CMMI® Version 1.3 and Beyond

August 2010

Mike Phillips
Software Engineering Institute
Carnegie Mellon University

© 2010 Carnegie Mellon University

Organizations Are Complex Systems

Inputs
Human, Financial, Technological, Material, Resources

Outputs
Products, Services

Organizational System
Strategic
Technological
Managerial
Human/Cultural
Structural

Input-output flow of materials, energy, information

Adapted from Kast and Rosenzweig, 1972.
What Is a Process?

A **process** is a logical organization of people and technology into work activities designed to transform information, materials, and energy into a specified result.

![Diagram](image)

**Process Improvement** flows from and extends the general management theories developed over the past ~30 years (Juran, Deming, Crosby, etc.)

How Do You Want to Work?

- Random motion – lots of energy, not much progress
- Directed motion – every step brings you closer to the goal
- No teamwork – individual effort
- Coordinated efforts
- Frequent conflict
- Cooperation
- You never know where you’ll end up
- Predictable results

Processes can make the difference!
Symptoms of Process Failure

Quality Problems

• Too much rework
• No product documentation
• Functions that don’t work correctly
• Customer complaints after delivery
• Delivery of embarrassing products
• Wide variation in how people perform identical tasks
• Work with wrong versions of work products

No View to the Future

• No concern for process improvement
• No feedback on process effectiveness
• Program cancellation

Workforce Challenges

“DoD faces significant challenges related to mitigating the pending departure of its highly experienced and seasoned talent – the critical challenge”

Frank Anderson, Jr., Director, AT&L Human Capital Initiatives and President, Defense Acquisition University 2007

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Workforce (Millions)</td>
<td>% Workforce</td>
<td>Workforce</td>
</tr>
<tr>
<td>Traditionalists (Born before 1946)</td>
<td>11.5</td>
<td>7.5%</td>
<td>45,625</td>
</tr>
<tr>
<td>Baby Boomers (1946 - 1964)</td>
<td>61.5</td>
<td>42.0%</td>
<td>438,971</td>
</tr>
<tr>
<td>Generation X (1965-1976)</td>
<td>43.5</td>
<td>29.5%</td>
<td>132,948</td>
</tr>
<tr>
<td>Generation Y (1977 -1989)</td>
<td>31.5</td>
<td>21.0%</td>
<td>62,676</td>
</tr>
<tr>
<td>Millennium (1990 - present)</td>
<td>51.0</td>
<td>0%</td>
<td>153</td>
</tr>
</tbody>
</table>

Source: Anderson 2007, NDIA STEM Initiative Strategy Session
Characteristics of Effective Processes

- Simple
- Trackable
- Measurable
- Trained
- Practiced
- Supported
- Enforced
- Flexible
- Well-defined gates

Process Definition Inputs

- Strategic Plans, Goals, Objectives
- Policies
- Process Descriptions, Procedures, Instructions
- Asset Library
- Measurement Repository

Process Needs

Process Architecture
Signs that Processes Are Insufficient

Unmet commitments
- Late delivery
- Last minute crunches
- Spiraling costs

Little or no management visibility
- You’re always being surprised

Quality problems
- Too much rework
- Functions do not work correctly
- Customer dissatisfaction post-delivery; continuing high costs

Poor morale
- Frustration
- Is anyone in charge?

Petrobras oil platform (Mar 2001)
- Significant construction cost savings from bypassing rigid engineering processes
- Sank before commissioned

Process Improvement

Whether intentional or not, you already have processes in place. Are they the RIGHT processes?

Something is wrong…

… if no one uses the processes (except under duress)

… if everyone has their own interpretation of the process

… if you find you are always tailoring your processes
SEI’s IDEAL SM Approach

Common Misconceptions

I don’t need process, I have ...

- Really good people
- Advanced technology
- An experienced manager

Process...

- Interferes with creativity
- = bureaucracy + regimentation
- Is only useful on large projects
- Hinders agility in fast-moving markets
- Costs too much
Threats to Process Improvement

Senior management problems
- Change or loss of sponsorship
- Inadequate support and resources
- Desire for quick fixes
- Unreasonable expectations
- Termination before institutionalization
- Inconsistent reinforcement

Middle management resistance
- “If it ain’t broke don’t fix it”
- “Flavor of the day”
- “This is another management initiative I can outlast”

If at First, You Don’t Succeed…

It took John Vu seven years to get Boeing to CMM maturity level 2. He started three separate improvement programs before one worked. Don’t expect to succeed on the first try.

On the other hand, don’t declare defeat too quickly. Try again.
How Can Process Help?

Process supports the goals of the company, enabling
- Repeatability
- Insight and oversight
- Control and tracking
- Measurement
- Improvement
- Training
- Transformation (via consistency, integration, coordination)

Value of Fixing Defects Early

Error Correction Costs By Phase

- Relative Cost to Correct Error
- Validation
- Implementation
- Integration
- Detailed Design
- Operation

Time
Late Discovery of System-Level Problems

- Requirements Engineering: 70%, 3.5%
- System Design: 10%
- Software Architectural Design: 16%
- Component Software Design: 5%
- Code Development: 20.5%, 110x
- Acceptance Test: 0%, 3%
- System Test: 0%, 40x
- Integration Test: 0%, 16x

Where faults are introduced
Where faults are found
The estimated nominal cost for fault removal

Source:
An Investment Is Required

Critical Success Factors for Process Improvement

Commitment to improve must start at the top.

First understand the current process.

Structured change must become a way of life.

Improvement requires investment.

When failure occurs, focus on the process, not the people.

Institutionalizing improvements requires vigilance and periodic reinforcement.
What Is CMMI?

“M” Is for Model

“Models are simplified views of the real world.”

“All models are wrong; some models are useful.” - George Box
CMMI in a Nutshell

CMMI is a collection of characteristics of effective processes that provides guidance for improving an organization’s processes and ability to manage the development, acquisition, and maintenance of products or product components.

CMMI places proven approaches into a structure that

• helps an organization examine the effectiveness of its processes
• establishes priorities for improvement
• helps implement these improvements

Improving processes for better products

CMMI Product Suite

CMMI Models

- CMMI for Development
- CMMI for Acquisition
- CMMI for Services

SCAMPI (Standard CMMI Appraisal Method for Process Improvement)

- Class A (results in ratings)
- Class B (deployment)
- Class C (approach)

Training

- Introduction to CMMI
- Advanced training courses
CMMI Framework

Training
- Understanding CMMI High Maturity Practices
- CMMI-Based Process Improvement Overview
- Implementing CMMI for High Performance, an Executive Seminar
- Introduction to CMMI (for Development)
- Introduction to CMMI for Services
- Acquisition Supplement for CMMI
- Services Supplement for CMMI
- CMMI Level 2 for Practitioners (DEV only)
- CMMI Level 3 for Practitioners (DEV only)
- CMMI Instructor Training
- CMMI Upgrade Training
- Intermediate Concepts of CMMI
- SCAMPI B and C Team Leader Training
- SCAMPI Lead Appraiser Training

Appraisals
- SCAMPI Class A Appraisal Method (Results in Ratings)
- SCAMPI Class B Appraisal Method
- SCAMPI Class C Appraisal Method
- Appraisal Requirements for CMMI

Five Reasons to Adopt CMMI

CMMI helps your organization to …

- Improve delivery of performance, cost, and schedule
- Collaborate with external stakeholders and integrate their expectations into day-to-day activities
- Provide competitive world-class products and services
- Implement an integrated enterprise business and engineering perspective
- Use common, integrated, and improving processes for systems and software
# Evolution of Process Capability

<table>
<thead>
<tr>
<th>Level</th>
<th>Process Characteristics</th>
<th>Predicted Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Process improvement is institutionalized</td>
<td>![Graph]</td>
</tr>
<tr>
<td>4</td>
<td>Product and process are quantitatively controlled</td>
<td>![Graph]</td>
</tr>
<tr>
<td>3</td>
<td>Software engineering and management processes are defined and integrated</td>
<td>![Graph]</td>
</tr>
<tr>
<td>2</td>
<td>Project management system is in place; performance is repeatable</td>
<td>![Graph]</td>
</tr>
<tr>
<td>1</td>
<td>Process is informal and unpredictable</td>
<td>![Graph]</td>
</tr>
</tbody>
</table>

## CMMI Models
CMMI Models for Three Constellations

**CMMI-DEV**
CMMI-DEV provides guidance for measuring, monitoring and managing development processes.

**CMMI-SVC**
CMMI-SVC provides guidance for those providing services within organizations and to external customers.

**CMMI-ACQ**
CMMI-ACQ provides guidance to enable informed and decisive acquisition leadership.

16 Core Process Areas, common to all
CMMI Models Have Common Components

CMMI Core PAs

Core PAs are shared by all three CMMI models. Core PAs include informative material that interprets the goals and practices for the model’s area of interest.
Example Page from a Model

Configuration Management

A Support Process Area at Maturity Level 2

Purpose

The purpose of Configuration Management (CM) is to establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.

Introductory Notes

The Configuration Management process area involves the following activities:

- Identifying the configuration of selected work products that comprise baselines at given points in time

Process Area Components

- Process Area (PA)
  - Specific Goals (SG)
    - Specific Practices (SP)
      - Typical Work Products
      - Subpractices
  - Purpose Statement
  - Introductory Notes
  - Related Process Areas
- Generic Goals (GG)
  - Generic Practices (GP)
    - Subpractices
    - Generic Practice Elaborations

Legend

- Required
- Expected
- Informative
Critical Distinctions Among Processes

perform 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)

Understanding Levels

Levels are used in CMMI to describe an evolutionary path for an organization that wants to improve the processes it uses to develop and maintain its products and services.

