I Say Tomato… You Say Eggplant
Comparing process references for Systems Engineers and Project Managers in a CMMI®-compliant organization.

CMMI 9th Technology Conference and User Group
November 18, 2009
Peter Henry, PMP
Glen Welsh, CSEP
Agenda

• Problem Statement
• Source documents
  • CMMI for Development, Ver. 1.2
  • PMBOK® Guide
  • INCOSE SE Handbook
• Discussion by CMMI® Process Area
• Conclusion & recommendations

® PMBOK is a registered mark of the Project Management Institute, Inc.
® CMMI is registered in the U.S. Patent and Trademark Office by Carnegie Mellon University
Problem Statement

- High-performing organizations place an emphasis on training and certification of practitioners to industry-recognized standards
- Two common training and certification standards
  - Project Managers - Project Management Institute’s *Guide to the Project Management Body of Knowledge* (PMBOK® Guide)
    - Results in certification as a *Project Management Professional (PMP)*
  - Systems Engineers - International Council on Systems Engineering’s (INCOSE) *Systems Engineering Handbook*
    - Results in certification as a *Certified Systems Engineering Professional (CSEP)*
- Organizations are likely to have PMs certified to the PMBOK® and SEs certified to the SE Handbook
- While these resources each recognize the existence of the other function they were developed independently as stand alone resources for their target audiences.
- Are these references consistent? Are they contradictory?
- How does the union of these references address CMMI® compliance?
PMBOK® Guide

- ANSI/PMI 99-001-2008
- 2-dimensional view of knowledge areas intersecting with process groups
  - 9 Knowledge Areas
    - Project Management Integration
    - Project Scope Mgmt
    - Project Time Mgmt
    - Project Cost Mgmt
    - Project Quality Mgmt
    - Project HR Mgmt
    - Project Communication Mgmt
    - Project Risk Mgmt
    - Project Procurement Mgmt
  - 5 Process Groups
    - Initiating Process Group
    - Planning Process Group
    - Executing Process Group
    - Monitoring & Controlling Process Group
    - Closing Process Group
PMBOK® Guide

- Focus is on the *Project* and the role of the *Project Manager*
  - *A project is a temporary endeavor undertaken to create a unique product, service, or result.* (PMBOK® guide, Sect 1.2)
  - Relationships between Projects, Program and Portfolios
- The enterprise’s overall project management process capability is modeled separately in the *Organizational Project Management Maturity Model* (not addressed here)
INCOSE Handbook

- **Systems Engineering Handbook**
  *A Guide for System Life Cycle Processes and Activities*
  Version 3.1, August 2007
- INCOSE-TP-2003-002-03.1
  - 11 Technical Processes
    - Stakeholder requirements definition
    - Requirements Analysis
    - Architectural design
    - Implementation
    - Integration
    - Verification
    - Transition
    - Validation
    - Operation
    - Maintenance
    - Disposal
  - 7 Project Processes
    - Project Planning
    - Project Assessment
    - Project Control
    - Decision-Making
    - Risk & Opportunity Mgmt
    - Configuration Mgmt
    - Information Mgmt
  - 7 Enterprise & Agreement Processes
    - Enterprise Environment Management
    - Investment Management
    - System Life Cycle Process Management
    - Resource Management
    - Quality Management
    - Acquisition
    - Supply
Focus is on the *System* and the role of the *Systems Engineer*

- A system is a combination of interacting elements organized to achieve one or more stated purposes. (INCOSE Handbook, Sect 1.5)

- Addresses *Operation, Maintenance and Disposal* in addition to the processes employed to develop the system
### CMMI® Process Management Processes

<table>
<thead>
<tr>
<th>CMMI® Process Area</th>
<th>PMBOK® Knowledge Area</th>
<th>INCOSE Handbook</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPF - Organizational Process Focus</td>
<td>--</td>
<td>Enterprise Environment Management Process</td>
</tr>
<tr>
<td>OPD - Organizational Process Definition</td>
<td>--</td>
<td>System Life Cycle Processes Management Process</td>
</tr>
<tr>
<td>OPP - Organizational Process Performance</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>OID - Organizational Innovation &amp; Deployment</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>OT - Organizational Training</td>
<td>Human Resources Management</td>
<td>Resource Management Process</td>
</tr>
</tbody>
</table>

