>
</table>
CMMI® Maturity Level 3 (Defined) - Process Area List

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PA Acronym</th>
<th>PA Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Integration</td>
<td>PI</td>
<td>Assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product</td>
</tr>
<tr>
<td>Validation</td>
<td>Val</td>
<td>Demonstrate that a product or product component fulfills its intended use when placed in its intended environment</td>
</tr>
<tr>
<td>Verification</td>
<td>Ver</td>
<td>Assure that selected work products meet their specified requirements</td>
</tr>
<tr>
<td>Decision Analysis and Resolution</td>
<td>DAR</td>
<td>Make decisions using a structured approach that evaluates identified alternatives against established criteria</td>
</tr>
</tbody>
</table>
## CMMI® Maturity Level 4 (Quantitatively Managed) - Process Area List

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PA Acronym</th>
<th>PA Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational Process Performance</td>
<td>OPP</td>
<td>Establish and maintain a quantitative understanding of the performance of the organization’s set of standard processes, and to provide the process performance data, baselines, and models to quantitatively manage the organization’s projects</td>
</tr>
<tr>
<td>Quantitative Project Management</td>
<td>QPM</td>
<td>Quantitatively manage the project’s defined process to achieve the project’s established quality and process performance objectives</td>
</tr>
</tbody>
</table>
## CMMI® Maturity Level 5
*(Optimizing) - Process Area List*

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PA Acronym</th>
<th>PA Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causal Analysis and Resolution</td>
<td>CAR</td>
<td>Identify causes of defects and other problems and take action to prevent them from occurring in the future</td>
</tr>
<tr>
<td>Organizational Innovation and Deployment</td>
<td>OID</td>
<td>Select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies</td>
</tr>
</tbody>
</table>
CMMI® Source Models

- EIA Interim Standard 731, System Engineering Capability Model (SECM)
- Capability Maturity Model® for Software V2, draft C (SW-CMM® V2C)
- Integrated Product Development Capability Maturity Model® (IPD-CMM®) V0.98
- Software Acquisition Capability Maturity Model® (SA-CMM®)

Industry
- SEI
- Government

- Team of Teams
- Modeling and Discipline Experts
- Collaborative Process

CMMI® Product Suite

CMMI® - SE/SW
CMMI® - SE/SW/IPPD