CMMI supports two improvement paths:

- **continuous** - enabling an organization to incrementally improve processes corresponding to an individual process area (or set of process areas) selected by the organization
- **staged** - enabling the organization to improve a set of related processes by incrementally addressing successive predefined sets of process areas
Staged Representation: PAs by Maturity Level

<table>
<thead>
<tr>
<th>Level</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Continuous Process Improvement</td>
</tr>
<tr>
<td>4 Quantitatively Managed</td>
<td>Quantitative Management</td>
</tr>
<tr>
<td>3 Defined</td>
<td>Process Standardization</td>
</tr>
<tr>
<td>2 Managed</td>
<td>Basic Project Management</td>
</tr>
<tr>
<td>1 Initial</td>
<td></td>
</tr>
</tbody>
</table>

Achieving Maturity Levels

- **GP2.1 through GP2.2**
  - ML5 Optimizing
  - All ML2, ML3, ML4, and ML5 PAs
  - Prevent defects; proactively improve; insert and deploy innovative technology

- **GP2.1 through GP3.2**
  - ML4 Quantitatively Managed
  - All ML2, ML3, and ML4 PAs
  - Measure process performance; stabilize process and control charts; deal with causes of special variations

- **GP2.1 through GP3.2**
  - ML3 Defined
  - All ML2 and ML3 PAs
  - Tailor the project’s process from organization’s standard processes; understand processes qualitatively; ensure that projects contribute to organization assets

- **GP2.1 through GP2.10**
  - ML2 Managed
  - All ML2 PAs
  - 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

- **ML1 Initial**
  - Processes are ad hoc and chaotic
Continuous Representation: PAs by Categories

Process Management  
Engineering  
Project Management  
Support

Achieving Capability Levels (CLs) for a Process Area

GP1.1 through GP3.2  
All SPs
CL3 Defined

Project’s process is tailored from organization’s standard processes; understand process qualitatively; process contributes to the organization’s assets

GP1.1 through GP2.10  
All SPs
CL2 Managed

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

GP1.1  
All SPs
CL1 Performed

Perform the work

A few GPs or SPs may be implemented
CL0

Not performed, incomplete
## Summary of Generic Goals and Practices

<table>
<thead>
<tr>
<th>Generic Goals</th>
<th>Generic Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG1: Achieve Specific Goals</td>
<td>GP 1.1: Perform Specific Practices</td>
</tr>
<tr>
<td>GG2: Institutionalize a Managed Process</td>
<td>GP 2.1: Establish an Organizational Policy</td>
</tr>
<tr>
<td></td>
<td>GP 2.2: Plan the Process</td>
</tr>
<tr>
<td></td>
<td>GP 2.3: Provide Resources</td>
</tr>
<tr>
<td></td>
<td>GP 2.4: Assign Responsibility</td>
</tr>
<tr>
<td></td>
<td>GP 2.5: Train People</td>
</tr>
<tr>
<td></td>
<td>GP 2.6: Manage Configurations</td>
</tr>
<tr>
<td></td>
<td>GP 2.7: Identify and Involve Relevant Stakeholders</td>
</tr>
<tr>
<td></td>
<td>GP 2.8: Monitor and Control the Process</td>
</tr>
<tr>
<td></td>
<td>GP 2.9: Objectively Evaluate Adherence</td>
</tr>
<tr>
<td></td>
<td>GP 2.10: Review Status with Higher Level Management</td>
</tr>
<tr>
<td>GG3: Institutionalize a Defined Process</td>
<td>GP 3.1: Establish a Defined Process</td>
</tr>
<tr>
<td></td>
<td>GP 3.2: Collect Improvement Information</td>
</tr>
</tbody>
</table>

Adapted from Cepeda Systems & Software Analysis, Inc.
Appraisals: What Are They?

- Measure an organization’s processes using a CMMI model as a yardstick
- Use a formalized process
- Involve senior management as a sponsor
- Focus on the sponsor’s business objectives
- Observes strict confidentiality and non-attribution of data
- Focuses on follow-on activities and decision making based on the appraisal results

There are three appraisal Classes: A, B, and C

SCAMPI Classes A, B, and C

Approach
SCAMPI C

Deployment
SCAMPI B

Institutionalization
SCAMPI A
(Maturity Levels)
SCAMPI Changes for V1.3

SCAMPI support for each constellation:
- Potential terminology barriers
- Scoping considerations
- Identifying appropriate pre-requisites for team members

Known defects and issues corrected:
- Errors documented during the use of v1.2
- Common pitfalls encountered based on user feedback
- Areas frequently encountered by quality assurance

Common Themes to SCAMPI Improvements

Scoping Appraisals
- Confusion caused by “focus-” and “non-focus” projects
- Minimum scoping rules for a wide range of organization types

Collecting Data
- Confusion caused by “direct” and “indirect” artifacts
- Handling generic practices

Characterization and Rating
- Issues with characterization rules
- Issues with rating rules

Pain Points that Make SCAMPI Difficult to Sustain
- Need to achieve efficiency
- Expanding organizational scope
- True cost of PIIDs

Attaining/Maintaining Appraisal Ratings
- Period of validity
- Maintenance appraisals
- Delta appraisals
- Enterprise appraisals
Appraisal Transition

Once CMMI Version 1.3 is released:

- During a period of one year, organizations may use either V1.2 or V1.3 models for their appraisals.
- All appraisals will be valid for 3 years.

CMMI Training
SEI Training for CMMI

Training Updates

The following courses updated for Version 1.3:

- Introduction to CMMI (for Development)
- Introduction to CMMI-SVC
- ACQ Supplement
- SVC Supplement
- SCAMPI Team Training
Training Transition

The SEI will provide on-line upgrade training:

- Users make the transition by taking the upgrade course.
- Instructors and Lead Appraisers make the transition by taking upgrade course and passing a test.
Countries where Appraisals have been Performed and Reported to the SEI

Argentina Australia Austria Bahrain Bangladesh Belarus Belgium Bulkina Faso Canada Chile China Colombia Costa Rica Cote d'Ivoire Croatia Cyprus Czech Republic Denmark Dominica Dominican Republic Ecuador Egypt Finland France Germany Greece Guatemala Honduras Hungary Indonesia Ireland Israel Italy Jamaica Japan Korea, Republic Of Latvia Lithuania Luxembourg Morocco Nepal Netherlands New Zealand Norway Pakistan Peru Philippines Poland Portugal Romania Russia Saudi Arabia Singapore Slovak Republic Slovenia Spain Sri Lanka Sweden Switzerland Taiwan Thailand Viet Nam Uruguay Venezuela

CMMI Adoption Has Been Broad

<table>
<thead>
<tr>
<th>Country</th>
<th>Appraisals</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>1582</td>
</tr>
<tr>
<td>China</td>
<td>1229</td>
</tr>
<tr>
<td>India</td>
<td>524</td>
</tr>
<tr>
<td>Japan</td>
<td>306</td>
</tr>
<tr>
<td>Spain</td>
<td>180</td>
</tr>
<tr>
<td>France</td>
<td>168</td>
</tr>
<tr>
<td>Korea (ROK)</td>
<td>165</td>
</tr>
<tr>
<td>Brazil</td>
<td>144</td>
</tr>
<tr>
<td>Taiwan</td>
<td>134</td>
</tr>
<tr>
<td>U.K.</td>
<td>113</td>
</tr>
<tr>
<td>Mexico</td>
<td>86</td>
</tr>
<tr>
<td>Argentina</td>
<td>77</td>
</tr>
<tr>
<td>Germany</td>
<td>76</td>
</tr>
<tr>
<td>Malaysia</td>
<td>71</td>
</tr>
<tr>
<td>Canada</td>
<td>59</td>
</tr>
<tr>
<td>Egypt</td>
<td>43</td>
</tr>
<tr>
<td>Italy</td>
<td>43</td>
</tr>
<tr>
<td>Thailand</td>
<td>38</td>
</tr>
<tr>
<td>Chile</td>
<td>37</td>
</tr>
<tr>
<td>Australia</td>
<td>36</td>
</tr>
<tr>
<td>And - Colombia, Pakistan, Philippines, Singapore, Israel, Hong Kong, Viet Nam, Turkey, Netherlands, Portugal, Sri Lanka, Ireland and Russia</td>
<td>33 countries with &gt; 10 appraisals (as of March 2010):</td>
</tr>
</tbody>
</table>

- Estimated 1.2 million people work in organizations that have had at least one SCAMPI A appraisal since April 2002.
- There were SCAMPI A appraisals reported from 68 countries.
- Approximately 75% of adopters are commercial organizations.
- Services: 1/6 Manufacturing
- Approximately 2/3 of adopters in the US are contractors for military/government or are government.

http://www.sei.cmu.edu/cmmi/casestudies/profiles/cmmi.cfm

Is the source for these statistical analyses.
### CMMI Transition Status
Reported to the SEI as of 7-31-10

<table>
<thead>
<tr>
<th>Training</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to CMMI V1.2</td>
<td>117,869</td>
</tr>
<tr>
<td>Intermediate Concepts of CMMI</td>
<td>3,195</td>
</tr>
<tr>
<td>Understanding CMMI High Maturity Practices</td>
<td>600</td>
</tr>
<tr>
<td>Introduction to CMMI V1.2 Supplement for ACQ</td>
<td>1,230</td>
</tr>
<tr>
<td>Introduction to CMMI V1.2 Supplement for SVC</td>
<td>2,065</td>
</tr>
<tr>
<td>Introduction to CMMI for Services V1.2</td>
<td>280</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Certifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to CMMI V1.2 Instructors</td>
<td>439</td>
</tr>
<tr>
<td>CMMI-ACQ V1.2 Supplement Instructors</td>
<td>63</td>
</tr>
<tr>
<td>CMMI-SVC V1.2 Supplement Instructors</td>
<td>130</td>
</tr>
<tr>
<td>Introduction to CMMI for Services V1.2 Instructors</td>
<td>11</td>
</tr>
<tr>
<td>SCAMPI V1.2 Lead Appraisers</td>
<td>484</td>
</tr>
<tr>
<td>SCAMPI V1.2 High Maturity Lead Appraisers</td>
<td>147</td>
</tr>
<tr>
<td>CMMI-ACQ V1.2 Lead Appraisers</td>
<td>71</td>
</tr>
<tr>
<td>CMMI-SVC V1.2 Lead Appraisers</td>
<td>141</td>
</tr>
</tbody>
</table>

### CMMI V1.2 Foreign Language Translation Status
Reported to the SEI as of 6-30-2010

<table>
<thead>
<tr>
<th>Language</th>
<th>Status (for CMMI-DEV V1.2)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese (trad.)</td>
<td>Completed December 2007</td>
<td></td>
</tr>
<tr>
<td>French</td>
<td>Completed August 2008</td>
<td></td>
</tr>
<tr>
<td>German</td>
<td>Completed April 2009. Intro course translated October 2009</td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>Completed in June 2009</td>
<td></td>
</tr>
<tr>
<td>Portuguese</td>
<td>Completed in May 2010</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Status (for CMMI-ACQ V1.2)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese (trad.)</td>
<td>Completed April 2009</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Status (for CMMI-SVC V1.2)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese (trad.)</td>
<td>Completed in July 2010</td>
<td></td>
</tr>
<tr>
<td>Arabic</td>
<td>To start, pending agreement</td>
<td></td>
</tr>
</tbody>
</table>
SCAMPI v1.1/v1.2 Class A Appraisals Conducted by Quarter Reported as of 7-31-10

Number of Appraisals Reported to the SEI by Continent

* North America includes Canada, the USA, and Mexico; South America includes Central America and the Caribbean; Australia includes New Zealand.
### Continuous Improvement

Certification of our process improvement professionals is appropriate and achievable

- Lead Appraisers first
- Instructors
- CMMI consultants/practitioners

Improved architecture allows process improvement model expansion.

- Extensions of the lifecycle
  - allows coverage of more of the enterprise or potential partnering organizations
  - adapts model features to fit non-developmental efforts
What Is a CMMI Model?

A CMMI model is a subset of the CMMI Product Suite that covers a particular area of interest. Currently, there are three models that address the following:

- The development of products and services
- The acquisition of products and services
- The establishment, management, and delivery of services

Every CMMI model

- is a process improvement approach that provides organizations with the essential elements of effective processes,
- can be used to guide improvement across a team, project, division, or entire organization, and
- helps to set process improvement goals and priorities, provide guidance for quality processes, and provide a point of reference for appraising current processes.
Presentation Model Material

As I present changes to the CMMI models, if you see goals and practices or other model material listed, it is based on the most current Version 1.3 material.