- PMI uses the *Organizational Project Management Maturity Model* to address organizational process areas
  - Not required for PMP certification
- INCOSE indirectly addresses OID with Enterprise Environment Management Process
  - Focus is on incremental improvement of System Life Cycle
CMMI® Process Management Processes

• PMBOK®
  • Due to its project focus, organizational functions such as organizational process development, process deployment, and training of the organization at large are not covered in the PMBoK
  • Improving the competencies of the assembled project team is addressed within the PMBoK within 9.3 Develop Project Team of the Project Human Resource Management knowledge area
  • Organizational processes and human resource skills, disciplines & knowledge are grouped with other internal and external factors that surround and influence a project into Enterprise Environmental Factors

• INCOSE Handbook
  • Organizational process areas are addressed in the INCOSE Handbook
    • Enterprise Environment Management Process addresses policies and procedures at the enterprise level
    • System Life Cycle Processes Management Process establishes a set of life cycle processes for the enterprise
  • Training of the organization is discussed within the Resource Management Process, although not to the level of detail provided within the CMMI® Guidelines
# CMMI® Project Management Processes

<table>
<thead>
<tr>
<th>CMMI® Process Area</th>
<th>PMBOK® Knowledge Area</th>
<th>INCOSE Handbook</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP - Project Planning</td>
<td>(All Areas - Planning Process Group)</td>
<td>Project Planning Process</td>
</tr>
<tr>
<td>PMC - Project Monitoring &amp; Control</td>
<td>(All Areas - Monitoring &amp; Controlling PG)</td>
<td>Project Assessment Process</td>
</tr>
<tr>
<td>SAM - Supplier Agreement Management</td>
<td>Project Procurement Management</td>
<td>Acquisition Process</td>
</tr>
<tr>
<td>IPM - Integrated Project Management &amp; IPPD</td>
<td>Project Integration Management</td>
<td>--</td>
</tr>
<tr>
<td>QPM - Quantitative Project Management</td>
<td>Project Scope Management Project Time Management Project Cost Management</td>
<td>--</td>
</tr>
</tbody>
</table>
Project Planning Processes

- PMBOK®: “The project management plan (is) the primary source of information for how the project will be planned, executed, monitored and controlled, and closed.”
- INCOSE Handbook: “The Systems Engineering Plan (SEP)...defines how the project will be organized, structured, and conducted and how the total engineering process will be controlled to provide a product that satisfies customer requirements.”
CMMI® Project Management Processes

• **PMBOK®**
  - Emphasizes planning across the project and across all knowledge areas through the Planning Process Group rather than confining planning to a discrete process step at the beginning of the project.
  - Similarly, most Knowledge Areas include processes to monitor and control the activities through the Monitoring and Controlling Process Group.
  - Quantitative techniques are included within Project Cost, Time and Scope Management Knowledge areas, although not discussed to the level of detail in the CMMI Guide.

• **INCOSE Handbook**
  - Most CMMI Project Management Process areas have a parallel within the INCOSE Handbook, except for Integrated Project Management.
  - TPMs are mentioned as a partner to cost and schedule status, but Quantitative Management is not otherwise discussed in detail.
### CMMI® Engineering Processes

<table>
<thead>
<tr>
<th>CMMI® Process Area</th>
<th>PMBOK® Knowledge Area</th>
<th>INCOSE Handbook</th>
</tr>
</thead>
<tbody>
<tr>
<td>REQM - Requirements Management</td>
<td>5. Project Scope Management</td>
<td>Requirements Management: Enabling Process Activity</td>
</tr>
<tr>
<td>RD - Requirements Development</td>
<td>5.1 Collect (Product) Requirements</td>
<td>Stakeholder Requirements Definition</td>
</tr>
<tr>
<td>TS - Technical Solution</td>
<td>5.2 Define (Product) Scope</td>
<td>Requirements Analysis</td>
</tr>
<tr>
<td>PI - Product Integration</td>
<td>--</td>
<td>Architectural Design Process</td>
</tr>
<tr>
<td>VER - Verification</td>
<td>5.4 Verify (Product) Scope</td>
<td>Verification Process</td>
</tr>
<tr>
<td>VAL - Validation</td>
<td>--</td>
<td>Validation Process</td>
</tr>
</tbody>
</table>
CMMI® Engineering Processes

- **PMBOK®**
  - The PMBoK treats Requirements Development and Requirements Management activities largely as management of the scope of the project.
  - Similarly, Verification is focused on the customer’s formal acceptance of the project deliverables. Requirements conformance is considered to be within Quality Control.
  - Validation is treated as a stakeholder management topic.

