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

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Agenda

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

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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

- *A Guide to the Project Management Body of Knowledge (PMBOK® Guide),* Fourth Edition, 2008
- ANSI/PMI 99-001-2008
- ISBN: 978-1-933890-51-7

- 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

INCOSE

SYSTEMS ENGINEERING HANDBOOK

A GUIDE FOR SYSTEM LIFE CYCLE PROCESSES AND ACTIVITIES
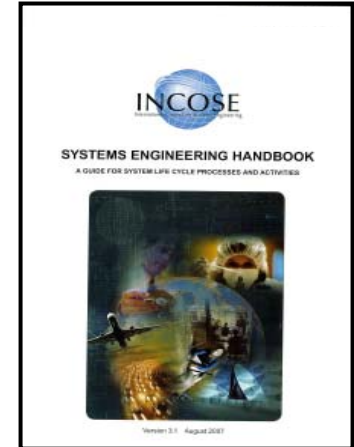
INCOSE Handbook

- 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

	CMMI® Process Area	PMBOK® Knowledge Area	INCOSE Handbook
Process Management	**OPF** - Organizational Process Focus	--	Enterprise Environment Management Process
	OPD - Organizational Process Definition	--	System Life Cycle Processes Management Process
	OPP - Organizational Process Performance	--	
	OID - Organizational Innovation & Deployment	--	--
	OT - Organizational Training	Human Resources Management	Resource Management Process

- 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

	CMMI® Process Area	PMBOK® Knowledge Area	INCOSE Handbook
Project Management	**PP** - Project Planning	(All Areas - Planning Process Group)	Project Planning Process
	PMC - Project Monitoring & Control	(All Areas - Monitoring & Controlling PG)	Project Assessment Process
			Project Control Process
	SAM - Supplier Agreement Management	Project Procurement Management	Acquisition Process
	IPM - Integrated Project Management & IPPD	Project Integration Management	--
	RSKM - Risk Management	Project Risk Management	Risk & Opportunity Management Process
	QPM - Quantitative Project Management	Project Scope Management	--
		Project Time Management	
		Project Cost Management	

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

CMMI® Process Area		PMBOK® Knowledge Area	INCOSE Handbook
Engineering	**REQM** - Requirements Management	5. Project Scope Management	Requirements Management: Enabling Process Activity
	RD - Requirements Development	5.1 Collect (Product) Requirements	Stakeholder Requirements Definition
		5.2 Define (Product) Scope	Requirements Analysis
			Architectural Design Process
	TS - Technical Solution	--	Implementation Process
	PI - Product Integration	--	Integration Process
	VER - Verification	5.4 Verify (Product) Scope	Verification Process
	VAL - Validation	--	Validation Process

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

	CMMI® Process Area	PMBOK® Knowledge Area	INCOSE Handbook
Support	**CM** - Configuration Management	4.5 Integrated Change Control	Configuration Management Process
	PPQA - Process & Product Quality Assurance	8. Project Quality Management	Quality Management Process
	MA - Measurement & Analysis	5. Project Scope Management	Project Assessment Process
		6. Project Time Management	Project Control Process
		7. Project Cost Management	
	DAR - Decision Analysis & Resolution	--	Decision-Making Process
	CAR - Causal Analysis & Resolution	--	--

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

CMMI® Process Area	PMBOK® Knowledge Area	INCOSE Handbook
--	10. Project Communications Management	Information Management Process
--	4.6 Close Project	Transition Process
--	4. Project Integration Management	Supply Process
	--	Investment Management Process
--	--	Operation Process
--	--	Maintenance Process
--	--	Disposal Process

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

	CMMI® Process Area	PMBoK Knowledge Area	INCOSE Handbook
Process Management	OPF - Organizational Process Focus	--	Enterprise Environment Management Process
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Process Management	OPP - Organizational Process Performance	--	System Life Cycle Processes Management Process
Process Management	OID - Organizational Innovation & Deployment	--	--
Process Management	OT - Organizational Training	9. Human Resources Management	Resource Management Process
Project Management	PP - Project Planning	(All Areas - Planning Process Group)	Project Planning Process
Project Management	PMC - Project Monitoring & Control	(All Areas - Monitoring & Controlling PG)	Project Assessment Process / Project Control Process
Project Management	SAM - Supplier Agreement Management	12. Project Procurement Management	Acquisition Process
Project Management	IPM - Integrated Project Management & IPPD	4. Project Integration Management	--
Project Management	RSKM - Risk Management	11. Project Risk Management	Risk & Opportunity Management Process
Project Management	QPM - Quantitative Project Management	5. Project Scope Management / 6. Project Time Management / 7. Project Cost Management	--
Engineering	REQM - Requirements Management	5. Project Scope Management	Configuration Management Process
Engineering	RD - Requirements Development	5.1 Collect (Product) Requirements	Stakeholder Requirements Definition / Requirements Analysis
Engineering	RD - Requirements Development	5.2 Define (Product) Scope	Architectural Design Process
Engineering	TS - Technical Solution	--	Implementation Process
Engineering	PI - Product Integration	--	Integration Process
Engineering	VER - Verification	5.4 Verify (Product) Scope	Verification Process
Engineering	VAL - Validation	Part of 10.4 - Manage Stakeholder Expectations	Validation Process
Support	CM - Configuration Management	4.5 Integrated Change Control	Configuration Management Process
Support	PPQA - Process & Product Quality Assurance	8. Project Quality Management	Quality Management Process
Support	MA - Measurement & Analysis	5. Project Scope Management / 6. Project Time Management	Project Assessment Process
Support	MA - Measurement & Analysis	7. Project Cost Management	Project Control Process
Support	DAR - Decision Analysis & Resolution	--	Decision-Making Process
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	--	10. Project Communications Management	Information Management Process
	--	4.6 Close Project	Transition Process
	--	4. Project Integration Management	Supply Process
		--	Investment Management Process
	--	--	Operation Process
	--	--	Maintenance Process
	--	--	Disposal Process

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