Using this approach enables you to see what to expect when the models are published in November.

How Similar Are Core PAs?

Core process areas appear in all CMMI models; however...

- These process areas are not identical across all models.
- Informative material can be different so that users interpret goals and practices for the area of interest addressed by the model.
- Sometimes practices can be different in one model from another (e.g., Project Planning).
V1.3 Model Architecture Changes

**IPPD/Teaming**
Removed the IPPD addition from CMMI-DEV and in its place added teaming practices used in CMMI-ACQ and CMMI-SVC, which are practices that are not optional.

**Amplifications**
Removed the “amplification” model component.

**CMMI-ACQ**
Renamed the “Acquisition” process area category to be “Acquisition Engineering.”
Moved AM and SSAD from the Acquisition PA category to the Project Management PA category.

**CMMI-DEV**
Moved REQM from the Engineering PA category to the Project Management PA category.

V1.3 Changes to GGs, GPs, and GP Elaborations

Positioned generic goals, generic practices, and GP elaborations in one central location as the first section of Part 2 in all three models.

Simplified GG1 to make it more readable.
Renamed GP 2.6 to “Control Work Products.”
Added “selected work products” to the GP 2.9 statement.
Simplified the GP 3.2 statement to replace “collect work products, measures, measurement results, and improvement information” with “collect process-related experiences.”
Eliminated GG4 and GG5 (proposed).
Core PAs by Maturity Level

<table>
<thead>
<tr>
<th>Level</th>
<th>Focus</th>
<th>Process Areas</th>
<th>Quality Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Continuous Process Improvement</td>
<td>Organizational Performance Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Causal Analysis and Resolution</td>
<td></td>
</tr>
<tr>
<td>4 Quantitatively Managed</td>
<td>Quantitative Management</td>
<td>Organizational Process Performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quantitative Project Management</td>
<td></td>
</tr>
<tr>
<td>3 Defined</td>
<td>Process Standardization</td>
<td>Organizational Process Focus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organizational Process Definition</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organizational Training</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrated Project Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Risk Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decision Analysis and Resolution</td>
<td></td>
</tr>
<tr>
<td>2 Managed</td>
<td>Basic Project Management</td>
<td>Requirements Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project Planning</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project Monitoring and Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measurement and Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Process and Product Quality Assurance</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Configuration Management</td>
<td></td>
</tr>
<tr>
<td>1 Initial</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Core PAs by Category

**Process Management**
- Organizational Performance Management (OPM)
- Organizational Process Definition (OPD)
- Organizational Process Focus (OPF)
- Organizational Process Performance (OPP)
- Organizational Training (OT)

**Support**
- Causal Analysis and Resolution (CAR)
- Configuration Management (CM)
- Decision Analysis and Resolution (DAR)
- Measurement and Analysis (MA)
- Process and Product Quality Assurance (PPQA)

**Project Management**
- Integrated Project Management (IPM)
- Project Monitoring and Control (PMC)
- Project Planning (PP)
- Requirements Management (REQM)
- Risk Management (RSKM)
- Quantitative Project Management (QPM)
- (+) Supplier Agreement Management (SAM)

SAM is a shared PA instead of a core PA.
Core PAs: Support Category

Configuration Management
establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits

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

Measurement and Analysis
develop and sustain a measurement capability used to support management information needs

Process and Product Quality Assurance
provide staff and management with objective insight into processes and associated work products

Core PAs: Process Management Category

Organizational Process Definition
establish and maintain a usable set of organizational process assets, work environment standards, and rules and guidelines for teams

Organizational Process Focus
plan, implement, and deploy organizational process improvements based on a thorough understanding of current strengths and weaknesses of the organization's processes and process assets

Organizational Training
develop skills and knowledge of people so they can perform their roles effectively and efficiently
Core PAs: Project Management Category -1

Integrated Project Management
establish and manage the project and the involvement of relevant stakeholders according to an integrated and defined process that is tailored from the organization’s set of standard processes

Project Monitoring and Control
provide an understanding of the project’s progress so that appropriate corrective actions can be taken when the project’s performance deviates significantly from the plan

Project Planning
establish and maintain plans that define project activities

Core PAs: Project Management Category -2

Requirements Management
manage requirements of the project’s products and product components and to identify inconsistencies between those requirements and the project’s plans and work products

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

Simplified SP 1.7 to replace “work products, measures, and documented experiences” with “process-related experiences.”
Converted goal on teaming to a single practice, which is no longer an “addition” for IPPD only.
Clarified that milestone reviews can include project start-up and project close-out.

Changed the focus of SP 1.5 so that it now reads “Ensure that project plans and work products remain aligned with the requirements.”
SAM – the Shared PA

SG 1: Establish Supplier Agreements
- SP 1.1 Determine Acquisition Type
- SP 1.2 Select Suppliers
- SP 1.3 Establish Supplier Agreements

SG 2: Satisfy Supplier Agreements
- SP 2.1 Execute the Supplier Agreement
- SP 2.2 Accept the Acquired Product
- SP 2.3 Ensure Transition of Products

New Informative Material

Update selected process areas to provide interpretation of practices for organizations with respect to the following topics:

- Agile methods
- Quality attributes (i.e., non functional requirements or “ilities”)
- Allocation of product capabilities to release increments
- Product lines
- System of systems
- Architecture-centric development practices
- Technology maturation
- Customer satisfaction
Terminology

Used “team” instead of “integrated team” in most cases when discussing teaming practices.

Simplified phrases such as “work products, measures, and improvement information” with simpler expressions such as the word “experiences.”

Revised the terminology in engineering-related material from a strong emphasis on “functionality” to a more balanced “behavior (functionality and quality attributes)” or simply “functionality and quality attributes.”

Clarified whether the use of “lifecycle” refers to a project lifecycle, product lifecycle, or both throughout the model.

Involved the CMMI Translation Team during model development work to identify and resolve translations issues.

Replaced the word “project” with other terms where needed. (SVC only)

Front Matter

Clarified that CMMI models are not processes or process descriptions.

Removed any biases favoring maturity levels or capability levels.

Explained that core process areas appear in all CMMI models and that they can have different expected and informative material. For example, PP can have an SP in ACQ that is absent in DEV’s PP.

Added information on selecting the right CMMI model for use.
Glossary -1

Differentiated between definitions and usage notes for each glossary entry.

Removed terms from the glossary, including: adequate, alternative practice, amplifications, appropriate, as needed, assessment, assignable cause of process variation, capability evaluation, discipline, functional configuration audit, integrated product and process development, objective, physical configuration audit, program, and root cause.

Revised the definitions of “quality” and “corrective action” to be more consistent with ISO definitions.

Revised the terms “process,” “development,” and “supplier” to be more broadly applicable.

Revised the definition of “supplier agreement” to include agreements within an organization.

Glossary -2

Revised the following definitions related to high maturity practices: causal analysis, natural bounds, optimizing process, process-performance model, quality and process-performance objectives, stable process, statistical predictability, statistical techniques, and subprocess.

Added the following terms related to high maturity: quantitative management.

Deleted the following terms related to high maturity: quantitatively managed process, and statistically managed process.
V1.3 Changes to High Maturity PAs

Many of the most significant changes to CMMI models as part of Version 1.3, are the changes to the high maturity process areas (CAR, OPM, OPP, and OPM).

These process areas are core process areas, but we’ve focused on these four over the others because of their significance in this release.

High Maturity changes for V1.3

- Terminology Confusion
- Common Cause
  - Statistical versus Quantitative Techniques
- Process Models and Process Modeling
- Business Objectives
- Subprocesses
- Requirements implied versus explicit/ Explanations not central or consistent
- Model/ Audit Criteria/ Presentations (Healthy Ingredients)/ UCHMP
- Perceptions
- Customers – ML 5 is expensive – no better than 3
- Industry – ML 5 is NOT RIGHT for every business
- High Maturity in ALL constellations
- Examples are focused on Development
High Maturity Restructuring for V1.3

- Insufficient link between process improvement, business objectives, and performance
- Clarify distinction between ML4 and ML5
- Eliminate GG4 and GG5
- CMMI V1.3 Webinar Suggestions (not covered elsewhere)
  - Clarify role of OID and CAR
  - Make CAR more relevant / clarification in role

Combined CPM/ OID — 1 ML5 PA
Organizational Performance Management

CMMI V1.3 and Beyond
Phillips — August 2010
© 2010 Carnegie Mellon University
Causal Analysis and Resolution

SG 1: Determine Causes of Selected Outcomes
SP 1.1 Select Outcomes for Analysis
SP 1.2 Analyze Causes

SG 2: Address Causes of Selected Outcomes
SP 2.1 Implement Actions
SP 2.2 Evaluate the Effect of Implemented Actions
SP 2.3 Record Causal Analysis Data

Changes to CAR in CMMI V1.3

CMMI 1.2
The purpose of Causal Analysis and Resolution (CAR) is to identify causes of defects and problems and take action to prevent them from occurring in the future.

SG 1 Root causes of defects and problems are systematically determined.
SP 1.1 Select defects and problems for analysis.
SP 1.2 Perform causal analysis of selected defects and problems and propose actions to address them.

SG 2 Root causes of defects and problems are systematically addressed to prevent their future occurrence.
SP 2.1 Implement selected action proposals developed in causal analysis.
SP 2.2 Evaluate the effect of changes on process performance.
SP 2.3 Record causal analysis and resolution data for use across the project and the organization.

CMMI V1.3
The purpose of Causal Analysis and Resolution (CAR) is to identify causes of selected outcomes and take action to improve process performance.

SG 1 Root causes of selected outcomes are systematically determined.
SP 1.1 Select outcomes for analysis.
SP 1.2 Perform causal analysis of selected outcomes and propose actions to address them.

SG 2 Root causes of outcomes are systematically addressed.
SP 2.1 Implement selected action proposals developed in causal analysis.
SP 2.2 Evaluate the effect of implemented actions on process performance.
SP 2.3 Record causal analysis and resolution data for use across projects and the organization.
### Organizational Performance Management

**SG 1: Manage Business Performance**
- **SP 1.1** Maintain Business Objectives
- **SP 1.2** Analyze Process-Performance Data
- **SP 1.3** Identify Potential Areas for Improvement

**Renamed the PA to be Organizational Performance Management (OPM).**

**Added a new goal about managing business performance using quantitative measures.**

**SP 2: Select Improvements**
- **SP 2.1** Elicit Suggested Improvements
- **SP 2.2** Analyze Suggested Improvements
- **SP 2.3** Validate Improvements
- **SP 2.4** Select and Implement Improvements for Deployment

**Provided more information about how improvements can be selected for deployment.**

**More explicitly described and discussed using process performance models.**

**Clarified that not all SPs must be implemented for each improvement proposal.**

**SG 3: Deploy Improvements**
- **SP 3.1** Plan the Deployment
- **SP 3.2** Manage the Deployment
- **SP 3.3** Evaluate Improvement Effects

---

### Changes to OPM (OID) in CMMI V1.3

#### OID (Organizational Innovation and Development) changes to OPM (Organization Performance Management)

**CMMI 1.2**
The purpose of Organizational Innovation and Development (OID) is to select and deploy incremental and innovative improvements that measurably improve the organization’s processes and technologies. These improvements support the organization’s quality and process-performance objectives as derived from the organization’s business objectives.