- **INCOSE Handbook**
  - Largely parallel with the scope of the CMMI Guide.
  - Requirements Management is an “Enabling SE Process Activity”
    - Supports Requirements Analysis Process
    - Managed throughout system life cycle
# CMMI® Support Processes

<table>
<thead>
<tr>
<th>CMMI® Process Area</th>
<th>PMBOK® Knowledge Area</th>
<th>INCOSE Handbook</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CM</strong> - Configuration Management</td>
<td>4.5 Integrated Change Control</td>
<td>Configuration Management Process</td>
</tr>
<tr>
<td><strong>MA</strong> - Measurement &amp; Analysis</td>
<td>5. Project Scope Management</td>
<td>Project Assessment Process</td>
</tr>
<tr>
<td></td>
<td>6. Project Time Management</td>
<td>Project Control Process</td>
</tr>
<tr>
<td></td>
<td>7. Project Cost Management</td>
<td></td>
</tr>
<tr>
<td><strong>DAR</strong> - Decision Analysis &amp; Resolution</td>
<td>--</td>
<td>Decision-Making Process</td>
</tr>
<tr>
<td><strong>CAR</strong> - Causal Analysis &amp; Resolution</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
CMMI® Support Processes

• PMBOK®
  • Lacks a strong discussion of decision making techniques and processes
    • Quantitative Analysis is discussed in the context of risk analysis
  • Causal Analysis techniques are presented within the Quality Control process
    • Fishbone Diagrams, Control Charts, etc.
  • Less emphasis on product configuration management; CM processes are discussed within the context of scope management and integrated change control

• INCOSE Handbook
  • Largely parallels CMMI processes
  • CMMI Measurement & Analysis is addressed via Project Assessment and Project Control processes
  • No treatment of Root Cause or Causal Analysis techniques
### Other Processes

<table>
<thead>
<tr>
<th>CMMI® Process Area</th>
<th>PMBOK® Knowledge Area</th>
<th>INCOSE Handbook</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10. Project Communications Management</td>
<td>Information Management Process</td>
</tr>
<tr>
<td></td>
<td>4.6 Close Project</td>
<td>Transition Process</td>
</tr>
<tr>
<td></td>
<td>4. Project Integration Management</td>
<td>Supply Process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Investment Management Process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operation Process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disposal Process</td>
</tr>
</tbody>
</table>
Other Processes, not explicitly covered in CMMI®

• Communications/Information Management
  • Storage, maintenance, security and accessibility of project-related data
  • Defined within Information Management Process in INCOSE Handbook
  • Implied within Project Communications Management Knowledge Area within PMBOK®
  • CMMI® - SP1.4 Monitor Data Management
    • Measurement and Analysis
    • Project Monitoring and Control
    • Requirements Management

• Transition
  • Transfer of custody from one organizational entity to another
  • Transition Process within INCOSE Handbook
  • Scope Verification and Project Closeout within the PMBOK®
  • CMMI® - SP2.5 Transition Products
    • Supplier Agreement Management

• Supply
  • The larger context in which the other processes are applied in a contract, in response to a request from an acquirer
    • CMMI® has acquisition perspective with supplier agreements
Processes Presented only in the INCOSE Handbook

• Investment Management Process
  • Initiation and sustainment of investment in projects meeting the objectives of the organization

• Operation Process
  • Use of the system to deliver its services
    • Training, tracking/managing system performance and malfunctions

• Maintenance Process
  • Sustainment of the system through its useful life
    • Provide operations support, logistics, material management

• Disposal Process
  • Permanent removal of a system element from its operational environment
  • Disposal of any hazardous or toxic materials in accordance with guidance, policy regulations and statutes
### Summary

