CMMI V1.1 Tutorial

E-SEPG

April 9, 2002

Mike Phillips, CMMI Program Manager

Sponsored by the U.S. Department of Defense
© 2002 by Carnegie Mellon University
Agenda

• Why focus on Process?
• Background – Why use a Model?
• CMMI Structure
• Comparisons with SW-CMM v1.1, SE-CMM, and EIA/IS 731
• Process Areas Overview
• Appraisal Methodology
• Training
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
What Is Process?

• How do you define process?
General Definition of Process

• How do you define process?

• A process is a set of practices performed to achieve a given purpose; it may include tools, methods, materials, and/or people.

• While process is often described as a leg of the process-people-technology triad, it may also be considered the “glue” that unifies the other aspects.
Why Focus on Process?

• Process provides a constructive, high-leverage focus...
  – as opposed to a focus on people
    » Your work force, on the average, is as “good” as it is trained to be.
    » Working harder is not the answer.
    » Working smarter, through process, is the answer.
  – as opposed to a focus on technology
    » Technology applied without a suitable roadmap will not result in significant payoff.
    » Technology provides the most benefit in the context of an appropriate process roadmap.
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.
Early Process Improvement

• The theories of process management are a synthesis of the concepts of Deming, Crosby, Juran, and others.

• Over the past 30 years, these theories have been used to address problems common to many organizations.

• Solutions have been discovered, but a gap existed between the state of the practice and the state of the art.

• Many of these concepts have been used to build process-improvement models.
What Is a Process Model?

• A model is a structured collection of elements that describe characteristics of effective processes.

• Processes included are those proven by experience to be effective.
How Is a Model Used?

A model is used

– to help set process improvement objectives and priorities, improve processes, and provide guidance for ensuring stable, capable, and mature processes

– as a guide for improvement of organizational processes
Why Is a Model Important?

• A model provides
  – a place to start
  – the benefit of a community’s prior experiences
  – a common language and a shared vision
  – a framework for prioritizing actions
“All models are wrong, but some are useful.”
– George Box

• Simplified approximations of reality that provide insight.
What Model do I use?

• Historically: Depends on the discipline that you want to model.
  – Software Engineering
  – Systems Engineering
  – Software Acquisition
  – Systems Security
  – etc.
What is a CMM?

• **Capability Maturity Model**: A reference model of mature practices in a specified discipline, used to assess a group’s capability to perform that discipline

• CMMs differ by
  – Discipline (software, systems, acquisition, etc.)
  – Structure (staged versus continuous)
  – How Maturity is Defined (process improvement path)
  – How Capability is Defined (institutionalization)

• “Capability Maturity Model®” and CMM® are used by the Software Engineering Institute (SEI) to denote a particular class of maturity models

---

Capability Maturity Model®, CMM®, CMM Integration, and CMMI are service marks and registered trademarks of Carnegie Mellon University
## Commonly Used CMMs

<table>
<thead>
<tr>
<th>CMM</th>
<th>Type</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software CMM</td>
<td>staged</td>
<td>software development</td>
</tr>
<tr>
<td>System Engineering CMM</td>
<td>continuous</td>
<td>system engineering</td>
</tr>
<tr>
<td>System Engineering Capability Model</td>
<td>continuous</td>
<td>system engineering</td>
</tr>
<tr>
<td>Software Acquisition CMM</td>
<td>staged</td>
<td>software acquisition</td>
</tr>
<tr>
<td>System Security Engineering CMM</td>
<td>continuous</td>
<td>security engineering</td>
</tr>
<tr>
<td>Personal Software Process</td>
<td>staged</td>
<td>individual software development</td>
</tr>
<tr>
<td>FAA-iCMM</td>
<td>continuous</td>
<td>software engineering, systems engineering, and acquisition</td>
</tr>
<tr>
<td>IPD-CMM</td>
<td>hybrid</td>
<td>integrated product development</td>
</tr>
<tr>
<td>People CMM</td>
<td>staged</td>
<td>workforce</td>
</tr>
<tr>
<td>SPICE Model</td>
<td>continuous</td>
<td>software development</td>
</tr>
</tbody>
</table>
The Problem

• Systems and software disciplines have traditionally not been well integrated
• The importance of software in systems has increased dramatically
  – Example: % of requirements allocated to software: *
    » B-2 -- 65%
    » F-22 -- 80%
• The DOD has emphasized the need to make the systems/software interface more seamless

* Source: Standish Group *Chaos Report*
So Many Models, So Little Time

- Different structures, formats, terms, ways of measuring maturity
- Causes confusion, especially when using more than one model
- Hard to integrate them in a combined improvement program
- Hard to use multiple models in supplier selection
CMMI to the Rescue!

• Integrates systems and software disciplines into one process improvement framework.

• Provides a framework for introducing new disciplines as needs arise.
Bridging the Divide

- Systems engineering and software engineering processes are integrated.
- Integrates systems and software disciplines into one process improvement framework.
- Provides a framework for introducing new disciplines as needs arise.
But We Don’t Do That...

- Some organizations see themselves as performing just one discipline
  - Software
  - Systems
  - Acquisition

- But...
  - Software always must be part of some kind of system
  - Systems that don’t have software are rare
  - Acquisition can involve both

- Communication and cooperation with other disciplines, even if they are external to our organization is vital
The CMMI Project

- DoD sponsored collaboration between industry, Government, SEI
- Over 100 people involved
  - U.S. Army, Navy, Air Force
  - Federal Aviation Administration
  - National Security Agency
  - Software Engineering Institute
  - ADP, Inc.
  - AT&T Labs
  - BAE
  - Boeing
  - Computer Sciences Corporation
  - EER Systems
  - Ericsson Canada
  - Ernst and Young
  - General Dynamics
  - Harris Corporation
  - Honeywell
  - KPMG
  - Lockheed Martin
  - Motorola
  - Northrop Grumman
  - Pacific Bell
  - Q-Labs
  - Raytheon
  - Reuters
  - Rockwell Collins
  - SAIC
  - Software Productivity Consortium
  - Sverdrup Corporation
  - TeraQuest
  - Thomson CSF
  - TRW
CMMI Models

Source Models

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

- Combined System Engineering / Software Engineering model
- Can be applied to:
  - Just the software engineering projects in an organization
  - Just the system engineering projects in an organization
  - Both
  - IPPD can be used in either/both
Comparing Model Representations

Staged

Continuous

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

. . .for a single process area or a set of process areas
Relating Process Area Capability and Organizational Maturity

- Process area capability and organizational maturity are similar concepts.

- The difference between them is that process area capability deals with a set of processes relating to a single process area or specific practice, while organizational maturity pertains to a set of process areas across an organization.
Relating Process Area Capability and Organizational Maturity

- Although the comparison of ratings and levels is an advanced topic we don’t address in this tutorial, in general terms, if a set of organizational processes have been appraised at a particular maturity level, the appraised processes may demonstrate a comparable level of process area capability.
Remember

• A model is not a process.

• The model shows what to do, NOT how to do it or who does it.
Why Do We Have Two Representations?

• Source Model Heritage
  – Software CMM--Staged
  – SECM--Continuous
  – IPD CMM--Hybrid

• Proponents for each type of representation were part of CMMI product development team.

• Selecting a single representation approach became “too hard”.

• A compromise was made to initially support two representations of the model with equivalent content.
Advantages of the Staged Representation

• Provides a roadmap for implementing:
  – groups of process areas
  – sequencing of implementation

• Familiar structure for those transitioning from the SW-CMM
Advantages of the Continuous Representation

• Provides maximum flexibility for focusing on specific process areas according to business goals and objectives.

• Familiar structure for those transitioning from the systems engineering community.
CMMI Product Suite

• Models
  – Disciplines
    » Systems Engineering SE
    » Software Engineering SW
    » Integrated Product and Process Development (IPPD)
    » Supplier Sourcing (SS)
  – Representations
    » Staged
    » Continuous

• Training
  – Model
    » Introduction to CMMI
    » Intermediate Concepts
  – Instructor Training
  – Lead Appraiser

• Appraisal methods
  – Appraisal Requirements for CMMI (ARC)
  – SCAMPI Method Description Document (MDD)
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

- Process improvement should be done to help the business—not for its own sake.

“In God we trust, all others bring data.”

- W. Edwards Deming
The Bottom Line 2

• 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 seven 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 Graph]

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

Man-hours per LOC

Normalized Man-hours

Release

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
Productivity Rate SLOC per Person Day

Level 2
Level 3
Level 4

Productivity Increased By 80% As Error Rates Decreased
Topics

• The structure of the CMMI documents
  • The structure of the CMMI Continuous representation
  • The structure of the CMMI Staged representation
  • Summary
Six chapters provide an overview

- The Introduction
- Structure of the Model
- Model Terminology
- Capability Level and Generic Model components
- Understanding the Model
- Using the Model
Organization of Continuous Model -2

• Process areas
  » Process management
  » Project Management
  » Engineering
  » Support

• Appendixes
  » References
  » Acronyms
  » Glossary
  » Required and expected Model Elements
  » CMMI Project Participants
  » Equivalent Staging
Organization of Staged Model -1

- Six chapters provide an overview
  - The Introduction
  - Structure of the Model
  - Model Terminology
  - Maturity Levels, Common Features, and Generic Practices
  - Understanding the Model
  - Using the Model
Organization of Staged Model -2

• Process areas
  » Maturity Level: 2 Managed
  » Maturity Level: 3 Defined
  » Maturity Level: 4 Quantitatively Managed
  » Maturity Level: 5 Optimizing

• Appendixes
  » References
  » Acronyms
  » Glossary
  » Required and expected Model Elements
  » CMMI Project Participants
Model Components

- Process Areas
  - Specific Goals
  - Specific Practices
  - Generic Goals
  - Generic Practices
    » Typical Work Products
    » Sub-practices
    » Notes
    » Discipline Amplifications
    » Generic Practice Elaborations
    » References
CMMI Structure
One Model, Two Representations

Overview
Introduction
Structure of the Model
Model Terminology
Maturity Levels, Common Features, and Generic Practices
Understanding the Model
Using the Model

CMMI-SE/SW
Staged

Maturity Level 5
OID, CAR

Maturity Level 4
OPP, QPM

Maturity Level 3
REQD, TS, PI, VER, VAL, OPF, OPD, OT, IPM, RSKM, DAR

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

Support
CM, PPQA, MA, CAR, DAR

Engineering
REQM, REQD, TS, PI, VER, VAL

Project Management
PP, PMC, SAM IPM, RSKM, QPM

Process Management
OPF, OPD, OT, OPP, OID

CMMI-SE/SW
Continuous

Appendixes

CMMI Tutorial Mar 25, 2002
Topics

• Structure of the CMMI documents

→ • The structure of the CMMI continuous representation
  • The structure of the CMMI staged representation
  • Summary
A process area capability profile may be represented by a set of points in two dimensions.