(SG1 of OID from CMMI V1.2 is compared below to SG2 of OPM in CMMI V1.3.)

**CMMI V1.3**
The purpose of Organizational Performance Management (OPM) is to manage the business performance of the organization to meet business needs. Organizational Performance management includes proactively selecting and deploying incremental and innovative improvements that measurably improve the organization’s performance. These improvements support the organization’s quality and process-performance objectives as derived from the organization’s business objectives.

**SG 1** Manage the organization’s business performance using statistical and other qualitative techniques to understand process-performance shortfalls and identify areas for process improvement.

- **SP 1.1** Maintain business objectives based on an understanding of business strategies and actual performance results.
- **SP 1.2** Analyze process-performance data to determine the organization’s ability to meet identified business objectives.
- **SP 1.3** Identify potential areas for improvement that could contribute to meeting business objectives.
### Changes to OPM (OID) in CMMI V1.3 2 of 3

**OID (Organizational Innovation and Development) changes to OPM (Organization Performance Management)**

<table>
<thead>
<tr>
<th>CMMI 1.2</th>
<th>CMMI V1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SG 1 Technology improvements, which contribute to meeting quality and process-performance objectives, are selected.</strong></td>
<td><strong>SG 2 Improvements are proactively identified, evaluated using statistical and other quantitative techniques, and selected for deployment based on their contribution to meeting quality and process-performance objectives.</strong></td>
</tr>
<tr>
<td><strong>SP 1.1 Collect and analyze process- and technology-improvement proposals.</strong></td>
<td><strong>SP 2.1 Elicit and identify suggested improvements.</strong></td>
</tr>
<tr>
<td><strong>SP 1.2 Identify and analyze innovative improvements that could increase the organization’s quality and process performance.</strong></td>
<td><strong>SP 2.2 Analyze suggested improvements for their possible impact on achieving the organization’s quality and process-performance objectives.</strong></td>
</tr>
<tr>
<td><strong>SP 1.3 Pilot process and technology improvements to select which ones to implement.</strong></td>
<td><strong>SP 2.3 Validate selected improvements.</strong></td>
</tr>
<tr>
<td><strong>SP 1.4 Select process and technology improvements for deployment across the organization.</strong></td>
<td><strong>SP 2.4 Select and implement improvements for deployment across the organization based on an evaluation of costs, benefits, and other factors.</strong></td>
</tr>
</tbody>
</table>

### Changes to OPM (OID) in CMMI V1.3 3 of 3

**OID (Organizational Innovation and Development) changes to OPM (Organization Performance Management)**

<table>
<thead>
<tr>
<th>CMMI 1.2</th>
<th>CMMI V1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SG 2 Measurable improvements to the organization’s processes and technologies are continually and systematically deployed.</strong></td>
<td><strong>SG 3 Measurable improvements to the organization’s processes and technologies are deployed and evaluated using statistical and other quantitative techniques.</strong></td>
</tr>
<tr>
<td><strong>SP 2.1 Establish and maintain plans for deploying selected process and technology improvements.</strong></td>
<td><strong>SP 3.1 Establish and maintain plans for deploying selected improvements.</strong></td>
</tr>
<tr>
<td><strong>SP 2.2 Manage the deployment of selected process and technology improvements.</strong></td>
<td><strong>SP 3.2 Manage the deployment of selected improvements.</strong></td>
</tr>
<tr>
<td><strong>SP 2.3 Measure the effects of deployed improvements.</strong></td>
<td><strong>SP 3.3 Evaluate the effects of deployed improvements on quality and process performance using statistical and other quantitative techniques.</strong></td>
</tr>
</tbody>
</table>

---

Software Engineering Institute | Carnegie Mellon

© 2010 Carnegie Mellon University
## Organizational Process Performance

SG 1: Establish Performance Baselines and Models

<table>
<thead>
<tr>
<th>SP 1.1</th>
<th>Establish Quality and Process-Performance Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 1.2</td>
<td>Select Processes</td>
</tr>
<tr>
<td>SP 1.3</td>
<td>Establish Process-Performance Measures</td>
</tr>
<tr>
<td>SP 1.4</td>
<td>Analyze Process Performance and Establish Process-Performance Baselines</td>
</tr>
<tr>
<td>SP 1.5</td>
<td>Establish Process-Performance Models</td>
</tr>
</tbody>
</table>

- Ensured that examples of quality and process performance objectives are balanced between sustainment and improvement.
- Revised SP 1.4 to include process performance analysis and assessment of subprocess stability.
- Revised SP 1.5 to clarify that mature organizations have and use process models throughout the development lifecycle.
- Clarified the relationship of OPP to other high maturity process areas.

## Changes to OPP in CMMI V1.3

### CMMI 1.2

The purpose of Organizational Process Performance (OPP) is to establish and maintain a quantitative understanding of the performance of the organization’s set of standard processes in support of achieving quality and process-performance objectives, and to provide process-performance data, baselines, and models to quantitatively manage the organization’s projects.

SG 1 Baselines and models, which characterize the expected process performance of the organization’s set of standard processes are established and maintained.

- SP 1.1 Select processes or subprocesses in the organization’s set of standard processes to be included in the organization’s process-performance analyses.
- SP 1.2 Establish and maintain definitions of measures to be included in the organization’s process-performance analyses.

### CMMI V1.3

The purpose of Organizational Process Performance (OPP) is to establish and maintain a quantitative understanding of the performance of selected processes within the organization’s set of standard processes in support of achieving quality and process-performance objectives, and to provide process-performance data, baselines, and models to quantitatively manage the organization’s work.

SG 1 Baselines and models, which characterize the expected process performance of the organization’s set of standard processes are established and maintained.

- SP 1.1 Establish and maintain the organization’s quantitative objectives for quality and process performance, which are traceable to business objectives.
- SP 1.2 Select processes or subprocesses in the organization’s set of standard processes to be included in the organization’s process-performance analyses and maintain traceability to business objectives.
Changes to OPP in CMMI V1.3 2 of 2

**CMMI 1.2**

SG 1 Continued

SP 1.3 Establish and maintain the organization’s quantitative objectives for quality and process-performance.
SP 1.4 Establish and maintain the organization’s process-performance analyses.
SP 1.5 Establish and maintain process-performance models for the organization’s set of standard processes.

**CMMI V1.3**

SG 1 Continued

SP 1.3 Establish and maintain definitions of measures to be included in the organization’s process-performance analyses.
SP 1.4 Analyze the performance of the selected processes, and establish and maintain the process-performance analyses.
SP 1.5 Establish and maintain process-performance models for the organization’s set of standard processes.

---

Quantitative Project Management

**SG 1: Prepare for Quantitative Management**

SP 1.1 Establish the Project’s Objectives
SP 1.2 Compose the Defined Process
SP 1.3 Select Subprocesses and Attributes
SP 1.4 Select Measures and Analytic Techniques

**SG 2: Quantitatively Manage the Project**

SP 2.1 Monitor the Performance of Selected Subprocesses
SP 2.2 Manage Project Performance
SP 2.3 Perform Causal Analysis and Resolution

- **Restructured QPM so that SG1 focuses on preparation and SG2 focuses on managing the project.**
- **Added guidance about using process performance baselines and process performance models.**
- **Defined quantitative management in the glossary to include statistical management and use that definition for use of the terms throughout QPM.**
- **Removed the practice about applying statistical methods to understand variation to reduce the over-emphasis on control charts.**
- **Added new practices about managing performance and performing causal analysis and resolution.**
Changes to QPM in CMMI V1.3 1 of 2

CMMI V1.2
The purpose of Quantitative Project Management (QPM) is to quantitatively manage the project’s defined process to achieve the project’s established quality and process-performance objectives.

SG 1 The project is quantitatively managed using quality and process-performance objectives.
SP 1.1 Establish and maintain the project’s quality and process-performance objectives.

CMMI V1.3
The purpose of Quantitative Project/Work Management (QP/WM) is to quantitatively manage the defined process to achieve the established quality and process-performance objectives for the work.

SG 1 Preparation for quantitative management is conducted.
SP 1.1 Establish and maintain the quality and process-performance objectives for the work.

Changes to QPM in CMMI V1.3 2 of 2

CMMI V1.2
SG 2 The performance of selected subprocesses within the project’s defined process is statistically managed.
SP 2.1 Select measures and analytic techniques to be used in statistically managing selected subprocesses.
SP 2.2 Establish and maintain an understanding of the variation of selected subprocesses using selected measures and analytic techniques.
SP 2.3 Monitor the performance of selected subprocesses to determine their capability to satisfy their quality and process-performance objectives, and identify corrective action as necessary.
SP 2.4 Record statistical and quality management data in the organization’s measurement repository.

CMMI V1.3
SG 2 The work is quantitatively managed.
SP 2.1 Monitor the performance of selected subprocesses using statistical and other quantitative techniques.
SP 2.2 Manage the work using statistical and other quantitative techniques to determine whether or not the objectives for quality and process performance for the work are being satisfied.
SP 2.3 Perform causal analysis of selected outcomes and take action to address root causes.
CMMI for Development Model

- Development-specific PAs
- Shared PA (SAM)
- Core PAs that are present in all CMMI models.

CMMI-DEV (22)

CMMI-Core PAs

CMMI-SVC

CMMI-ACQ
Development-Specific PAs

CMMI Model Framework (CMF)

16 Project, Organizational, and Support Process Areas

- Requirements Development
- Supplier Agreement Management (Shared with SVC)
- Technical Solution
- Validation
- Product Integration
- Verification

CMMI-DEV PAs by Maturity Level

<table>
<thead>
<tr>
<th>Maturity Level</th>
<th>Process Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Causal Analysis and Resolution, Organizational Performance Management</td>
</tr>
<tr>
<td>4 Quantitatively Managed</td>
<td>Quantitative Project Management, Organizational Process Performance</td>
</tr>
<tr>
<td>2 Managed</td>
<td>Project Planning, Project Monitoring and Control, Requirements Management, Supplier Agreement Management, Configuration Management, Process and Product Quality Assurance, Measurement and Analysis</td>
</tr>
</tbody>
</table>

For the V1.3 release, there were no changes that affected the DEV PAs’ positioning by maturity level.
# CMMI-DEV PAs by Category

<table>
<thead>
<tr>
<th>Process Management</th>
<th>Project Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational Innovation and Deployment (OID)</td>
<td>Integrated Project Management (IPM)</td>
</tr>
<tr>
<td>Organizational Process Definition (OPD)</td>
<td>Project Monitoring and Control (PMC)</td>
</tr>
<tr>
<td>Organizational Process Focus (OPF)</td>
<td>Project Planning (PP)</td>
</tr>
<tr>
<td>Organizational Process Performance (OPP)</td>
<td>Requirements Management (REOM)</td>
</tr>
<tr>
<td>Organizational Training (OT)</td>
<td>Risk Management (RSKM)</td>
</tr>
<tr>
<td>Support</td>
<td>Quantitative Project Management (QPM)</td>
</tr>
<tr>
<td>Causal Analysis and Resolution (CAR)</td>
<td>(+) Supplier Agreement Management (SAM)</td>
</tr>
<tr>
<td>Configuration Management (CM)</td>
<td>Requirements Management (REOM)</td>
</tr>
<tr>
<td>Decision Analysis and Resolution (DAR)</td>
<td></td>
</tr>
<tr>
<td>Measurement and Analysis (MA)</td>
<td></td>
</tr>
<tr>
<td>Process and Product Quality Assurance (PPQA)</td>
<td></td>
</tr>
</tbody>
</table>

For the V1.3 release, REQM was moved from “Engineering” to “Project Management.”