<table>
<thead>
<tr>
<th>CMMI® Process Area</th>
<th>PMBoK Knowledge Area</th>
<th>INCOSE Handbook</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPF - Organizational Process Focus</td>
<td>--</td>
<td>Enterprise Environment Management Process</td>
</tr>
<tr>
<td>OPD - Organizational Process Definition</td>
<td>--</td>
<td>System Life Cycle Processes Management Process</td>
</tr>
<tr>
<td>OPP - Organizational Process Performance</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>OID - Organizational Innovation &amp; Deployment</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>PP - Project Planning</td>
<td>(All Areas - Planning Process Group)</td>
<td>Project Planning Process</td>
</tr>
<tr>
<td>PMC - Project Monitoring &amp; Control</td>
<td>(All Areas - Monitoring &amp; Controlling PG)</td>
<td>Project Assessment Process</td>
</tr>
<tr>
<td>SAM - Supplier Agreement Management</td>
<td>12. Project Procurement Management</td>
<td>Acquisition Process</td>
</tr>
<tr>
<td>IPM - Integrated Project Management &amp; IPPD</td>
<td>4. Project Integration Management</td>
<td>--</td>
</tr>
<tr>
<td>QPM - Quantitative Project Management</td>
<td>5. Project Scope Management</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>6. Project Time Management</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>7. Project Cost Management</td>
<td>--</td>
</tr>
<tr>
<td>QRM - Requirements Management</td>
<td>5. Project Scope Management</td>
<td>Configuration Management Process</td>
</tr>
<tr>
<td>RD - Requirements Development</td>
<td>5.1 Collect (Product) Requirements</td>
<td>Stakeholder Requirements Definition</td>
</tr>
<tr>
<td></td>
<td>5.2 Define (Product) Scope</td>
<td>Requirements Analysis</td>
</tr>
<tr>
<td>TS - Technical Solution</td>
<td>--</td>
<td>Architectural Design Process</td>
</tr>
<tr>
<td>PI - Product Integration</td>
<td>--</td>
<td>Implementation Process</td>
</tr>
<tr>
<td>VER - Verification</td>
<td>5.4 Verify (Product) Scope</td>
<td>Integration Process</td>
</tr>
<tr>
<td>VAL - Validation</td>
<td>Part of 10.4 - Manage Stakeholder Expectations</td>
<td>Verification Process</td>
</tr>
<tr>
<td>CM - Configuration Management</td>
<td>4.5 Integrated Change Control</td>
<td>Validation Process</td>
</tr>
<tr>
<td></td>
<td>6. Project Time Management</td>
<td>Project Assessment Process</td>
</tr>
<tr>
<td></td>
<td>7. Project Cost Management</td>
<td>Project Control Process</td>
</tr>
<tr>
<td>DAR - Decision Analysis &amp; Resolution</td>
<td>--</td>
<td>Decision-Making Process</td>
</tr>
<tr>
<td>CAR - Causal Analysis &amp; Resolution</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>--</td>
<td>10. Project Communications Management</td>
<td>Information Management Process</td>
</tr>
<tr>
<td>--</td>
<td>4.6 Close Project</td>
<td>Transition Process</td>
</tr>
<tr>
<td>--</td>
<td>4. Project Integration Management</td>
<td>Supply Process</td>
</tr>
<tr>
<td>--</td>
<td>--</td>
<td>Investment Management Process</td>
</tr>
<tr>
<td>--</td>
<td>--</td>
<td>Operation Process</td>
</tr>
<tr>
<td>--</td>
<td>--</td>
<td>Maintenance Process</td>
</tr>
<tr>
<td>--</td>
<td>--</td>
<td>Disposal Process</td>
</tr>
</tbody>
</table>
Conclusion

• PMBOK® has little emphasis on Organizational functions
  • Process development and deployment
  • Organizational training
• PMBOK® has little or no emphasis on Engineering processes
  • Technical Solution
  • Product Integration
  • Requirements Development and Management are considered synonymous with project scope control
• INCOSE Handbook has less emphasis on Project Management
  • Earned Value Techniques
  • Causal/Root Cause Analysis
Recommendations

• The PMBOK® and the INCOSE Handbook can be used as primary training and certification references for Project Managers and Systems Engineers, respectively
• Organizational process definition and training is required to tie the standards together into a cohesive process for the enterprise
• The organizational process framework should show
  • The relationship between Project Management and Systems Engineering
  • The work products of each part of the organization
• Necessary topics not fully covered in the Guides should be addressed through additional training topics:
  • Project Managers
    • Quantitative decision techniques
    • Decision documentation
    • Organizational process development and deployment
  • Systems Engineers
    • Project Time and Cost Management (including earned value)
    • Root cause analysis techniques