- the *process dimension*
  - “What” you do
- the *capability dimension*
  - “How well” you do it
The Process Dimension

- The values on this axis describe what processes (described within Process Areas) you perform.
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”
## Continuous Organization of Process Areas

<table>
<thead>
<tr>
<th>Category</th>
<th>Process Area</th>
</tr>
</thead>
</table>
| Project Management| Project Planning  
Project Monitoring and Control  
Supplier Agreement Management  
Integrated Project Management (IPPD)  
**Integrated Supplier Management (SS)**  
**Integrated Teaming (IPPD)**  
Risk Management  
Quantitative Project Management |
| Support           | Configuration Management  
Process and Product Quality Assurance  
Measurement and Analysis  
Causal Analysis and Resolution  
Decision Analysis and Resolution  
**Organizational Environment for Integration (IPPD)** |
| Engineering       | Requirements Management  
Requirements Development  
Technical Solution  
Product Integration  
Verification  
Validation |
| Process Management| **Organizational Process Focus**  
**Organizational Process Definition**  
**Organizational Training**  
**Organizational Process Performance**  
**Organizational Innovation and Deployment** |
The Capability Dimension -1

• The values on this axis describe how well you perform a process (called Capability Levels).
The Capability Dimension -2

- The values on this axis describe how well you perform a process (called Capability Levels).
A capability level is a well-defined evolutionary plateau describing the capability of a process area.

There are six capability levels.

Each level is a layer in the foundation for continuous process improvement.

Thus, capability levels are cumulative, i.e., a higher capability level includes the attributes of the lower levels.
Capability Levels are Cumulative

- Because capability levels build upon one another, there can be no gaps.
• The capability of an implemented process can be represented by a bar.

![Graph showing process capability](chart.png)

This point represents a higher level of capability than this point in a specific process area.
An Example Process Area Capability Profile

![Bar Chart](image)

- **Process Areas**: RM, PP, PMC, etc.
- **Capability Levels**: 0, 1, 2, 3, 4, 5

The chart illustrates the capability levels of different process areas in an example scenario.
Realizing These Concepts in the CMMI Continuous Model

• **Goals** and **Practices** are the model elements used to realize the values on both the capability and process dimensions.

  – **Goal**
    » A high level statement of the outcome to be achieved by effective implementation of a group of practices.

  – **Practice**
    » A description of an action that is necessary to enact a key element of a process area.
There Are Two Types of Goals and Practices

• Specific Goals and Specific Practices
  – realize the process dimension
  – therefore, they apply to a particular Process Area

• Generic Goals and Generic Practices
  – realize the capability dimension
  – therefore, they apply across all Process Areas
Example: Specific Goal and Specific Practice

• Specific Goal (from Requirements Management PA)
  – Requirements are maintained and accurately reflected in project plans, activities and products.

• Specific Practice (from Requirements Management PA)
  – Maintain the traceability of requirements to their source requirements.
Example: Generic Goal and Generic Practice

• Generic Goal (from Capability Level 1)
  – The implemented process achieves the specific goals of the process area.

• Generic Practice (from Capability Level 1)
  – Perform the basic activities of the process to develop work products and provide services to achieve the specific goals of the process area.
Structure of the CMMI
Continuous Representation

Generic Goals & Generic Practices

Specific Goals & Practices

Specific Goals & Practices
Critical Distinctions

- performed vs. managed
  - the extent to which the process is planned; performance is managed against the plan; corrective actions are taken when needed

- managed vs. defined
  - the scope of application of the process descriptions, standards, and procedures (i.e., project vs. organization)

- defined vs. quantitatively managed
  - the predictability of process performance

- quantitatively managed vs. optimizing
  - the process is continuously improved by addressing common causes of process variation
## Improving a Process Area

<table>
<thead>
<tr>
<th>Process Area</th>
<th>CL Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP1.1 through GP5.2, CL1+CL2*+CL3* SPs</td>
<td>CL5</td>
<td>Defect prevention, proactive improvement, innovative technology insertion and deployment</td>
</tr>
<tr>
<td>GP1.1 through GP4.2, CL1+CL2*+CL3* SPs</td>
<td>CL4</td>
<td>Measure process performance, stabilize process, control charts, deal with causes of special variations</td>
</tr>
<tr>
<td>GP1.1 through GP3.2, CL1+CL2*+CL3* SPs</td>
<td>CL3</td>
<td>Project’s process is tailored from organization’s standard processes, understand process qualitatively, process contributes to the organizations assets</td>
</tr>
<tr>
<td>GP1.1 through GP2.10, CL1 + CL2* SPs</td>
<td>CL2</td>
<td>Adhere to policy, follow documented plans and processes, apply adequate resources, assign responsibility and authority, train people, apply CM, monitor, control, and evaluate process, identify and involve stakeholders, review with management</td>
</tr>
<tr>
<td>GP1.1, CL1 (base) SPs</td>
<td>CL1</td>
<td>Perform the work</td>
</tr>
<tr>
<td>No GPs or SPs exist</td>
<td>CL0</td>
<td>Not performed, incomplete</td>
</tr>
</tbody>
</table>

* Advanced practices exist only in the Engineering PAs.
Requirements Management

Specific practices (CL1 - “base”)

SP1.1-1: Obtain an Understanding of Requirements
SP1.3-1: Manage Requirements Changes
SP1.5-1: Identify Inconsistencies Between Project Work and Requirements

Generic practices (CL1)

GP1.1: Perform Base Practices

Specific practices (CL2 - “advanced”)

SP1.2-2: Obtain Commitment to Requirements
SP1.4-2: Maintain Bi-directional Traceability of Requirements

Generic practices (CL2)

GP2.1: Establish an Organizational Policy
GP2.2: Plan the Process
GP2.3: Provide Resources
GP2.4: Assign Responsibility
GP2.5: Train People
GP2.6: Manage Configurations
GP2.7: Identify and Involve Relevant Stakeholders
GP2.8: Monitor and Control the Process
GP2.9: Objectively Evaluate Adherence
GP2.10: Review Status with Higher Level Management
## Requirements Management

<table>
<thead>
<tr>
<th>Specific practices (CL1 &amp; CL2)</th>
<th>Generic practices (CL1 &amp; CL2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1.1-1: Obtain an Understanding of Requirements</td>
<td>GP1.1: Perform Base Practices</td>
</tr>
<tr>
<td>SP1.2-2: Obtain Commitment to Requirements</td>
<td>GP2.1: Establish an Organizational Policy</td>
</tr>
<tr>
<td>SP1.3-1: Manage Requirements Changes</td>
<td>GP2.2: Plan the Process</td>
</tr>
<tr>
<td>SP1.4-2: Maintain Bi-directional Traceability of Requirements</td>
<td>GP2.3: Provide Resources</td>
</tr>
<tr>
<td>SP1.5-1: Identify Inconsistencies Between Project Work and Requirements</td>
<td>GP2.4: Assign Responsibility</td>
</tr>
<tr>
<td></td>
<td>GP2.5: Train People</td>
</tr>
<tr>
<td></td>
<td>GP2.6: Manage Configurations</td>
</tr>
<tr>
<td></td>
<td>GP2.7: Identify and Involve Relevant Stakeholders</td>
</tr>
<tr>
<td></td>
<td>GP2.8: Monitor and Control the Process</td>
</tr>
<tr>
<td></td>
<td>GP2.9: Objectively Evaluate Adherence</td>
</tr>
<tr>
<td></td>
<td>GP2.10: Review Status w/Higher Level Management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific practices (CL3)</th>
<th>Generic practices (CL3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All the CL1 &amp; CL2 Specific Practices</td>
<td>All the CL1 &amp; CL2 Generic Practices plus(+)</td>
</tr>
<tr>
<td></td>
<td>GP3.1: Establish a Defined Process</td>
</tr>
<tr>
<td></td>
<td>GP3.2: Collect Improvement Information</td>
</tr>
</tbody>
</table>
## Requirements Management

<table>
<thead>
<tr>
<th>Specific practices (CL4)</th>
<th>Generic practices (CL4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All the CL1 &amp; CL2 Specific Practices</td>
<td>All the CL1 &amp; CL2 &amp; CL3 Generic Practices plus(+)</td>
</tr>
<tr>
<td></td>
<td>GP4.1: Establish Quantitative Objectives for the Process</td>
</tr>
<tr>
<td></td>
<td>GP4.2: Stabilize Subprocess Performance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific practices (CL5)</th>
<th>Generic practices (CL5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All the CL1 &amp; CL2 Specific Practices</td>
<td>All the CL1 &amp; CL2 &amp; CL3 &amp; CL4 Generic Practices plus(+)</td>
</tr>
<tr>
<td></td>
<td>GP5.1: Ensure Continuous Process Improvement</td>
</tr>
<tr>
<td></td>
<td>GP5.2: Correct Root Causes of Problems</td>
</tr>
</tbody>
</table>
Summary

• CMMI models were developed with broad participation and review.