---

# Product Integration

<table>
<thead>
<tr>
<th>SG 1: Prepare for Product Integration</th>
<th>Revised the purpose statement to ensure proper behavior instead of proper function, thereby including quality attributes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 1.1 Establish an Integration Strategy</td>
<td>Changed emphasis on integration sequence to an emphasis on integration strategy.</td>
</tr>
<tr>
<td>SP 1.2 Establish the Product Integration Environment</td>
<td>Described an integration strategy and how it relates to an integration sequence.</td>
</tr>
<tr>
<td>SP 1.3 Establish Product Integration Procedures and Criteria</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SG 2: Ensure Interface Compatibility</th>
<th>Revised SP 3.2 to replace “product integration sequence” with “product integration strategy and procedures.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 2.1 Review Interface Descriptions for Completeness</td>
<td></td>
</tr>
<tr>
<td>SP 2.2 Manage Interfaces</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SG 3: Assemble Product Components and Deliver the Product</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 3.1 Confirm Readiness of Product Components for Integration</td>
<td></td>
</tr>
<tr>
<td>SP 3.2 Assemble Product Components</td>
<td></td>
</tr>
<tr>
<td>SP 3.3 Evaluate Assembled Product Components</td>
<td></td>
</tr>
<tr>
<td>SP 3.4 Package and Deliver the Product or Product Component</td>
<td></td>
</tr>
</tbody>
</table>
Requirements Development

SG 1: Develop Customer Requirements
SP 1.1 Elicit Needs
SP 1.2 Transform Stakeholder Needs into Customer Requirements

SG 2: Develop Product Requirements
SP 2.1 Establish Product and Product Component Requirements
SP 2.2 Allocate Product Component Requirements
SP 2.3 Identify Interface Requirements

SG 3: Analyze and Validate Requirements
SP 3.1 Establish Operational Concepts and Scenarios
SP 3.2 Establish a Definition of Required Functionality and Quality Attributes
SP 3.3 Analyze Requirements
SP 3.4 Analyze Requirements to Achieve Balance
SP 3.5 Validate Requirements

Technical Solution

SG 1: Select Product Component Solutions
SP 1.1 Develop Alternative Solutions and Selection Criteria
SP 1.2 Select Product Component Solutions

SG 2: Develop the Design
SP 2.1 Design the Product or Product Component
SP 2.2 Establish a Technical Data Package
SP 2.3 Design Interfaces Using Criteria
SP 2.4 Perform Make, Buy, or Reuse Analyses

SG 3: Implement the Product Design
SP 3.1 Implement the Design
SP 3.2 Develop Product Support Documentation

Added informative material that requirements can be monitored through development based on their criticality to the customer or end user.

Revised the terminology used from a strong emphasis on "operational scenarios" to a more balanced "scenarios (operational, sustainment, and development)."

Added "quality attributes" as properties of products and services in addition to "functionality," which resulted in changes to SP3 and SP3.2.
Validation

SG 1: Prepare for Validation
   SP 1.1 Select Products for Validation
   SP 1.2 Establish the Validation Environment
   SP 1.3 Establish Validation Procedures and Criteria
SG 2: Validate Product or Product Components
   SP 2.1 Perform Validation
   SP 2.2 Analyze Validation Results

Verification

SG 1: Prepare for Verification
   SP 1.1 Select Work Products for Verification
   SP 1.2 Establish the Verification Environment
   SP 1.3 Establish Verification Procedures and Criteria
SG 2: Perform Peer Reviews
   SP 2.1 Prepare for Peer Reviews
   SP 2.2 Conduct Peer Reviews
   SP 2.3 Analyze Peer Review Data
SG 3: Verify Selected Work Products
   SP 3.1 Perform Verification
   SP 3.2 Analyze Verification Results
CMMI for Acquisition Model

- CMMI-ACQ (22 PAs)
- CMMI-SVC
- CMMI-DEV

Core PAs that are present in all CMMI models.
Acquisition-Specific PAs

CMMI Model Framework (CMF)

16 Project, Organizational, and Support Process Areas

Acquisition Requirements Development

Agreement Management

Acquisition Technical Management

Acquisition Verification

CMMI-ACQ PAs by Maturity Level

<table>
<thead>
<tr>
<th>Maturity Level</th>
<th>Process Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Causal Analysis and Resolution Organizational Performance Management</td>
</tr>
<tr>
<td>4 Quantitatively Managed</td>
<td>Quantitative Project Management Organizational Process Performance Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Acquisition Technical Management Acquisition Verification Acquisition Validation Decision Analysis and Resolution</td>
</tr>
<tr>
<td>3 Defined</td>
<td>Acquisition Requirements Development Agreement Management Project Planning Project Monitoring and Control Requirements Management Configuration Management Process and Product Quality Assurance Measurement and Analysis Solicitation and Supplier Agreement Development</td>
</tr>
<tr>
<td>2 Managed</td>
<td></td>
</tr>
</tbody>
</table>

For the V1.3 release, there were no changes that affected the ACQ PAs’ positioning by maturity level.
CMMI-ACQ PAs by Category

**Process Management**
- Organizational Innovation and Deployment (OID)
- Organizational Process Definition (OPD)
- Organizational Process Focus (OPF)
- Organizational Process Performance (OPP)
- Organizational Training (OT)

**Support**
- Causal Analysis and Resolution (CAR)
- Configuration Management (CM)
- Decision Analysis and Resolution (DAR)
- Measurement and Analysis (MA)
- Process and Product Quality Assurance (PPQA)

**Project Management**
- Integrated Project Management (IPM)
- Project Monitoring and Control (PMC)
- Project Planning (PP)
- Requirements Management (REQM)
- Risk Management (RSM)
- Quantitative Project Management (QPM)
- Solicitation and Supplier Agreement Development (SSAD)
- Agreement Management (AM)

**Acquisition Engineering**
- Acquisition Requirements Development (ARD)
- Acquisition Technical Management (ATM)
- Acquisition Validation (AVAL)
- Acquisition Verification (AVER)

For the V1.3 release, the category "Acquisition" was renamed to be "Acquisition Engineering" and SSAD and AM were moved to "Project Management."

---

**Agreement Management**

SG 1: Satisfy Supplier Agreements

- SP 1.1 Execute the Supplier Agreement
- SP 1.2 Monitor Selected Supplier Processes
- SP 1.3 Accept the Acquired Product
- SP 1.4 Manage Supplier Invoices
Acquisition Requirements Development

SG 1: Develop Customer Requirements
   SP 1.1 Elicit Stakeholder Needs
   SP 1.2 Develop and Prioritize Customer Requirements

SG 2: Develop Contractual Requirements
   SP 2.1 Establish Contractual Requirements
   SP 2.2 Allocate Contractual Requirements

SG 3: Analyze and Validate Requirements
   SP 3.1 Establish Operational Concepts and Scenarios
   SP 3.2 Analyze Requirements
   SP 3.3 Analyze Requirements to Achieve Balance
   SP 3.4 Validate Requirements

Acquisition Technical Management

SG 1: Evaluate Technical Solutions
   SP 1.1 Select Technical Solutions for Analysis
   SP 1.2 Analyze Selected Technical Solutions
   SP 1.3 Conduct Technical Reviews

SG 2: Perform Interface Management
   SP 2.1 Select Interfaces to Manage
   SP 2.2 Manage Selected Interfaces
Acquisition Validation

SG 1: Prepare for Validation
   SP 1.1 Select Products for Validation
   SP 1.2 Establish the Validation Environment
   SP 1.3 Establish Validation Procedures and Criteria

SG 2: Validate Selected Products and Product Components
   SP 2.1 Perform Validation
   SP 2.2 Analyze Validation Results

Acquisition Verification

SG 1: Prepare for Verification
   SP 1.1 Select Work Products for Verification
   SP 1.2 Establish the Verification Environment
   SP 1.3 Establish Verification Procedures and Criteria

SG 2: Perform Peer Reviews
   SP 2.1 Prepare for Peer Reviews
   SP 2.2 Conduct Peer Reviews
   SP 2.3 Analyze Peer Review Data

SG 3: Verify Selected Work Products
   SP 3.1 Perform Verification
   SP 3.2 Analyze Verification Results
Solicitation and Supplier Agreement Development

SG 1: Prepare for Solicitation and Supplier Agreement Development
- SP 1.1 Identify Potential Suppliers
- SP 1.2 Establish a Solicitation Package
- SP 1.3 Review the Solicitation Package
- SP 1.4 Distribute and Maintain the Solicitation Package

SG 2: Select Suppliers
- SP 2.1 Evaluate Proposed Solutions
- SP 2.2 Establish Negotiation Plans
- SP 2.3 Select Suppliers

SG 3: Establish Supplier Agreements
- SP 3.1 Establish an Understanding of the Agreement
- SP 3.2 Establish the Supplier Agreement

Added informative material about using preferred suppliers.

Inside the Acquirer’s Mind

Operational Need

What are the key activities you perform when you acquire systems?

Need to counter these attitudes:
“I’d rather have it wrong than have it late.” — Industry senior manager
“Ad hoc, catch as you can...that's our motto.”
“We do not work problems until they’re unrecoverable.”
Acquisition and Development Lifecycles

Why Acquisition Processes Are Important

Improve acquisition office operating practices

- Improve Reviews – documents, PMRs, PDRs, CDRs…
- Improve specific areas: risk mgt, requirements mgt, configuration control, contracting actions (including source selection)
- Improve communications
- Create a “strategic rhythm”
- Facilitate synergy between program segments/organizations, and even among “systems of systems”

Facilitate supplier processes

- Oversight/Insight into supplier processes
- Encourage strategic acquirer-supplier teamwork that may last for years
A Guidebook for Acquirers

*Understanding and Leveraging a Supplier’s CMMI Efforts: A Guidebook for Suppliers* is an SEI technical report.

- Provides a “process toolbox” for the acquirer
- Includes practical guidance on how to recognize the real practitioners…
- Encourages the use of capability and maturity profiles vice “single level” approach
- Improves acquisition organizations’ understanding of the meaning of high maturity (levels 4 and 5) and equivalent staging
- Includes multiple tools and guidance that may be used throughout the acquisition lifecycle
CMMI for Services Model

- CMMI-SVC
- CMMI-DEV
- CMMI-ACQ

Service-specific PAs
- Capacity and Availability Management
- Incident Resolution & Prevention
- Service Continuity
- Service Delivery
- Service System Development
- Strategic Service Management
- Service System Transition

Core PAs that are present in all CMMI models.

16 Core Process Areas and 1 shared PA (SAM)

CMMI V1.3 and Beyond Phillips – August 2010
© 2010 Carnegie Mellon University
### CMMI-SVC PAs by Maturity Level

<table>
<thead>
<tr>
<th>Maturity Level</th>
<th>Process Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Causal Analysis and Resolution Organizational Performance Management</td>
</tr>
<tr>
<td>4 Quantitatively Managed</td>
<td>Quantitative Project Management Organizational Process Performance</td>
</tr>
<tr>
<td>3 Defined</td>
<td>Service Continuity Service System Development Service System Transition Strategic Service Management Capacity and Availability Management Incident Resolution and Prevention Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Decision Analysis and Resolution</td>
</tr>
<tr>
<td>2 Managed</td>
<td>Service Delivery Project Planning Project Monitoring and Control Requirements Management Supplier Agreement Management Configuration Management Process and Product Quality Assurance Measurement and Analysis</td>
</tr>
</tbody>
</table>

For the V1.3 release, the word “project” was replaced with “work” in the names of four process areas: IPM, PMC, PP, and QPM.

### CMMI-SVC PAs by Category

**Process Management**
- Organizational Innovation and Deployment (OID)
- Organizational Process Definition (OPD)
- Organizational Process Focus (OPF)
- Organizational Process Performance (OPP)
- Organizational Training (OT)

**Support**
- Causal Analysis and Resolution (CAR)
- Configuration Management (CM)
- Decision Analysis and Resolution (DAR)
- Measurement and Analysis (MA)
- Process and Product Quality Assurance (PPQA)

**Project and Work Management**
- Capacity and Availability Management (CAM)
- Integrated Work Management (IWM)
- Work Monitoring and Control (WMC)
- Work Planning (WP)
- Requirements Management (REQM)
- Risk Management (RSMK)
- Quantitative Work Management (QWM)
- Service Continuity (SCON)
- Supplier Agreement Management (SAM)

**Service Establishment and Delivery**
- Incident Resolution and Prevention (IRP)
- Service Delivery (SD)
- (+) Service System Development (SSD)
- Service System Transition (SST)
- Strategic Service Management (STSM)

For the V1.3 release, the category ‘Project Management’ became “Project and Work Management” and the word “project” was replaced with “work” in the names of four process areas: IPM, PMC, PP, and QPM.
Capacity and Availability Management

SG 1: Prepare for Capacity and Availability Management
   SP 1.1 Establish a Capacity and Availability Management Strategy
   SP 1.2 Select Measures and Analytic Techniques
   SP 1.3 Establish Service System Representations

SG 2: Monitor and Analyze Capacity and Availability
   SP 2.1 Monitor and Analyze Capacity
   SP 2.2 Monitor and Analyze Availability
   SP 2.3 Report Capacity and Availability Management Data

Incident Resolution and Prevention

SG 1: Prepare for Incident Resolution and Prevention
   SP 1.1 Establish an Approach to Incident Resolution and Prevention
   SP 1.2 Establish an Incident Management System

SG 2: Identify, Control, and Address Individual Incidents
   SP 2.1 Identify and Record Incidents
   SP 2.2 Analyze Individual Incident Data
   SP 2.3 Resolve Incidents
   SP 2.4 Monitor the Status of Incidents to Closure
   SP 2.5 Communicate the Status of Incidents

SG 3: Analyze and Address Causes and Impacts of Selected Incidents
   SP 3.1 Analyze Selected Incident Data
   SP 3.2 Establish Solutions to Respond to Future Incidents
   SP 3.3 Establish and Apply Solutions to Reduce Incident Occurrence

Updated the terminology throughout the PA to describe “solutions” and “repeatable solutions” in addition to “workarounds,” which are a subset of “repeatable solutions.”

Reorganized the SPs in SG2 and SG3 to be more usable.
Service Delivery

SG 1: Establish Service Agreements
SP 1.1 Analyze Existing Agreements and Service Data
SP 1.2 Establish the Service Agreement

SG 2: Prepare for Service Delivery
SP 2.1 Establish the Service Delivery Approach
SP 2.2 Prepare for Service System Operations
SP 2.3 Establish a Request Management System

SG 3: Deliver Services
SP 3.1 Receive and Process Service Requests
SP 3.2 Operate the Service System
SP 3.3 Maintain the Service System

Service Continuity

SG 1: Identify Essential Service Dependencies
SP 1.1 Identify and Prioritize Essential Functions
SP 1.2 Identify and Prioritize Essential Resources

SG 2: Prepare for Service Continuity
SP 2.1 Establish Service Continuity Plans
SP 2.2 Establish Service Continuity Training
SP 2.3 Provide and Evaluate Service Continuity Training

SG 3: Verify and Validate the Service Continuity Plan
SP 3.1 Prepare for the Verification and Validation of the Service Continuity Plan
SP 3.2 Verify and Validate the Service Continuity Plan
SP 3.3 Analyze Results of Verification and Validation of the Service Continuity Plan

Revised SP 3.3 to clarify that verification and validation apply to the service continuity plan.
Service System Development

SG 1: Develop and Analyze Stakeholder Requirements
   SP 1.1 Develop Stakeholder Requirements
   SP 1.2 Develop Service System Requirements
   SP 1.3 Analyze and Validate Requirements

SG 2: Develop Service Systems
   SP 2.1 Select Service System Solutions
   SP 2.2 Develop the Design
   SP 2.3 Ensure Interface Compatibility
   SP 2.4 Implement the Service System Design
   SP 2.5 Integrate Service System Components

SG 3: Verify and Validate Service Systems
   SP 3.1 Prepare for Verification and Validation
   SP 3.2 Perform Peer Reviews
   SP 3.3 Verify Selected Service System Components
   SP 3.4 Validate the Service System

Revised SP 1.3 to include “quality attributes” as well as “functionality” when analyzing and validating requirements.

Service System Transition

SG 1: Prepare for Service System Transition
   SP 1.1 Analyze Service System Transition Needs
   SP 1.2 Develop Service System Transition Plans
   SP 1.3 Prepare Stakeholders for Changes

SG 2: Deploy the Service System
   SP 2.1 Deploy Service System Components
   SP 2.2 Assess and Control the Impacts of the Transition
Strategic Service Management

SG 1: Establish Strategic Needs and Plans for Standard Services
- SP 1.1 Gather and Analyze Data
- SP 1.2 Establish Plans for Standard Services

SG 2: Establish Standard Services
- SP 2.1 Establish Properties of Standard Services and Service Levels
- SP 2.2 Establish Descriptions of Standard Services

Why Is CMMI-SVC Needed?

Service providers deserve a consistent benchmark as a basis for process improvement that is appropriate to the work they do and is based on a proven approach.

- Demand for process improvement in services is likely to grow: services constitute more than 80% of the US and global economy.
- Services constitute more than 54% of what the DoD acquires. In FY2006, DoD spent $146 billion on services. GAO reports a 72% increase in DoD service contracts between 1996 and 2005.
- Other service models exist, but don’t cover what CMMI covers. Many organizations are cobbling together their own ITIL + CMMI solutions, reinventing the wheel over and over, and that wheel is not designed for services other than IT.
- Customers are requesting that their service providers demonstrate a CMMI rating or capability profile, but attempts to use CMMI-DEV in a service setting can distort the integrity of appraisal results.
- A variety of potential stakeholders approached the SEI asking for help with services.

* FY 2006 data is from “DoD throws light on how it buys services [GCN 2006].” GAO data is from GAO report GAO-07-20.
What Types of Services Does CMMI-SVC Cover?

How Do Services Differ from Other Products?

A service is an intangible, non-storable product (e.g., operations, maintenance, logistics, and IT).

Services imply on-going relationships governed by service agreements.

Services are delivered through the operation of a service system.

Services are simultaneously produced and consumed.

Services have a different business rhythm.

<table>
<thead>
<tr>
<th>Product</th>
<th>Develop</th>
<th>Deliver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>Develop</td>
<td>Deliver</td>
</tr>
</tbody>
</table>
Can CMMI Be Harmonized with Other Standards and Process Improvement Efforts?

Agree that harmonization should be a goal, but should not slow progress too much

Harmonization efforts take time

(This may be the only formal harmonization effort) Currently, 15288 being harmonized with 12207 (ongoing several years). There is a move to say “either or”. Recent work in this area to come out soon.

Are there “standards” we want to focus on?

Standards

Process Improvement Methods

9001, 14000 (environmental standard), AS 9100, FAA Standard (Aviation Critical Safety Items), 15288, 12207, 15504, ITIL, COBIT, Sarbanes-Oxley, 632 (Systems Engineering), 1220, Malcolm Baldridge, Six Sigma [not all standards here are at the same level of abstraction], PM BOK and OPM3
CMMI Planned Elements: Multi-Model

Improving interfaces is of interest to both government and industry....

CMMI and the People CMM

CMMI (DEV, ACQ, SVC) improves the capability of organizations’ processes within specific domains.

The People CMM improves the capability of organizations’ workforces through enhanced management and human capital. (The People CMM defines capability as the level of knowledge, skills, and process abilities available within each workforce competency of the organization to build its products or deliver its services.)
Use of Multiple Models

Multiple models complicate process improvement – but make it much more powerful by addressing specific needs in various environments.

<table>
<thead>
<tr>
<th>Governance (including external mandates, regulations and internally chosen governance)</th>
<th>EFQM</th>
<th>Lean</th>
<th>FDA 510K</th>
<th>6S/MAIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational infrastructure and readiness (including business, engineering, and change improvement practices)</td>
<td>Six Sigma</td>
<td>6S/DMAIC</td>
<td>eSCM - CL</td>
<td>6S/DFSS</td>
</tr>
<tr>
<td>Tactical (procedural, for both improvement and engineering tasks)</td>
<td>P-CMM</td>
<td>CMMI</td>
<td>ISO 12207</td>
<td>ITIL</td>
</tr>
<tr>
<td>Enterprise oriented</td>
<td>eSCM - SR</td>
<td>ISO 4000</td>
<td>SWEBOK</td>
<td>TPS/Agile</td>
</tr>
</tbody>
</table>

Increasing decision authority of process group
AV-8B CMMI “Quick Look” Profile

Combined Appraisals

The possible options for assessment and surveillance
Putting People Back Into the Equation

Today, organizations are largely dependent on high-technology to build and develop their products and services.

The dependence on high-technology has lead to a reliance on a knowledgeable and skilled workforce.
Modern organizations can’t succeed unless the people they employ agree to contribute to their mission and survival.”
Denise M. Rousseau (2004), Professor Carnegie Mellon University

**People: Growing Contributors to Organization Success**

Organizational Value: Tangible and Intangible

<table>
<thead>
<tr>
<th>Year</th>
<th>Tangible Assets</th>
<th>Intangible Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>62%</td>
<td>38%</td>
</tr>
<tr>
<td>2006</td>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td>Current/Future?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

---

**What Is the People CMM?**

The People CMM is an organizational change model based on state-of-the-art workforce practices to help organizations do the following:

- Develop the workforce required to execute a business strategy.
- Characterize the maturity of workforce practices.
- Set priorities for improving workforce capability.
- Integrate improvements in processes and the workforce.
- Become an employer of choice.