• Process Areas identify “what you do.”

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

• Structure of the CMMI documents
• The structure of the CMMI Continuous representation document
  • The Structure of the CMMI Staged representation
• Summary
Maturity Levels

• A maturity level is a well-defined evolutionary plateau on the path to becoming a mature organization.

• There are five maturity levels.

• Each level is a layer in the foundation for continuous process improvement.
The Maturity Levels

1. Process unpredictable, poorly controlled and reactive
2. Process characterized for projects and is often reactive
3. Process characterized for the organization and is proactive
4. Process measured and controlled
5. Focus on process improvement

- Performed
- Managed
- Defined
- Quantitatively Managed
- Optimizing
Structure of the CMMI Staged Representation

Commitment to Perform: creates policies and secures sponsorship for process improvement efforts
Ability to Perform: ensures that the project and/or organization has the resources it needs to pursue process improvement
Directing Implementation: collects, measures, and analyzes data related to processes
Verification: verifies that the projects and/or organization’s activities conform to requirements, processes, and procedures
Maturity Levels Cannot Be Skipped

• A level provides a necessary foundation for effective implementation of processes at the next level.
  – Higher level processes are easily sacrificed without the discipline provided by lower levels.
  – The effect of innovation is obscured in a noisy process.

• Higher maturity level processes may be performed by organizations at lower maturity levels, with risk of not being consistently applied in a crisis.
Process Areas

- Process Areas (PAs) are clusters of related practices performed collectively to achieve a set of goals.
- They are the major building blocks in establishing the process capability of an organization.
- Each process area has been defined to reside at a given maturity level.
# Process Areas by Maturity Level

<table>
<thead>
<tr>
<th>Level</th>
<th>Focus</th>
<th>Process Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Continuous process improvement</td>
<td>Organizational Innovation and Deployment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Causal Analysis and Resolution</td>
</tr>
<tr>
<td>4 Quantitatively</td>
<td>Quantitative management</td>
<td>Organizational Process Performance</td>
</tr>
<tr>
<td>Managed</td>
<td></td>
<td>Quantitative Project Management</td>
</tr>
<tr>
<td>3 Defined</td>
<td>Process standardization</td>
<td>Requirements Development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical Solution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Product Integration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Verification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Validation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organizational Process Focus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organizational Process Definition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organizational Training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrated Project Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrated Supplier Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Risk Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decision Analysis and Resolution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organizational Environment for Integration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrated Teaming</td>
</tr>
<tr>
<td>2 Managed</td>
<td>Basic project management</td>
<td>Requirements Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project Planning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project Monitoring and Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supplier Agreement Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measurement and Analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Process and Product Quality Assurance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Configuration Management</td>
</tr>
<tr>
<td>1 Performed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example: Specific Goal and Specific Practice

• **Specific Goal (from Requirements Management PA)**
  – Requirements are maintained and accurately reflected in project plans, activities and products.

• **Specific Practice (from Requirements Management PA)**
  – Maintain the traceability of requirements to their source requirements.
Example: Generic Goal and Generic Practice

• Generic Goal (from Maturity Level 2)
  – Institutionalize a Managed Process.

• Generic Practice (from Maturity Level 2)
  – Establish an Organizational Policy.
Common Features

Common features are a means of categorizing Generic practices.

- **Commitment to perform:**
  establishment of management policies

- **Ability to perform:**
  establishment and maintenance of plans, resources, assigned responsibility and authority, and training

- **Directing implementation:**
  measurement, control, and performance practices

- **Verification:**
  ensure implementation and compliance
Another way to look at Common Features -1

- Common feature categories are very similar across process areas.

- They are referred to as Institutionalization Common Features because they:
  - ensure the process areas are effective, repeatable and lasting
  - provide needed infrastructure support
Common Feature Examples -1
from Requirements Management Process Area

• *Commitment to perform:*
  – Establish and maintain an organizational policy for planning and performing the requirements management process.

• *Ability to perform:*
  – Train the people performing or supporting the requirements management process as needed.
• **Directing implementation:**
  – Place designated work products of the requirements management process under appropriate levels of configuration management.

• **Verification:**
  – Review the activities, status, and results of the requirements management process with higher level management and resolve issues.
Summary -1

• There is one CMMI Model with two representations, Staged and Continuous.

• The material in both representations is the same just organized differently.

• Each representation provides different ways of implementing processes

• The CMMI model should be applied using intelligence, common sense, and professional judgment.
Summary -2

• Continuous
  – Flexible in its application so the organization can choose which areas to emphasize.
  – Provides equivalent staging to compare to staged representation.

• Staged
  – Structured for implementation based on proven grouping and ordering of processes.
CMMI-SE/SW
Compared to SW-CMM v1.1
SW-CMM v1.1 vs. CMMI

Process Areas

**LEVEL 5 OPTIMIZING**
- Defect Prevention
- Technology Change Mgmt
- Process Change Management
- Causal Analysis and Resolution
- Organizational Innovation & Deployment

**LEVEL 4 MANAGED**
- Quantitative Process Mgmt
- Software Quality Mgmt
- Organizational Process Performance
- Quantitative Project Management

**LEVEL 3 DEFINED**
- Organization Process Focus
- Organization Process Definition
- Training Program
- Integrated Software Mgmt
- Software Product Engr
- Integrated Project Management
- Risk Management
- Requirements Development
- Technical Solution
- Product Integration
- Verification
- Validation
- Decision Analysis and Resolution

**LEVEL 2 REPEATABLE**
- Requirements Management
- Software Project Planning
- Software Project Tracking & Oversight
- Software Subcontract Mgmt
- Software Quality Assurance
- Software Configuration Mgmt
- Requirements Management
- Project Planning
- Project Monitoring and Control
- Supplier Agreement Management
- Product & Process Quality Assurance
- Configuration Management
- Measurement and Analysis
CMMI Improvements Over the CMM

• Emphasis on measurable improvements to achieve business objectives.

• Process areas have been added to place more emphasis on some important practices:
  – Risk Management
  – Measurement and Analysis
  – Engineering Process Areas
  – Decision Analysis
CMMI-SE/SW/IPPD
Compared to EIA/IS 731
(Systems Engineering Capability Model)
Background

• Electronic Industries Alliance Interim Standard (EIA/IS) 731, System Engineering Capability Model (SECM), was created as a merger of the SE-CMM and the INCOSE Systems Engineering Capability Assessment Model (SECAM)

• Used as a source model for CMMI
What is the Systems Engineering Capability Model (SECM)?

• Describes the essential systems engineering and management tasks that any organization must perform

• Road map for systems engineering & management process improvement

• Systems engineering and management process measurement tool
SECM Focus Areas

- Define & Improve SE Process
- Plan & Organize
- Monitor & Control
- Integrate Disciplines
- Define SE Stkhldr & Sys Level Rqmnts
- Define Solution
- Integrate System
- Manage Risk
- Define Technical Problem
- Assess & Select
- Verify System
- Manage Configurations
- Validate System
- Ensure Quality
- Coordinate with Suppliers
- Manage Data
- Manage SE Support Environment
- Manage Competency
- Manage Technology
- Environment
- Management
- Technical
Comparison of Elements -1

SECM Technical Focus Areas  CMMI Engineering PAs

1.1 Define Stakeholder & Requirements
    System Level Requirements

1.2 Define Technical Requirements

1.3 Define Solution

1.4 Assess and Select Support

1.5 Integrate System

1.6 Verify System

1.7 Validate System

Requirements Management
Requirements Development
Technical Solution
Product Integration
Verification
Validation
## Comparison of Elements -2

<table>
<thead>
<tr>
<th>SECM Management Focus Areas</th>
<th>CMMI Project Management Process Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Plan and Organize</td>
<td>Project Planning</td>
</tr>
<tr>
<td>2.2 Monitor &amp; Control</td>
<td>Project Monitor &amp; Control</td>
</tr>
<tr>
<td>2.3 Integrate Disciplines</td>
<td>Integrated Project Mgt</td>
</tr>
<tr>
<td>2.4 Coordinate w/ Supp.</td>
<td>Supplier Agreement Mgt</td>
</tr>
<tr>
<td>2.5 Manage Risk</td>
<td>Risk Management</td>
</tr>
<tr>
<td>2.6 Manage Data</td>
<td>Quantitative Project Mgt</td>
</tr>
<tr>
<td>2.7 Manage Configurations</td>
<td>Support Process Areas</td>
</tr>
<tr>
<td>2.8 Ensure Quality</td>
<td>Configuration Mgt</td>
</tr>
</tbody>
</table>

### Support Process Areas
- Proc & Prod QA
- Measurement & Analysis
- Causal Analysis and Resolution
- Decision Analysis & Resolution
Comparison of Elements -3

CMMI Process Management
Process Areas

SECM Environment Focus Areas

Organizational Process Focus

3.1 Define & Improve SE Process
Organizational Process Definition

3.2 Manage Competency
Organizational Training

3.3 Manage Technology
Organizational Process Performance

3.4 Manage SE Support Environment
Organizational Innovation & Deployment
Comparison of Generic Elements

**SECM Capability Level 2**

2.1 Follow recorded & approved plans & processes

2.2 Verify compliance & take action when needed

**CMMI Capability Level 2**

2.1 Establish org policy
2.2 Plan the process
2.3 Provide resources
2.4 Assign responsibilities
2.5 Train people
2.6 Manage configurations
2.7 Identify & involve relevant stakeholders
2.8 Monitor & control process
2.9 Objectively evaluate adherence
2.10 Review status w/ higher-level mgmt
Comparison of Generic Elements -3