Curtis, Hefley, & Miller (2009)
How Is the People CMM Used?

The People CMM is used...

- as a guide in planning and implementing improved human capital management practices,
- as a guide for improving organizational standards, and
- as a standard for analyzing and appraising an organization’s implemented workforce practices.

Why Implement Workforce Practices?

There are several reasons why organizations choose to implement high-performance workforce practices, including the following:

- to improve organizational capability
- to support and maintain high-maturity capability (e.g., CMMI implementation)
- to increase the accountability of the organization’s HR management activities
- to implement teams of competence
- to communicate and put into routine practice shared value regarding the workforce
- to implement strategic imperatives
- to meet competitive pressures in the marketplace
Example Benefits of the People CMM

- Developing a common language to address workforce issues
- Encouraging a systems perspective of workforce processes
- Providing a framework for process documentation
- Involving first-line managers as active process owners
- Using process measurements to get objective evaluations
- Shifting attention to effective performance feedback
- Creating a greater willingness to use documented performance improvement plans
- Enhancing clarity and communication about the organization’s compensation philosophy
- Addressing the challenges of career planning
- Addressing higher maturity issues, such as empowered groups

Types of Organizations Using the People CMM

<table>
<thead>
<tr>
<th>Business Processing Outsourcing</th>
<th>Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitality</td>
<td>Consulting</td>
</tr>
<tr>
<td>Construction</td>
<td>Defense Contracting</td>
</tr>
<tr>
<td>Insurance</td>
<td>Pharmaceuticals</td>
</tr>
<tr>
<td>US Government Agencies</td>
<td>Department of Defense</td>
</tr>
<tr>
<td>Utilities</td>
<td>Software Development</td>
</tr>
<tr>
<td>Banking</td>
<td>Management Information Systems</td>
</tr>
</tbody>
</table>
People CMM and Process Area Threads

<table>
<thead>
<tr>
<th>Maturity Levels</th>
<th>People CMM Threads</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Continuous Capability Improvement</td>
</tr>
<tr>
<td></td>
<td>Organizational Performance Alignment</td>
</tr>
<tr>
<td></td>
<td>Continuous Workforce Innovation</td>
</tr>
<tr>
<td>4 Predictable</td>
<td>Mentoring</td>
</tr>
<tr>
<td></td>
<td>Competency Based Assets</td>
</tr>
<tr>
<td></td>
<td>Competency Integration Empowered Workgroups</td>
</tr>
<tr>
<td></td>
<td>Quantitative Performance Management</td>
</tr>
<tr>
<td></td>
<td>Organizational Capability Management</td>
</tr>
<tr>
<td>3 Defined</td>
<td>Competency Development</td>
</tr>
<tr>
<td></td>
<td>Workgroup Development</td>
</tr>
<tr>
<td></td>
<td>Participatory Culture</td>
</tr>
<tr>
<td></td>
<td>Competency Based Practices</td>
</tr>
<tr>
<td></td>
<td>Career Development</td>
</tr>
<tr>
<td></td>
<td>Workforce Planning</td>
</tr>
<tr>
<td>2 Managed</td>
<td>Training and Development</td>
</tr>
<tr>
<td></td>
<td>Communication &amp; Coordination</td>
</tr>
<tr>
<td></td>
<td>Compensation Performance Management</td>
</tr>
<tr>
<td></td>
<td>Work Environment</td>
</tr>
<tr>
<td></td>
<td>Staffing</td>
</tr>
</tbody>
</table>

Process Area Components

- **Process Area**
- **Purpose Statement**
- **Description**
- **Goals**
- **Implementation Goals**
- **Practices** (Practice Statements)
- **Subpractices**
- **Supplementary Information**

Key:
- Required
- Expected
- Informative
People CMM Primary Objective

The primary objective of the People CMM is to improve the capability of the workforce.

Workforce capability can be defined as the level of knowledge, skills, and process abilities available for performing an organization’s business activities.

Workforce capability indicates the following about an organization:

- its readiness to perform its critical business activities
- likely results from performing these business activities
- its potential for benefiting from investments in process improvement or advanced technology

### Defining Capability Components

**Knowledge** represents the comprehension acquired by experience and or study.

**Skills** represents the proficiency or ability in techniques or tools that an individual must be able to demonstrate.

**Process abilities** is the capacity to perform individual skills in the sequencing or method used in the organization.

\[
\text{Knowledge} + \text{Skills} + \text{Process abilities} = \text{Workforce capability}
\]
Understanding Capability and Capacity - 1

Current Resource Profile (initial inventory)

<table>
<thead>
<tr>
<th>Workforce Competency</th>
<th>Staffing by Capability Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Engineer</td>
<td>I I I I</td>
</tr>
<tr>
<td>Project Manager</td>
<td>2 8 4 1</td>
</tr>
</tbody>
</table>

Current Resource Needs (one year cycle)

<table>
<thead>
<tr>
<th>Workforce Competency</th>
<th>Current Staffing Level Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Engineer</td>
<td>23 30 15 7</td>
</tr>
<tr>
<td>Project Manager</td>
<td>4 9 6 2</td>
</tr>
</tbody>
</table>

Strategic Resource Needs (two to five year)

<table>
<thead>
<tr>
<th>Workforce Competency</th>
<th>2012 Staffing Level Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Engineer</td>
<td>31 35 18 6</td>
</tr>
<tr>
<td>Project Manager</td>
<td>4 16 8 5</td>
</tr>
</tbody>
</table>

Understanding Capability and Capacity - 2

From counting heads to understanding Capability and Capacity

10 Software Engineers
5 Project Managers
4 Systems Engineers

Resource Capability Profile

<table>
<thead>
<tr>
<th>Workforce Competency</th>
<th>Staffing by Capability Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Engineer</td>
<td>I I I I</td>
</tr>
<tr>
<td>Project Manager</td>
<td>2 8 4 1</td>
</tr>
</tbody>
</table>

Software Engineering Competency Family

Software Engineering Institute | Carnegie Mellon

Software Engineering Institute | Carnegie Mellon
People CMM: Focus for Changing Practices

Maturity Level 1
- Ad-hoc inconsistent practices

Maturity Level 2
- Managers perform practices repeatedly

Maturity Level 3
- Empowered workgroups & measured capability

Maturity Level 4
- Improvement at multiple levels

Maturity Level 5
- Organization develops workforce competencies

Improvement Efforts: Missing Elements of Change

- Vision
- Resources
- Capable Workforce
- Capable Processes
- Organizational Culture
- Incentives
- Action Plan
- Change

- Vision
- Resources
- Capable Workforce
- Capable Processes
- Organizational Culture
- Incentives
- Action Plan
- Confusion

- Vision
- Resources
- Capable Workforce
- Capable Processes
- Organizational Culture
- Incentives
- Action Plan
- Anxiety & frustration

- Vision
- Resources
- Capable Workforce
- Capable Processes
- Organizational Culture
- Incentives
- Action Plan
- Slow or little progress

- Vision
- Resources
- Capable Workforce
- Capable Processes
- Organizational Culture
- Incentives
- Action Plan
- Reinventing the wheel

- Vision
- Resources
- Capable Workforce
- Capable Processes
- Organizational Culture
- Incentives
- Action Plan
- Barriers to change

- Vision
- Resources
- Capable Workforce
- Capable Processes
- Organizational Culture
- Incentives
- Action Plan
- Sporadic change

- Vision
- Resources
- Capable Workforce
- Capable Processes
- Organizational Culture
- Incentives
- Action Plan
- False starts

Source: Buttles, Svolou, and Valdez 2007.
The People CMM as a Contributor to other Models and Frameworks

Focus Areas of Improvement

To increase capability and performance on multiple levels, organizations typically focus on four areas of improvement.

The People CMM contributes to and impacts improvements in process, technology, people and organizational culture.

Source: Buttles, Svolou, and Valdez 2008
Focus Areas of Improvement

To implement process improvement activities that are enduring, organizations need the following:

- the ability to manage and control the complex development, delivery, and maintenance processes and the processes used to manage and develop the workforce and services
- to monitor changes in technology and deploy it to make the work efficient
- a workforce that has the appropriate knowledge, skills, and process abilities (competencies) that are adaptable to rapid changes in a technological environment
- an organizational culture that is adaptable to changing conditions and is in alignment with policies, business objectives, and strategies

Source: Buttles, Svolou, and Valdez 2008

CMMI Synergies

The People CMM and the CMMI constellations work together to promote improvements via a holistic approach that support the following:

- Process enablers and reinforcement
- Technology enablers and reinforcement
- People enablers and reinforcement
- Cultural enablers and reinforcement

In many cases, the People CMM enhances and supports practices related to people, training, and culture.
CMM-SVC and People CMM: Working Together

- **Business Objectives**
  - Drives
  - CMMI-SVC

- **Service Delivery**
  - Enhances
  - People CMM
  - Human Capital Resources
    - Contributes
  - Performance & Capability

- **Organizational Culture**
  - Customer Satisfaction and Loyalty

 Delivering Services through a Service System

- **Organization**
  - CMMI-SVC
  - People CMM
  - Work Products
  - Processes
  - Tools
  - Consumable Items
  - Facilities
  - Human Resources

**Service system**: everything needed to enable service delivery
Focus: Balancing Work Commitments with Resource Capacity Requirements

Service Delivery Organizations: The Service Profit Chain

- "Employee satisfaction soars when you enhance internal service quality (equipping employees with the skills and power to serve customers)
- Employee satisfaction in turn fuels employee loyalty, which raises employee productivity.
- Higher productivity means greater external service value for customers – which enhances customer satisfaction and loyalty. A mere 5% jump in customer loyalty can boost profits 25%--85%.” (Heskett et al. Harvard Business Review: RO807L)

Improvement in customer satisfaction has a significant and positive impact on firms' financial performance” (Gupta and Zeithaml 2006)
People CMM: Contributing to Service-Profit Chain

The People CMM directly contributes to all the links in the Service-Profit Chain.