**SECM** Capability Level 3

3.1 Standardize & record a well-defined proc

3.2 Tailor the standard proc using standard guidelines

3.3 Implement & improve the FA activities

3.4 Improve the standard process

**CMMI** Capability Level 3

3.1 Establish a defined process

3.2 Collect improvement information

CMMI Tutorial Mar 25, 2002
**Comparison of Generic Elements -4**

**SECM Capability Level 4**

4.1 Collect & analyze metrics

4.2 Take appropriate action to align performance & expectations

**CMMI Capability Level 4**

4.1 Establish quantitative objectives for the process

4.2 Stabilize subprocess performance
Comparison of Generic Elements -5

**SECM** Capability Level 5

5.1 Identify FA activities for which it is appropriate to quantify process repeatability

5.2 Establish quantitative goals for improving the standard process

5.3 Improve the std proc based on data & metrics

5.4 Perform causal analysis & eliminate causes of variation by changing the standard process

**CMMI** Capability Level 5

5.1 Ensure continuous process improvement

5.2 Correct root causes of problems
Conclusions

• EIA/IS 731 users should be able to smoothly transition to the CMMI-SE/SW model
  – Continuous representation (+ “equivalent” staged representation)
  – Some lower-level differences
  – Application of common SE/SW practices to product development community
Overview of CMMI\textsuperscript{SM}
SE/SW/IPPD/SS Model
Process Areas
## Continuous Organization of PAs

<table>
<thead>
<tr>
<th>Category</th>
<th>Process Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Management</strong></td>
<td>Project Planning&lt;br&gt;Project Monitoring and Control&lt;br&gt;Supplier Agreement Management&lt;br&gt;Integrated Project Management (IPPD)&lt;br&gt;<strong>Integrated Supplier Management (SS)</strong>&lt;br&gt;<strong>Integrated</strong> Teaming (IPPD)&lt;br&gt;Risk Management&lt;br&gt;Quantitative Project Management</td>
</tr>
<tr>
<td><strong>Support</strong></td>
<td>Configuration Management&lt;br&gt;Process and Product Quality Assurance&lt;br&gt;Measurement and Analysis&lt;br&gt;Causal Analysis and Resolution&lt;br&gt;Decision Analysis and Resolution&lt;br&gt;<strong>Organizational</strong> Environment for Integration (IPPD)</td>
</tr>
<tr>
<td><strong>Engineering</strong></td>
<td>Requirements Management&lt;br&gt;Requirements Development&lt;br&gt;Technical Solution&lt;br&gt;Product Integration&lt;br&gt;Verification&lt;br&gt;Validation</td>
</tr>
<tr>
<td><strong>Process Management</strong></td>
<td>Organizational Process Focus&lt;br&gt;Organizational Process Definition&lt;br&gt;Organizational Training&lt;br&gt;Organizational Process Performance&lt;br&gt;Organizational Innovation and Deployment</td>
</tr>
</tbody>
</table>
There are eight Project Management Process Areas.

- Project Planning
- Project Monitoring and Control
- Supplier Agreement Management
- Integrated Project Management
- Integrated Supplier Management (SS)
- Risk Management
- Quantitative Project Management

- Integrated Teaming (IT) and IPM(IPPD) will be discussed with IPPD.
Basic Project Management PAs

PMC

Corrective action
Replan
Status, issues, results of progress and milestone reviews
Plans

PP

What To Monitor
Corrective action
What To Build
What To Do
Commitments
Measurement needs

SAM

Supplier agreement

Supplier

Product component requirements
Technical issues
Completed product components
Acceptance reviews and tests

Status, issues, results of process and product evaluations; measures and analyses

Engineering and Support process areas
Project Planning

- **Purpose:**
- Establish and maintain plans that define project activities.
Project Planning - Context

1. Establish Estimates
2. Planning Data
3. Obtain Commitment to the Plan
4. Develop a Project Plan

PMC
Project Planning - Context

Establish Estimates

- Estimate the Scope of the Project
- Establish Estimates of Work Product and Task Attributes
- Determine Estimates of Effort and Cost
- Define Project Life Cycle

Planning Data
Project Planning - Context

Planning Data

Develop a Project Plan

- Establish the Budget and Schedule
- Identify Project Risks
- Plan for Data Management
- Plan for Project Resources
- Plan for Needed Knowledge and Skills
- Plan Stakeholder Involvement

Establish the Project Plan

Project Plans
Project Planning - Context

1. Obtain Commitment to the Plan
2. Review Plans that Affect the Project
3. Reconcile Work and Resource Levels
4. Obtain Plan Commitment

Project Plans
Project Monitoring and Control

• Purpose:

• 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.
Project Monitoring and Control - Context

- Monitor Project Against Plans
- Monitor Project Planning Parameters
- Monitor Project Risks
- Monitor Stakeholder Involvement
- Monitor Commitments
- Monitor Data Management
- Conduct progress Reviews
- Conduct Milestone Reviews
- Manage Corrective Actions to Closure
  - Analyze Issues
  - Take Corrective Actions
  - Manage Corrective Actions

PP

Project Plans
Supplier Agreement Management

• Purpose:

• Manage the acquisition of products from suppliers for which there exists a formal agreement.
Supplier Agreement Management

Context

- **List of Products**
  - **Establish Supplier Agreements**
    - **Determine Acquisition Type**
    - **Select Suppliers**
    - **Establish Supplier Agreements**
  - **Supplier Requirements**
    - **Review COTS Products**
    - **Accept the Acquired Product**
    - **Transition Products**
  - **Product**
  - **Supplier Agreement**
    - **Execute the Supplier Agreement**

Satisfy Supplier Agreements
Advanced Project Management PAs

- Process Performance Objectives, Baselines, Models
- Statistical Mgmt Data
  - sub-processes for quantitative mgmt.
  - Organization’s Std. Processes
  - Lessons Learned, Performance Data
- QPM
  - Risk exposure due to unstable processes
  - Identified risks
- RSKM
  - Coordination & collaboration; Shared vision & IT structure
  - Risk Taxonomies & Parameters, Status, Mitigation, and Corrective Action
- IPM
  - Coordination, commitments, issues; Product Architecture for Structuring Teams
  - Project’s Defined Process
- IT
  - IT mgmt for engineering processes;
  - Integrated work environment people & practices

Process Management process areas

Engineering & Support process areas

Basic Project Management process areas
• Purpose:

• 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.
Integrated Project Management - Context

Use the Project’s Defined Process

- Establish the Project’s Defined Process
- Use Org Proc Assets for Planning Project Activities
- Integrate Plans

Coordinate with Relevant Stakeholders

- Defined Process Based Project Plan
- Manage Stakeholder Involvement
- Manage Dependencies
- Resolve Coordination Issues

Other Project & Org Functions

- Project’s Defined Process
- Agendas and Schedules for Collaborative Activities
- Documented Critical Dependencies
- Documented Technical Issues

- Manage Project Using Integrated Plans
- Contribute to Org Process Assets
- Other Project & Org Functions

- • Estimates and Measures
- • Documentation
- • Lessons Learned

- Use Org Proc Assets for Planning Project Activities
- Integrate Plans

CMMI Tutorial Mar 25, 2002
Integrated Supplier Management

• Purpose:

• Proactively identify sources of products that may be used to satisfy the project’s requirements and to manage selected suppliers while maintaining a cooperative project-supplier relationship.
Integrated Supplier Management - Context

Analyze and Select Sources of Products

- Analyze Potential Sources of Products
- Evaluate and Determine Sources of Products

Coordinate Work with Suppliers

- Monitor Selected Supplier Processes
- Evaluate Selected Supplier Work Products
- Revise the Supplier Agreement or Relationship

SAM

Supplier Processes

Supplier Work Products
Risk Management

• Purpose:

• Identify potential problems before they occur, so that risk handling activities may be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.
Risk Management - Context

- Identify and Analyze Risks
  - Identify Risks
  - Evaluate, Categorize, and Prioritize Risks
  - Mitigate Risks
    - Implement Risk Mitigation Plans
    - Develop Risk Mitigation Plans
  - Define Risk Parameters
  - Establish a Risk Management Strategy
  - Determine Risk Sources and Categories

- Prepare for Risk Management
  - Establish a Risk Management Strategy
  - Define Risk Parameters
  - Determine Risk Sources and Categories

- Risk Repository

- From Project Planning and Project Monitoring and Control
  - DAR

CMMI Tutorial Mar 25, 2002
Quantitative Project Management

• Purpose:

• Quantitatively manage the project’s defined process to achieve the project’s established quality and process-performance objectives.
Quantitative Project Management - Context

- Quantitatively Manage the Project
  - Establish Project's Objectives
  - Manage Project Performance
  - Statistically Manage Subprocess Performance

- OPP
  - Predictions of Quality and Process Performance
  - Organization Measurement Repository
  - Subprocesses Capability Measure

- Quality and Process Performance Objectives
  - Remedial Actions
  - Project's Defined Process

- Compose the Defined Process
  - Select the Subprocesses that will be Statistically Managed
  - Selected Subprocesses
  - Definitions of Measures; Derived Objectives

- Statistically Manage Subprocess Performance
  - Record Statistical Management Data
  - Monitor Performance of Selected Subprocesses
  - Apply Statistical Methods to Understand Variation
  - Select Measures and Analytic Techniques
  - Stable Sub-processes
Summary

- Project Planning
- Project Monitoring and Control
- Supplier Agreement Management
- Risk Management
- Integrated Project Management
- Integrated Supplier Management (SS)
- Quantitative Project Management

Special Note: Integrated Teaming (IT) and IPM(IPPD) will be discussed with IPPD.
Support Process Areas

There are six Support Process Areas:

- Configuration Management
- Process and Product Quality Assurance
- Measurement and Analysis
- Causal Analysis and Resolution
- Decision Analysis and Resolution
- Organizational Environment for Integration will be discussed with IPPD.
Support process areas cover the practices that support product development, maintenance, and acquisition.