People CMM and Malcolm Baldrige

Increase strategic alignment
Increased human capital management capability to meet business needs

Reduce turnover/attrition
Increased employee satisfaction
Current and future competency inventory
Graduated competency career paths
Increased human capital management capability
Distinct capability parameter
Reputation signals

Scope of the People CMM

Workforce Practices → Workforce Activities Implemented

Executive Management Leadership
Strategic Planning
Human Resource Management
Process Management

Information and Analysis
- Measurement and analysis of organizational performance
- Information management

Business Results (or outcomes)
- Customer-focused results
- Financial and market results
- Human resource results
- Organizational effectiveness

MBNQA Criteria
More Information Is Available

For more information about CMMI

- http://www.sei.cmu.edu/cmmi/ (main CMMI site)

Other Web sites of interest include

- http://seir.sei.cmu.edu/seir/ (Software Engineering Information Repository)
- http://dtic.mil/ndia (annual CMMI Technology Conferences)
- http://seir.sei.cmu.edu/pars (publicly released SCAMPI appraisal summaries)
- https://bscw.sei.cmu.edu/pub/bscw.cgi/0/79783 (CMMI project artifacts)

Or, contact

SEI Customer Relations
Phone: 412 / 268-5800
Email: customer-relations@sei.cmu.edu

Contact Information

Mike Phillips
CMMI Program Manager
dmp@sei.cmu.edu
412-268-5884
Backup

Benefits of CMMI Within the Defense Industry

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA  15213

May 2010
Outline

Introduction
Benefits of CMMI Implementation
  - Quantitative
  - Qualitative
Looking Ahead
Summary

This report was created with the cooperation of the Systems Engineering Division (SED) of the National Defense Industrial Association (NDIA) and their member companies and DoD organizations.

Purpose of Presentation

Present new evidence about effective implementations of CMMI

- Examples are provided by the defense industrial base and DoD organizations.
- New examples are based upon the measures that practicing organizations use to track value to their businesses.
- Examples are provided by organizations that have tracked and measured performance improvements from using CMMI over many years.
- Many of the organizations emphasize high maturity results and show that they enabled superior performance.
- Their data indicate why CMMI is important to the DoD & its suppliers.

The new data presented in this report demonstrates that effective implementation of good practices aided by use of CMMI can improve cost, schedule, and quality performance.
CMMI: Major Benefits to DoD

“Does CMMI work?” We asked our nation’s defense contractors, as well as government agencies, to share results from their performance improvement efforts using CMMI. The results spoke for themselves: “Yes, CMMI works!”

The following slides include information from six defense organizations that responded.*

*Results reported in this presentation are not attributed to protect confidentiality.

Background on the Data for this Presentation

Organizational and project leaders decided which measures were most useful to them when tracking the results of CMMI-based improvements.

A common thread was their interest in measuring the effect CMMI had on schedule, effort and cost, and quality.

The summarized results demonstrate the wide scope of business values and goals of the participating organizations.

The source studies in this presentation used current data as follows:

- 2010: Organizations 1, 2A, 3, & 6
- 2009: Organizations 5 & 7
## Quantitative Measures: Schedule Performance Results Summary

<table>
<thead>
<tr>
<th>Measure Used By The Organization</th>
<th>Performance Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-time deliverables (Organization 2a)</td>
<td>On-time deliverable increase of 4.9% (organization went from 95% to 99.9% of projects delivered on time)</td>
</tr>
<tr>
<td>Earlier Defect Detection and Repair (Organization 1)</td>
<td>6.35 times less defect discovery and repair hours after start of system testing; potential savings of 5 – 6.5 months in schedule delay after system tests begin for average sized project</td>
</tr>
<tr>
<td>Schedule performance index (Organization 7)</td>
<td>Increased from .78 to .93 over three years (a 19.2% improvement in estimation and execution of schedule)</td>
</tr>
</tbody>
</table>

## Quantitative Measures: Effort (Rework) and Cost Performance Results Summary

<table>
<thead>
<tr>
<th>Measure Used By The Organization</th>
<th>Performance Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total hours for defect repair (Organization 1)</td>
<td>58% fewer hours needed to repair defects for ML5 versus ML3; Result: a potential cost savings of $1.9 to $2.3 M per average-sized project (defined as 233 KESLOC [Kilo Equivalent Source Lines of Code])</td>
</tr>
<tr>
<td>Hours per KLOC to find and fix defects for CMMI ML5 relative to the SW-CMMI ML3 baseline (Organization 6)</td>
<td>Defect find and fix cost down 22%</td>
</tr>
<tr>
<td>Effort hours needed to repair high severity defects in integration and test phases (Organization 4)</td>
<td>24% reduction in effort hours per defect</td>
</tr>
<tr>
<td>Cost performance index (Organization 4)</td>
<td>Increased from .88 to .96 over two years</td>
</tr>
<tr>
<td>Overhead rates for CMMI ML5 relative to the SW-CMMI ML3 baseline (Organization 6)</td>
<td>Reduced by 7.3%</td>
</tr>
<tr>
<td>Software development cost for CMMI ML5 relative to the SW-CMMI ML3 baseline (Organization 6)</td>
<td>Reduced by 28%</td>
</tr>
</tbody>
</table>
Selected Results: High Maturity Reduces Costs for Repair (Organization 1)

High Maturity Projects Discover defects earlier

- Early detection and repair lowers Costs
- 57.7% fewer hours for ML5 projects expended to repair defects versus ML3
- 105.3 fewer hours per defect
  - 88.6 fewer hours during Testing alone
  - When largest risk to schedule occurs

Average Hours per Defect per Phase

<table>
<thead>
<tr>
<th>Phase</th>
<th>ML3</th>
<th>ML5</th>
<th>ML5 vs ML3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req &amp; Design</td>
<td>7.9</td>
<td>4.3</td>
<td>3.6</td>
</tr>
<tr>
<td>Code &amp; UT</td>
<td>6.7</td>
<td>6.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Sys &amp; Acpt. Test</td>
<td>22.1</td>
<td>18.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Post Delivery</td>
<td>22.7</td>
<td>20.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Total</td>
<td>105.3</td>
<td>77.2</td>
<td>28.1</td>
</tr>
</tbody>
</table>

Selected Results: Effort to Repair Defects by Phase (Organization 1)

- 57.7% fewer hours (24,527) expended for ML5
- 6.35 times (20,641 hrs) less risk of Cost or Schedule impact late in program
- When largest risk to schedule occurs

Potential Cost Savings From $1.9 M to $2.3 M per average sized program
## Quantitative Measures: Quality Performance Results Summary

<table>
<thead>
<tr>
<th>Measure Used By The Organization</th>
<th>Performance Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defect density by severity, ML5 compared to ML3 (Organization 1)</td>
<td>62.5% fewer high-severity defects with ML5 projects</td>
</tr>
<tr>
<td>Defect density in circuit board design (Organization 2a)</td>
<td>65% improvement</td>
</tr>
<tr>
<td>Defect containment by phase (Organization 3)</td>
<td>The fix of defects within the phase they were injected increased by 240%</td>
</tr>
<tr>
<td>Defect containment, ML5 compared to ML3, by phase per KLOC (thousands of lines of code) (Organization 2b)</td>
<td>Defect containment improved 13%</td>
</tr>
<tr>
<td>User acceptance test defects per KLOC (Organization 7)</td>
<td>Less than 0.15 defects per KLOC</td>
</tr>
<tr>
<td>% of defects removed prior to system test (Organization 7)</td>
<td>&gt;85%</td>
</tr>
</tbody>
</table>

## Selected Results: Quality Performance (Organization 3)

### Defects Phase Containment / Leakage

- **(High Severity Defects - Priority 1, 2 & 3)**

  - **Within ML5 projects:**
    - Defect containment (within phase) increased by 240%
    - Leakage is reduced by 90% for defects discovered “1 phase later”
    - 84% reduction in defects leaked “2 or 2+ Phases”

  - Optimizing verification activities:
    - Peer reviews
    - Unit testing
    - Integration testing

### Cost avoidance realized:

- Less rework late in the life cycle when it is most expensive to repair
- Resulting in reduced schedule risk
### Quantitative Measures: Productivity Results Summary

<table>
<thead>
<tr>
<th>Measure Used By The Organization</th>
<th>Performance Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity Gain with ML5 (Organization 1)</td>
<td>42% gain with ML5 organizational practices over 9 years</td>
</tr>
<tr>
<td>Organizational productivity vs. Galorath SEER SEM Estimation Model (Organization 1)</td>
<td>Production hours reduction: 33.0% at ML3; 37.4% at ML5</td>
</tr>
<tr>
<td>Productivity for CMMI ML5 relative to the SW-CMM ML3 baseline (Organization 6)</td>
<td>Productivity up 25.2%</td>
</tr>
</tbody>
</table>

### Selected Results: Software Productivity

(Organization 1)

- Average project size was 233 KESLOC
- Largest = 1,360 KESLOC
- Smallest = 29 KESLOC

![Productivity Gain with Long Term ML5](image)

42% Gain with ML5 Organizational Practices

Average customer project savings due to increased productivity:
- Equivalent of 406 work months per project (33.8 work years)
Quantitative Measures: Customer Satisfaction Results Summary

<table>
<thead>
<tr>
<th>Measure Used By The Organization</th>
<th>Performance Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Award fee (used as an indicator of customer satisfaction) for CMMI ML5 relative to the SW-CMM ML2 baseline (Organization 6)</td>
<td>50% of potential additional award fee achieved</td>
</tr>
<tr>
<td>Cost savings to customer in a cost-plus contract (Organization 1)</td>
<td>Rose from 5.7 M to 7.1 M (25%)</td>
</tr>
</tbody>
</table>

Selected Results: Award Fee (Organization 6)

Customer Satisfaction Continues to Improve
Quantitative Result: Return on Investment  
(Organization 2a)

Organization 2a reported their quantified ROI from CMMI Maturity Level 5 activity to be $24 : 1$.

Using the data in *Performance Results of CMMI®-Based Process Improvement* (CMU/SEI-2006-TR-004) they were able to compare their ROI performance to others in industry:

- Median ROI: $4 : 1$
- Lowest ROI: $1.7 : 1$
- Organization 2a: $24 : 1$
- Highest ROI: $27.7 : 1$

These results are a consequence of meaningful process improvement aligned with the business and engineering objectives.

CMMI Provides Many Qualitative Benefits as Well*

Organizations also gathered various qualitative measures to compliment their quantitative measurements. They found qualitative benefits such as:

- Reduced overtime and less intense pressure
- Clear roles and responsibilities for business execution
- Common language (i.e., defined processes, measures) across business units
- Decrease in replanning
- Products with lower levels of defects and lower risk; one organization offers a lifetime warranty on products
- Improved program insight, control, and tracking
- Reduced training: process documentation enables knowledge transfer to new generation of workers
- Process transformation (via consistency, integration, coordination)
- Personnel retention and job satisfaction

*based on published benefits from a wide variety of organizations
The Bottom Line

Why improve processes? - Because processes are the foundation for all other business improvements, and critical for
- lasting improvements
- successful technology insertion

If a performance management system is not in use, leadership is unaware of what is and is not working.

CMMI is a proven approach to performance management – with more than a decade of results showing it does work.

Organizations have provided data that shows CMMI enables the delivery of lower-defect products, with predictable cost, schedule, and quality.
improves business performance
serves as competitive discriminator

Results Depend on Implementation

Simply deciding to “do CMMI” is not enough to achieve benefits.

Defining good processes, using them, measuring the results, and making improvements based on what you learn are all key to reaping the benefits described in this presentation.

The CMMI models are a foundational part of a comprehensive approach to process improvement that helps organizations understand

- why they should improve
- what frameworks and tools would best fit their needs
- how to implement them
Recent Research on CMMI: Just the Tip of the Iceberg!