They provide essential processes used by all the CMMI process areas, and are typically used in the context of performing other processes.
Basic Support Process Areas

- Measurements, analyses
- Information needs
- Configuration items; change requests
- Processes and work products; standards and procedures
- Baselines; audit reports
- Quality and noncompliance issues
Configuration Management

• Purpose:

• Establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.
Configuration Management - Context

- Identify Configuration Items
- Establish a Config. Management System
- Create or Release Baselines
- Track and Control Changes
- Change Requests

Establish Integrity

Establish Configuration Management System

Change Request Database

Change Requests

Establish Config Mgmt Records

Perform Configuration Audits

Track Change Requests

Control Configuration Items

Establish Baselines
Process and Product Quality Assurance

• Purpose:

• Provide staff and management with objective insight into processes and associated work products.
Process and Product Quality Assurance - Context

- Objectively Evaluate Processes
- Objectively Evaluate Work Products & Services
- Reports and Records
- Provide Objective Insight
- Communicate and Ensure Resolution of Non-compliance Issues
- Establish Records

Work Products

Communicate and Ensure Resolution of Non-compliance Issues
Measurement and Analysis

• Purpose:

  • Develop and sustain a measurement capability that is used to support management information needs.
Advanced Support Process Areas

- **CAR**
  - Process improvement proposals;
  - Defects & other problems

- **OEI**
  - Ability to develop & deploy IPPD processes & supporting assets;
  - IPPD knowledge & skill needs;
  - Integrated work environment & people practices;
  - Selected issues;
  - Structured decisions

- **Process Management PAs**
- **Project Management PAs**

- **DAR**
  - All process areas

- **Organization**
  - IPPD Infrastructure

- **OEI**
  - Process improvement proposals;
  - Ability to develop & deploy IPPD processes & supporting assets;
  - IPPD knowledge & skill needs;
  - Integrated work environment & people practices;
  - Selected issues;
  - Structured decisions
Causal Analysis and Resolution

• Purpose:

• Identify causes of defects and other problems and take action to prevent them from occurring in the future.
Causal Analysis and Resolution - Context

- Analyze Causes
- Select Data for Analysis
- Determine Causes of Defects
- Implement Action Proposals
- Record Data
- CAR Records
- Performance Measures
- Action Plans
- Address Causes of Defects
- Evaluate Effect of Changes
- Action Proposal

- Defect & Problem Data
• Purpose:

• Analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.
Decision Analysis and Resolution

- Applicability:
  - The project should document guidelines for when a structured decision analysis process is to be used.
  - DAR should be applied where significant technical, cost, or schedule risks evolve.
Decision Analysis and Resolution - Context

Evaluate Alternatives

Establish Guidelines for Decision Analysis

Establish Evaluation Criteria

Identify Alternative Solutions

Select Evaluation Methods

Guidelines

Criteria

Proposed Alternatives

Methods

Select Solutions

Evaluate Alternatives
Engineering Process Areas

- There are six Engineering Process Areas.
- Requirements Management
- Requirements Development
- Technical Solution
- Product Integration
- Verification
- Validation
Engineering Process Areas

REQM: Requirements

RD: Requirements

TS: Product & product component requirements

PI: Product components

Ver: Alternative solutions

Val: Product components, work products, verification and validation reports

Customer needs

Customer
Requirements Management

• Purpose:

• Manage the requirements of the project’s product and product components and identify inconsistencies between those requirements and the project’s plans and work products.
Requirements Management
Context

- Obtain an Understanding of Requirements
- CL2 Obtain Commitment to Requirements
- Manage Requirements Changes
- Identify Inconsistencies between Project Work and Reqmts
- CL2 Maintain Bi-directional Requirements Traceability

Manage Requirements

Traceability Hierarchy
Requirements Development

• Purpose:

• Produce and analyze customer, product, and product component requirements.
Requirements Development - Context

Develop Customer Requirements

Customer Requirements

Develop Product Requirements

Product Requirements

Analyze and Validate Requirements

Validated Requirements
Requirements Development

Context

Develop Customer Requirements

- Collect Stakeholder Needs
- CL2: Elicit Needs
- Develop the Customer Requirements

Customer Requirements
Requirements Development

- Context
  - Establish Product & Product Component Requirements
  - Identify Interface Requirements
  - Allocate Product and Product-Component Requirements

Develop Product Requirements

- Customer Requirements
- Product Requirements
Requirements Development
Context

Analyze and Validate Requirements

- Establish Operational Concepts & Scenarios
- Establish a Definition of Required Functionality
- Analyze Requirements
- Analyze Requirements to Achieve Balance
- Validate Requirements
- CL2 Validate Requirements with Comprehensive Methods
- CL3 Analyze Requirements to Achieve Balance

Product Requirements

Validated Requirements
Technical Solution

• Purpose:

• Design, develop, and implement solutions to requirements. Solutions, designs and implementations encompass products, product components, and product related life-cycle processes either singly or in combinations as appropriate.
Technical Solution - Context

- Select Product-Component Solutions
- Develop the Design
- Implement the Product Design

- Validated Requirements
- Alternative Designs and Evaluation Criteria
- Design Detail & Documentation
- Delivered Product
Technical Solution - Context

Validated Requirements

Operational Scenarios Timeline Analysis Use Cases

Select Product Component Solutions

- Develop Alternative Solutions and Selection Criteria
- CL 2 Develop Detailed Solutions and Selection Criteria
- CL 2 Evolve Operational Concepts & Scenarios
- Select Product Component Solutions

Alternative Solutions Selection Criteria New Technology Evaluations

Selection Decisions Compliance w/ Reqmts

DAR
Technical Solution - Context

Develop the Design

Design the Product or Product Component

Establish a Tech Data Package

Establish Interface Descriptions

Perform Make, Buy, or Reuse Analyses

Selection Criteria Make/Buy Analysis

Tech Data Package

I/F Design Documentation
I/F Specification
I/F Control Documents

CL 3 Design Interfaces Using Criteria

Design Methods
Design Tools
Design Processes
Technical Solution - Context

Implement the Product Design

Implement The Design

Parts Fabricated
Software Coded
Data Documented
Processes Documented
Facilities Constructed

Develop Product Support Documentation

Training Manuals
Users Manual
Operator’s Manual
Maintenance Manual
On-line Help
Product Integration

• Purpose:

• Assemble the product from the product components, ensure the product, as integrated, functions properly and deliver the product.
Product Integration - Context

Prepare for Product Integration

Integration Plan

Ensure Interface Compatibility

Assemble Product Components and Deliver the Product

Technical Solution

DAR

Sub-assemblies

Assemblies
Product Integration - Context

Prepare for Product Integration

- Determine Integration Sequence
- CL2 Establish the Product Integration Environment
- CL3 Establish Product Integration Procedures and Criteria
- Decision Analysis & Resolution
- Technical Solution

Integration Plan
- Integration Resources
- Integration Procedures
- Interface Data
Product Integration - Context

Ensure Interface Compatibility

Review Interface Descriptions for Completeness

Manage Interfaces

Integration Plan
- Integration Resources
- Integration Procedures
- Interface Data

Technical Solution
Product Integration - Context

Assemble Product Components and Deliver Product

Assemble Product Components

Confirm Readiness of Components for Integration

Evaluate Assembled Product Components

Package and Deliver the Product or Product Component

Integration Plan
- Integration Resources
- Integration Procedures
- Interface Data

Technical Solution
Verification versus Validation

• Verification
  – Did you build the product right?
  – That is, did you meet the requirements specification?

• Validation
  – Did you build the right product?
  – That is, did you meet the operational need?
Verification

• Purpose:

• Ensure that selected work products meet their specified requirements.
Verification - Context

- Prepare for Verification
- Verification Plan
- Perform Peer Reviews
- Verify Selected Work Products
- Corrective Actions
Verification - Context

Prepare for Verification

Select Work Products for Verification

CL2 Establish the Verification Environment

CL3 Establish Verification Procedures and Criteria

Requirements, Methods, Processes, Evaluation Criteria

Technical Solution

Verification Plan
- Verification Resources
- Verification Procedures
Verification - Context

Prepare For Peer Reviews

Conduct Peer Reviews

Perform Peer Reviews

CL 2 Analyze Peer Review Data

- Requirement for Data Collection
- Entry and Exit Criteria
- Peer Review Plan
- Review Results
- Review Issues
- Review Data
- Action Items
Verification - Context

Verify Selected Work Products

Perform Verification

Verification Results
Deficiencies
Verification Data
Corrective Actions

CL2
Analyze Verification Results and Identify Corrective Actions
Validation

• Purpose:
  
  • Demonstrate that a product or product component fulfills its intended use when placed in its intended environment.
Validation - Context

- Customer Requirements
- Product Requirements
- Products
- Validation Requirements

Prepare for Validation

- Requirements Validation Plan
- Product Validation Plan
- Process and Support Needs

Validate Product or Product Components

- Conformance
- Deficiencies
Validation - Context

Requirements

Select Products For Validation

- Validation Plan
- Support Needs
- Environment Needs
- Resources

CL3
Establish Validation Procedures and Criteria

CL2
Establish the Validation Environment

- Test Case Scenario
- Validation Procedures

Prepare for Validation
Validation - Context

Validate Product or Product Components

Perform Validation

Analyze Validation Results

Validation Reports
Validation Results
Cross Reference Matrix
As run procedures log
Operational Demonstrations

Validation Deficiency Reports
Validation Issues
Procedure Change Request
There are six Process Management Process Areas:

- Organizational Process Focus
- Organizational Process Definition
- Organizational Training
- Organizational Process Performance
- Organizational Innovation and Deployment
- Organizational Environment for Integration will be covered with IPPD
Understanding Process Management Process Areas

• The process management PAs apply across the organization as a whole and provide details that support the Capability Level 3 Generic Goal.

• For selected PAs, the organization has standard processes, which individual projects tailor to their needs.
Understanding Process Management Process Areas

• Process Management PAs can capitalize on *project level* stability provided by PAs that are institutionalized at CL 2.

• (i.e., policy, planning, resources, responsibility, training, performing the process, managing configurations, monitoring and controlling, objective verification, management review)
Basic Process Management PAs

Senior Management

Organization's process needs and objectives

Training for Projects and Support Groups in Std Process and Assets

OT

Training needs

Std Process and Other Assets

Project Management, Support, and Engineering process areas

OPD

Std Process and Other Assets

OPF

Resources and Coordination

Process Improvement Proposals; Participation in defining, assessing, and deploying processes

Senior Management

Organization's business objectives

Project Management, Support, and Engineering process areas

Training needs

Std Process and Other Assets

Improvement information (e.g., lessons learned, data, artifacts)
Organizational Process Focus

• Purpose:

• Plan and implement organizational process improvement based on a thorough understanding of the current strengths and weaknesses of the organization’s processes and process assets.
Organizational Process Focus
- Context

- Establish Organizational Process Needs
  - Determine Process Improvement Opportunities
  - (Revised) Process Assets
  - Incorporate Process-Related Experiences

- Appraise Org’s Processes
  - Findings & Ratings
  - Deployable Process Assets
  - Deploy Organizational Process Assets

- Identify Org.’s Process Improvements
  - Improvement Initiatives
  - Selected Improvements
  - Process Experiences
  - Implement Process Action Plans

- Process Action plans
  - Establish Process Action Plans

- Plan and Implement Process Improvement Activities
Organizational Process Definition

• Purpose:

• Establish and maintain a usable set of organizational process assets.
Organizational Process Definition - Context

- Establish the Organization's Measurement Repository
- Establish the Organization's Process Asset Library
- Establish Tailoring Criteria and Guidelines
- Establish Standard Processes
- Establish Life-Cycle Model Descriptions
- Establish Organizational Process Assets

Process Implementers

Life Cycle Models
Organizational Standard Processes
Organizational Measurement Repository
Organizational Library of Process Documentation
Tailoring Guidelines

Deployment
Improvements
OPF
Organizational Training

• Purpose:

• Develop the skills and knowledge of people so they can perform their roles effectively and efficiently.
Organizational Training - Context

Establish an Organizational Training Capability

- Establish the Strategic Training Needs
- Determine which Training Needs are the Responsibility of the Org.
- Establish an Organizational Training Tactical Plan

- Analysis
- Needs
- Strategy
- Reqmts
- Materials

Training Repository

- Change Requests
- Records
- Records
- Materials

- Surveys
- Establish Training Records
- Deliver Training

Assess Training Effectiveness

Provide Necessary Training
Advanced Process Management Process Areas

- **Organization**
  - Improvements
  - Quality and process performance objectives, measures, baselines, models

- **Senior Management**
  - Progress toward achieving business objectives
  - Ability to develop and deploy process and supporting assets

- **OID**
  - Quality and process performance objectives, measures, baselines, models

- **OPP**
  - Common measures
  - Process performance and capability data

- **Project Management, Support, and Engineering process areas**
  - Cost and benefit data from piloted improvements

- **“Basic Set” of Process Management Process Areas**
Organizational Process Performance

• Purpose:

• Establish and maintain a quantitative understanding of the performance of the organization’s set of standard processes in support of quality and process-performance objectives, and to provide the process performance data, baselines, and models to quantitatively manage the organization’s projects.
Organizational Process Performance - Context

Establish Performance Baselines and Models

Select Processes

Selected Subprocesses from Org. Std. Processes

Establish Process Performance Objectives

Establish Process Performance Baselines

Organizational Process Performance Objectives

Organizational Process Performance Baselines

Project Process Measurements

• Org set of measures

Establish Quality and Process Performance Measures

Business Objectives

QPM

MA

Business Objectives

Process Performance Models

Establish Process Performance Models

Organizations’s Standard Processes

Select Processes

Establish Process Performance Models
Organizational Innovation and Deployment

• Purpose:

• Select and deploy incremental and innovative improvements that measurably improve the organization’s processes and technologies. The improvements support the organization’s quality and process-performance objectives as derived from the organization’s business objectives.
Organizational Innovation and Deployment - Context

Select Improvements
- Collect and Analyze Improvement Proposals
- Identify and Analyze Innovations
- Pilot Improvements
- Select Improvements for Deployment

Deploy Improvements
- Measure Improvements Effects
- Manage the Deployment
- Plan the Deployment

Measurement Results
Improvement Proposals and Analysis
Improvements
Overview of Integrated Product and Process Development

IPPD
About IPPD

• IPPD affects all process areas.
• IPPD is *not* a discipline like SE or SW.
• Rather, it is a way of doing business.

• IPPD is employed in conjunction with the CMMI disciplines (software and systems engineering).

• Implementation of IPPD shapes how you perform the work in these disciplines.
IPPD - Definition

IPPD provides a systematic approach to product development that achieves a timely collaboration of relevant stakeholders throughout the product life cycle to better satisfy customer needs.
Integration of the development of product-related processes (e.g., manufacturing, support, training, disposal) during product development is embedded in SE/SW specific practices by involving relevant stakeholders from all life cycle phases and by the concept of “work product.”
Stakeholder Involvement

• Stakeholder Involvement is guided and assured by three constructs in CMMI- SE/SW/IPPD:

  • GP 2.7 Identify and involve the relevant stakeholders of the process as planned.

  • PP SP 2.6-1 Plan the involvement of identified stakeholders.

  • IPM SG 2 Collaborate and coordinate with relevant stakeholders.
CMMI Work Product - Definition

– Any artifact produced by a process.
– This may include files, documents, parts of the product, services, processes, specifications, and invoices.
– Examples of processes as work product include a manufacturing process, a training process, and a disposal process.
– A key distinction between a work product and a product component is that a work product need not be engineered (although it may be).
IPPD in CMMI Models

• Then, what makes IPPD different from pure SE/SW implementations?

• IPPD relies on integrated teams to develop the product and processes.

• IPPD provides an integrated work environment and the management of people to incentivize teamwork.

• Processes are tailored to be used by integrated teams.
CMMI Integrated Team Definition

• An integrated team is comprised of people
  – with complementary skills and expertise
  – appropriate skills and advocacy
  – fully empowered to represent stakeholders
  – from all phases of the work product’s life cycle

• These people are committed to and are collectively responsible for
  – delivering specified work products
  – through timely collaboration
Scope of IPPD

- CMMI SE/SW/IPPD adds to CMMI-SE/SW:
  - Two new process areas
    » Organizational Environment for Integration
    » Integrated Teaming
  - A revised Integrated Project Management (IPPD) process area
  - IPPD amplifications and references
  - New glossary definitions and acronyms
  - Overview material
Organizational Environment for Integration (OEI)

• Purpose:
  • To provide an Integrated Product and Process Development (IPPD) infrastructure and manage people for integration.
Organizational Environment for Integration (OEI)- Context

- Provide IPPD Infrastructure
- IPPD-Enabled People and Work Environments
- Manage People for Integration
- Mechanisms and Incentives to Support Integration and Collaboration
Organizational Environment for Integration – Context

Provide IPPD Infrastructure

- Establish the Organization's Shared Vision
- Establish an Integrated Work Environment
- Identify IPPD-Unique Skill Requirements

Organizations Shared Vision Guidelines for Shared Vision Building

Integrated Work Environment

Manage People for Integration

- Establish Leadership Mechanisms
- Establish Incentives for Integration
- Establish Mechanisms to Balance Responsibilities

Guidelines for Empowerment
Guidelines for Leadership, Decision-making Context
Process for Issue Resolution
Team & Individual Rewards
Organizational Guidelines
Joint Performance Review Process
Integrated Project Management
For IPPD

• Purpose:

• 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.

• For Integrated Product and Process Development, Integrated Project Management also covers the establishment of a shared vision for the project and an integrated team structure that will carry out the objectives of the project.
Integrated Project Management (IPPD) - Context

1. **Use the Project’s Defined Process**
   - Coordinate and Collaborate with Relevant Stakeholders
   - Use the Project’s Defined Process
   - Define Process Based Project Plan

2. **Stakeholders**
   - Contributions to Organization’s Process Assets

3. **Project’s Shared Vision**
   - Organize Integrated Teams for IPPD
   - Organizational Environment for Integration

4. **Product Requirements**
   - Stakeholders
   - Use the Project’s Shared Vision for IPPD
Integrated Project Management (IPPD)

Use the Project’s Shared Vision for IPPD

Define the Project’s Shared Vision Context

- Info on Org/Project Situation
- Member Aspirations

Establish the Project’s Shared Vision

Organize Integrated Teams for IPPD

Determine Team Structure

Develop a Preliminary Distribution of Requirements

Establish Integrated Teams

- Team Structure
- List of Teams
- Responsibility & Requirements Allocation

Integrated Teams

Integrated Teaming

Project’s Shared Vision

OEM
Integrated Teaming

• Purpose:

• To form and sustain an integrated team for the development of work products.
Integrated Teaming - Context

- Sponsor’s Objectives
- Assigned Product Requirements
- Relevant Stakeholders

Establish Team Composition

Integrated Team

Govern Team Operation

IPM

PP

OEI

Plans and Commitments
Integrated Teaming - Context

Establish Team Composition

- Identify Team Tasks
- Identify Knowledge and Skills
- Assign Appropriate Team Members

Govern Team Operation

- Establish a Shared Vision
- Establish a Team Charter
- Define Roles & Responsibilities
- Establish Operating Procedures

- Collaborate among Interfacing Teams
- Plans and Commitments

Results Lists
Task Descriptions
Functions, Skills, & Expertise Lists

Sponsors Objectives
Assigned Product Requirements
Stakeholders

Integrated Team

Product Requirements
Team’s Shared Vision
Team Charter
Assignments, & Responsibilities
Ground Rules and Procedures

Task Descriptions
Functions, Skills, & Expertise Lists
Assignments, & Responsibilities
Ground Rules and Procedures

Task Descriptions
Functions, Skills, & Expertise Lists
Assignments, & Responsibilities
Ground Rules and Procedures
Training and Appraisals
“Introduction to the CMMI” Course, Staged & Continuous (Separate Courses)

• Introduction course will enable the participant to
  – Understand the importance of defined processes
  – Understand the rationale for process improvement
  – Comprehend the CMMI model
  – Identify ways of applying the CMMI model for process improvement

• Broad audience
  – Systems and software developers
  – Systems, Program and software managers
  – Practitioners of disciplines that support systems and software
  – Government and industry acquirers of software-intensive systems

• Assumes one year of experience in systems and software

• No process improvement or Capability Maturity Model® (CMM®) experience assumed
“Intermediate Concepts of CMMI Models” Course

• Provides a deeper understanding of the CMMI and its fundamental concepts.
  – PA’s in more detail
  – Linking the PA’s together
  – Interpreting the CMMI for appraisals
  – Application of CMMI for process improvement

• Required as a prerequisite to SCAMPI Lead Appraiser training.
Appraisal Requirements for CMMI (ARC) v1.1

• Similar to the current CMM Appraisal Framework (CAF) V1.0
  – A guide to appraisal method developers

• Specifies the requirements for classes of appraisal methods
  – **Class A**: Full, comprehensive appraisal methods
  – **Class B**: Initial, incremental, self-appraisals
  – **Class C**: Quick-look

• Method developers can declare which class their method fits

• Implications of the desired class of appraisal
Standard CMMI Appraisal Method for Process Improvement (SCAMPI)

- Similar to CBA IPI method
- Led by authorized Lead Appraiser
- Tailorable to organization and model scope
- Source selection appraisals or process monitoring are tailoring options of SCAMPI
- SCAMPI Method Definition Document V1.1
CMMI Lead Appraiser Program

• Similar to existing SEI Lead Assessor and Lead Evaluator programs
  – To be administered by SEI

• Will transition current SW & SE Lead Assessors or Evaluators, as well as new candidates

• Lead Appraiser requirements:
  – Introduction to CMMI Training
  – Appraisal team experience
  – Intermediate CMMI Training
  – SCAMPI Lead Appraiser Training
Expectations

• The method has been simplified, but...
  – CMMI models have more process areas and more practices than each of the individual source models

• The goal:
  – Assuming an organization of 3-6 projects, 6-9 team members, experienced Lead Appraiser
  – SCAMPI appraisals of process areas through Levels 3 in 100 hours or less
Pilot Results

• Six SCAMPIs performed against V1.02 models:
  – 2 government, 4 industry
  – All explored continuous representation

• Each appraisal was characterized by:
  – 6-12 assessment team members
  – 2-4 projects
  – 15-21 interviews

• Total on-site hours ranged from 85-137 hours
  – All went beyond SE/SW
  – “Equivalent” hours: 77-120; median 92
Discoveries in Use - 1

• Appraisal time shows an excellent learning curve
  – 40% reduction in appraisal time over five Australian assessments

• “Shadow appraisals” show ease of transition
  – High maturity CBA IPI at Litton PRC
  – Multiple EIA/IS 731 Systems Engineering assessments

• Mappings and gap analyses confirm evolutionary expansion from predecessor models
  – Government and contractors agree on CMMI’s improved engineering coverage in contract monitoring
Wrap-Up
CMMI Transition Plan

**Development Phase**
- Development of CMMI products
- Verification and validation of CMMI products

**Transition Phase**
- Approval of initial CMMI products for public release
- Evidence of sufficient use
- Transition planning to help organizations use CMMI products

**Sustainment Phase**
- Upkeep and continuous improvement of the product suite
- Additional evidence of adoption and use

---

V0.2 Aug 1999
V1.0 Aug 2000
V1.1 Dec 2001
SW-CMM, EIA 731 phased out Dec 2003
DoD Expectations for CMMI

Comments of Dr. Jack Ferguson,
Director, Software Intensive Systems (OUSD (AT&L))
At STC, 2001

CMMI will improve the maturity for the software intensive systems development and maintenance
– Integration of systems and software emphasis will focus programs on the essential engineering processes
– Gains already made in software will migrate to systems engineering

CMMI will become the logical integrated successor for the CMM-SW for software engineering and EIA/IS 731 for systems engineering
– Simplifies the process of viewing the two disciplines
– Major companies have migration plans in place
– Support for pilot assessments across Government and Industry
– Transition Partners are being trained as CMMI Lead Appraisers
DoD Expectations for CMMI (continued)

• CMMI will become the approved means of judging engineering maturity for procurements within two years
  – Integrated appraisal method should minimize the impact on industry and Government during procurement evaluations
  – OSD policy update to reference CMMI being considered

• New techniques for minimizing costs and schedule impacts during appraisals related to procurements will be considered and adopted
  – Government participation in internal assessments

Comments of Dr. Jack Ferguson,
Director, Software Intensive Systems (OUSD (AT&L))
At STC, 2001
CMMI Schedule

• Available now
  – CMMI-SE/SW, V1.1
  – CMMI-SE/SW/IPPD, V1.1
  – CMMI-SE/SW/IPPD/SS, V1.1
  – SCAMPI Method Definition Document. V1.1
  – V1.1 model and method training

• December 2003
  – Sunset period for SW-CMM, EIA/IS 731 completed (no more public courses, new lead assessors)

• December 2005
  – SW-CMM Transition Partner licenses end
CMMI – What is coming next?

• Emphasis through 2003 is on CMMI adoption and transition from legacy models
  – Quarterly transition workshops will complement an annual User Workshop and SEPG Conference
  – “Communities of Practice” will be encouraged
    » Course Instructors
    » CMMI Appraisers
    » Transition Teams

• “Technical Notes” and “Special Reports” will complement V1.1:
  – Mapping CMMI with other standards and models
  – Managing COTS integration
  – Making attribute tradeoffs in design
  – Allowing prototypical coverage for specific interests (e.g., safety, security, modeling and simulation)
CMMI...Re-cap

- ... Is not so different from the models with which we are familiar
- ... Has 2 representations in a single model:
  - Staged
  - Continuous
- ... Contains specific and generic goals that must be satisfied
- ... Is directly related to our work:
  - Not everything we do is just ‘software’ engineering
  - There is a lot of systems engineering and “other”
For More Information About CMMI

– Go to CMMI Website

» http://sei.cmu.edu/cmmi
» http://seir.sei.cmu.edu/seir/
» http://jo.sei.cmu.edu/pub/english.cgi/0/323123
» http://dtic.mil/ndia (first annual CMMI Conference)
» http://www.faa.gov/aio

– Assistance for government organizations:

» SW-CMM v1.1 to CMMI v1.1 Mappings

Software Technology Support Center
OO-ALC/TI-3
7278 4th Ave
Hill AFB, UT 84056-5705
http://www.stsc.hill.af.mil
Back-up
The State of the Practice

• Is this the state of affairs in your organization?
  – “I'd rather have it wrong than have it late.”
    » A senior software manager (industry)
  – “The bottom line is schedule. My promotions and raises are based on meeting schedule first and foremost.”
    » A program manager (government)

• If it is, are managers and practitioners unhappy with the status quo?
  – sufficiently unhappy to change things?
  – willing and able to attack the known problems?
A Need for Improvement?

• Why is the organization interested in CMMI?
  – flavor of the month?
    » prescription for disaster!
  – customer concerns about process performance?
    » leading to collaborative improvement? or dysfunctional behavior?
  – concern about development capability evaluations
    » cost-effective for small organizations?

• The only “valid” reason: desire to improve
  – tied to business objectives
  – willingness to invest in improvement
Assessment Readiness Survey
(1 of 6)

• Sponsorship
  – sponsor dissatisfied with current state?
  – sponsor willing/able to demonstrate public support conveying strong commitment?
  – sponsor willing to commit resources to assessment and improvement?
  – sponsor has power and resources?
  – sponsor willing to assure progress and problems tracked?
  – sponsor aware of personal, organizational, and political cost of change?
Assessment Readiness Survey
(2 of 6)

• **Culture**
  – consistency between organization’s view of teamwork and that established during assessment?
  – consistency between way goals, tasks, and role assignments currently defined and how they’re expected to be defined when beginning process improvement?

• *Favorable scores in Sponsorship and Culture are critical for doing an assessment.*
• Resistance
  – practitioners see a need for improvement?
  – managers see a need for improvement?
  – communication between managers and practitioners clear and direct?
  – cost of improvement in time and personnel seen as reasonable by management?
  – practitioners confident that management will provide organizational support?
  – anticipated impact on budgets and schedules seen as reasonable by management?
  – organization has a history of success in making changes?
Assessment Readiness Survey
(4 of 6)

• Resistance (cont)
  – sponsor inspires confidence in subordinates?
  – assessment team members widely trusted and viewed as effective?
  – past performance in improvement viewed as springboard by sponsor and managers?
  – practitioners and managers believe sources of information will remain confidential?
Organizational Issues
- stress from day-to-day workload low enough to manage change resulting from assessment?
- clear lines of responsibility and authority; get results rather than protect turf?
- employees have latitude to make mistakes (risk taking encouraged)?
- negative consequences for failing to support changes?
- rewards for supporting changes?
- organization acts on new strategic directions?
- decision making involves true consensus?
- corporate goals have priority over individual goals?
• Synergy
  – groups communicate directly and with few misunderstandings?
  – managers create an open atmosphere?
  – task groups generate creative ways to merge diverse perspectives into alternatives everyone supports?

• Favorable scores in Resistance, Organizational Issues, and Synergy are critical for doing improvement.
What are the CMM’s SM?

• *Common-sense* applications of process management and quality improvement concepts to acquisition, development and maintenance

• *Community-developed* guides

• Models for *organizational* improvement

• The underlying structure for *reliable and consistent* CMM-based appraisal methods
SEI’s IDEAL SM Approach

Initiating
- Set Context
- Build Sponsorship
- Charter Infrastructure

Diagnosing
- Characterize Current and Desired States
- Develop Recommendations
- Set Priorities

Learning
- Propose Future Actions
- Analyze and Validate

Acting
- Implement Solution
- Refine Solution
- Create Solution
- Plan Actions
- Develop Approach

Establishing
- Stimulus for Change

Charter
- Infrastructure
- Build Sponsorship
- Set Context
- Plan Actions
- Develop Approach
- Create Solution
- Refine Solution
- Implement Solution

Propose Future Actions
- Analyze and Validate
Managing Improvement

1. Do you have improvement objectives?

2. Do you measure progress toward achieving those objectives?

3. Can you forecast whether you will achieve the objectives?
   3a. If yes, are you considering what new objectives to establish?
   3b. If no, what are you doing to take corrective action? Revise plans? Develop a new strategy?
CMM [CMMI] Criticisms

• Large (approximately 500 [700] pages)
• Designed for large organizations and projects
• Rigid and bureaucratic – for “process nazis”
• Process for process’ sake; focus on levels

• Note that the CMM/CMMI requirements to be Level 5 are the 52 [69] goals of the 18 [22] key process areas.
  – practices, subpractices, and examples are informative material [practices are “expected” in CMMI]
  – common sense and professional judgment are intrinsic to effective process management
“M” is for Model

“The REAL WORLD
[Integrated product teams]
[System Engineering]
[People issues]
Organization culture
Technology
Marketing

Models are simplified views of the real world.

Maturity Levels
Key Process Areas
Key Practices

Process descriptions, models, and instantiations are below the level of detail of the CMMs.

“All models are wrong; some models are useful.” George Box
Where Does CMMI Apply?

• CMMI was written to provide good engineering and management practices for any development project in any environment.
  – model described in hierarchy
  – detailed practices primarily support large, contracting software organizations
  – “normative” components of the CMMI are maturity and capability levels, process areas, and goals

• Practices in the CMMI are “expected,” but alternative practices are perfectly acceptable!
“What” Versus “How To”

• CMMs are intended to be
  – descriptive of software engineering and management practices
  – prescriptive for process improvement priorities

• Process Areas describe “what” not “how.”
Using the CMMs Correctly

• Correct use of the CMM implies
  – reflecting the reality of your *business* environment
    » tailoring (interpreting) the CMM to suit your context and needs
    » allowing for professional judgment
  – *identifying problems* as objectively as possible
  – *thinking* and analyzing how the CMMs apply
    » doing and not just thinking!
    » not forcing foolish decisions!
  – supporting *worker participation* and *empowerment*
Interpreting and Tailoring

- Organizational structures
  - independent groups (quality assurance, testing, configuration management)

- Roles and relationships
  - project manager
  - project software manager
  - customer (internal? external?)

- Formality
  - frequency of periodic, event-driven
  - granularity of procedures, plans, etc.
  - scope of processes (e.g., subcontracting)
Invariants of Process Discipline

- Assume key process areas and goals are always relevant to any environment.
  - *Supplier Agreement Management* may be “not applicable” if no suppliers
  - *Peer Reviews* cannot be reasonably tailored out for a Level 3 organization

- Some “informative” practices should always be present, some are context-sensitive, and sometimes it depends....

- Professional judgment and trained, experienced assessors are crucial.
Implementation Independent Requirements

- Communication with customer (and end users)
- Documented customer (system) requirements
- Agreed-to commitments
- Work breakdown structure
- Planning
- Documented processes
Context-Sensitive?

- CM group and Change Control Board
  - but configuration management necessary

- Independent QA group
  - but objective verification necessary

- Independent testing group
  - but testing necessary

- Many context-sensitive, large project implementation issues relate to organizational structure
It Depends.... Even for “Small”

- Use of historical data in planning
  - use work packages directly in estimating small efforts

- Training
  - may be through external sources rather than internally developed
  - training on internal processes may still be necessary

- Risk management
  - complete failure of the project may be a minor risk
The Business Environment ....

• Environments where interpretation and tailoring are needed
  – very large programs
  – virtual projects or organizations
  – geographically distributed projects
  – rapid prototyping projects
  – research and development organizations
  – software services organizations
  – small projects and organizations

• ... pretty much everywhere!
Can CMMI be used for small projects and organizations?

• Defining “Small”
  – Is a small project (or team)
    » 2-3 professionals? 4-7? fewer than 25?

  – Operating for a small period of time
    » 2-3 months? 5-6? less than a year?

  – For a small organization
    » fewer than 10 employees? 25? 100?

• Result of CMM Tailoring workshop (1995) was conclusion that we could not even agree on what “small” really meant!
Variations of “Small”

- **Small** = 3-5 people 6-month project
- **Very small** = 2-3 people 4-month project
- **Tiny** = 1-2 people 2-month project
- **Individual** = 1 person 1-week project
- **Ridiculous** = 1 person 1-hour project
  - distinguish between a task and a project!

- **Team Software Process (TSP)**
- **Personal Software Process (PSP)**
Challenges for the “Small”

- The primary business objective of small organizations? *Survive!*

- Problems in initiating process improvement?
  - deciding the status quo is unsatisfactory....
  - deciding process improvement will help....
  - finding the resources and assigning responsibility for process improvement!

- Problems in follow through?
  - finding the resources and assigning responsibility for defining and deploying processes
Small Is Beautiful

• Although there are massive problems that may require large numbers of people to solve . . . .

• Small teams can be much more productive than large teams.
  – teams jell quicker
  – fewer communication problems
  – ideal team size fewer than 10 people

• Is process discipline needed for small teams?

• What do we mean by discipline?
Assessing “Small” Organizations

• A two-week appraisal is probably excessive
  – less rigorous appraisals should identify important problems, but may miss some

• Focus on institutionalization practices appropriate to the organization

• Remember to look beyond the model!
  – business needs, not just an appraisal
  – people and technology issues

• Perform a readiness survey before trying to begin the improvement cycle
  – dissatisfaction with the status quo is needed to drive change
Where the Rubber Meets the Road

• Use the model as a *guide*, not a *dictate*.

• Tie process improvement to business goals!

• CMMs are about management, communication, and coordination.

• Keep process documentation concise and simple.
Improving “Small” Projects

• The Personal Software Process (PSP) demonstrates the applicability and validity of the process discipline for individual efforts.

• The Team Software Process (TSP) brings software-intensive systems developers together as a team in an industry project setting.

• TSP and PSP are applications of CMM concepts to the micro-level of the organization.
  – demonstrate that we can be “Level 5 professionals!”
The Interpretation Guidance for Small Projects & Organizations ....

Is Also Applicable to Large Projects & Organizations!

• All projects are different ....

• All projects are the same ....

• Organizational learning is the lesson!
Discoveries in Use - 2

• Feedback from end users
  – “What took SEI so long? CMMI concepts are needed and have been used successfully for a long time.”
    Christian Hertneck (SEI Resident Affiliate from Siemens)
  – CMMI applies in non-project situations:
    “CMMI can be applied to non-developmental projects, increasing the “bang for the buck””
    Wayne Sherer, TACOM-ARDEC
  – CMMI supports strategically-focused IT organizations
    » “Why CMMI:
      o GM CIO mandate for global, common processes
      o Desired IT capabilities and maturity of IT organization
      o Common assessment across key processes in a global IT organization
      o Integrated vision of process improvement
      o Leverage industry best practice and incorporate GM-specific practices in standard improvement framework”
    Dr. Hubert F. Hofmann, Christine Walsh, Zahira Gonzalvo, General Motors Corp.
Discoveries in Use - 3

• Feedback from end users
  – Value from new Measurement PA
    “Involvement with and use of CMMI could have prevented a $21M cost overrun if we had had level 3
capability measurement and analysis process in place”
    Don Michels, SOF System Program Office, USAF/WR-ALC
  – Works in very small organizations
    “[tailoring SCAMPI resulted in a] 4-day on-site schedule
    for the 4-person business unit [and it worked well]”
    Tim Kasse, Kasse Initiatives
  – Migrating to CMMI proves surprisingly natural
    “[SW-CMM] investments will migrate naturally to CMMI.”
    Gary Natwick & Geoff Draper, Harris Corporation
    “If you have reached mostly Level 2s or 3s in a SE model, you will find that you have most of the CMMI’s
    requirements for comparable levels covered.”
    Sarah Sheard, Software Productivity Consortium
Discoveries in Use - 4

• And Version 1.1 should even prove better

  “We are in the midst of a SCAMPI assessment in [...] We are using 1.02d for this assessment, since the assessment started just after V1.1 came out, but when we are running into questions of interpretation, we are looking to V1.1 for clarification, since many ambiguities were cleared up with that version.”

Email from SCAMPI lead appraiser to Dave Kitson, SEI