INCOSE Los Angeles

Tensions and Opportunities: Program Management and Systems Engineering

Dr. Tina P. Srivastava (MIT) | Mark S. Kaufman (MITRE) | August, 2024

LEARNING OBJECTIVES

At the conclusion of this session, participants will be able to:



1. Identify opportunities to achieve improved program outcomes and reduced overruns in complex environments.

2. Critically evaluate and, when necessary, credibly challenge management on potentially unrealistic expectations related to project cost, schedule, scope, and risk.

MARK KAUFMAN



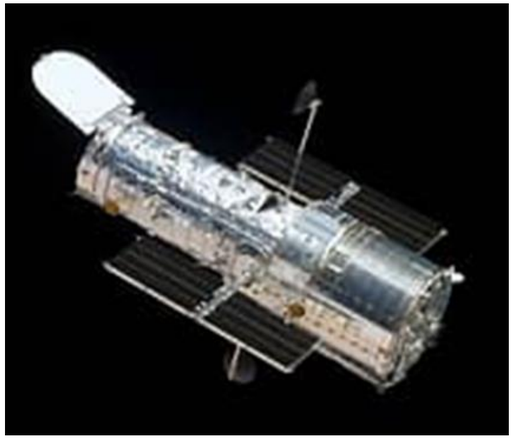
Bachelor Engineering

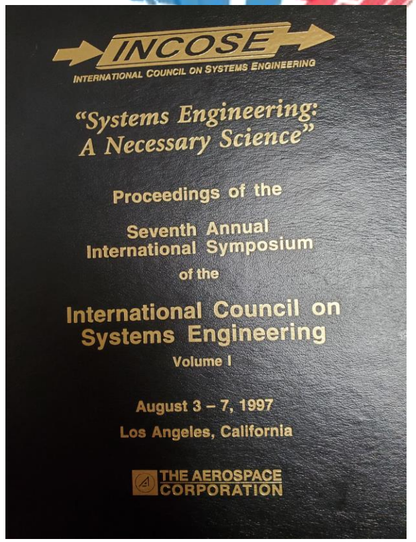
M.S. Electrical Engineering

MITRE

Department Manager
Enterprise Program and
Risk Management

EARTH OBSERVING SYSTEM







DR. TINA P. SRIVASTAVA

- S.B. Aeronautics & Astronautics, MIT
- S.M. Engineering & Management, MIT
- Ph.D. Strategy, Innovation, & Engineering, MIT



Zero-Gravity Flight Testing

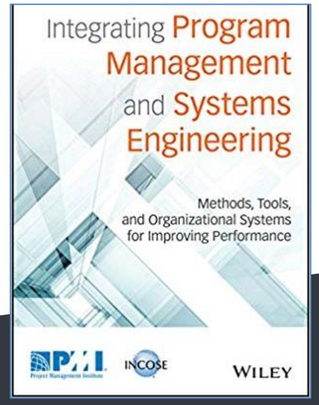


Pilot

Raytheon

- Chief Engineer, Raytheon
- $40M Radar Program
- Team of 30
- Received National Recognition for Technical Innovation

Founded security company with fellow MIT alums; exited to public company



- Board of Directors
- Co-author

INCOSE

Co-Founder Badge Inc.

badge



Author



Source: Minerva Studio

Source: Zurijeta

EXERCISE:

"Who Has the Responsibility?"

EXERCISE:

"Who Has the Responsibility?"

Technical Requirements?



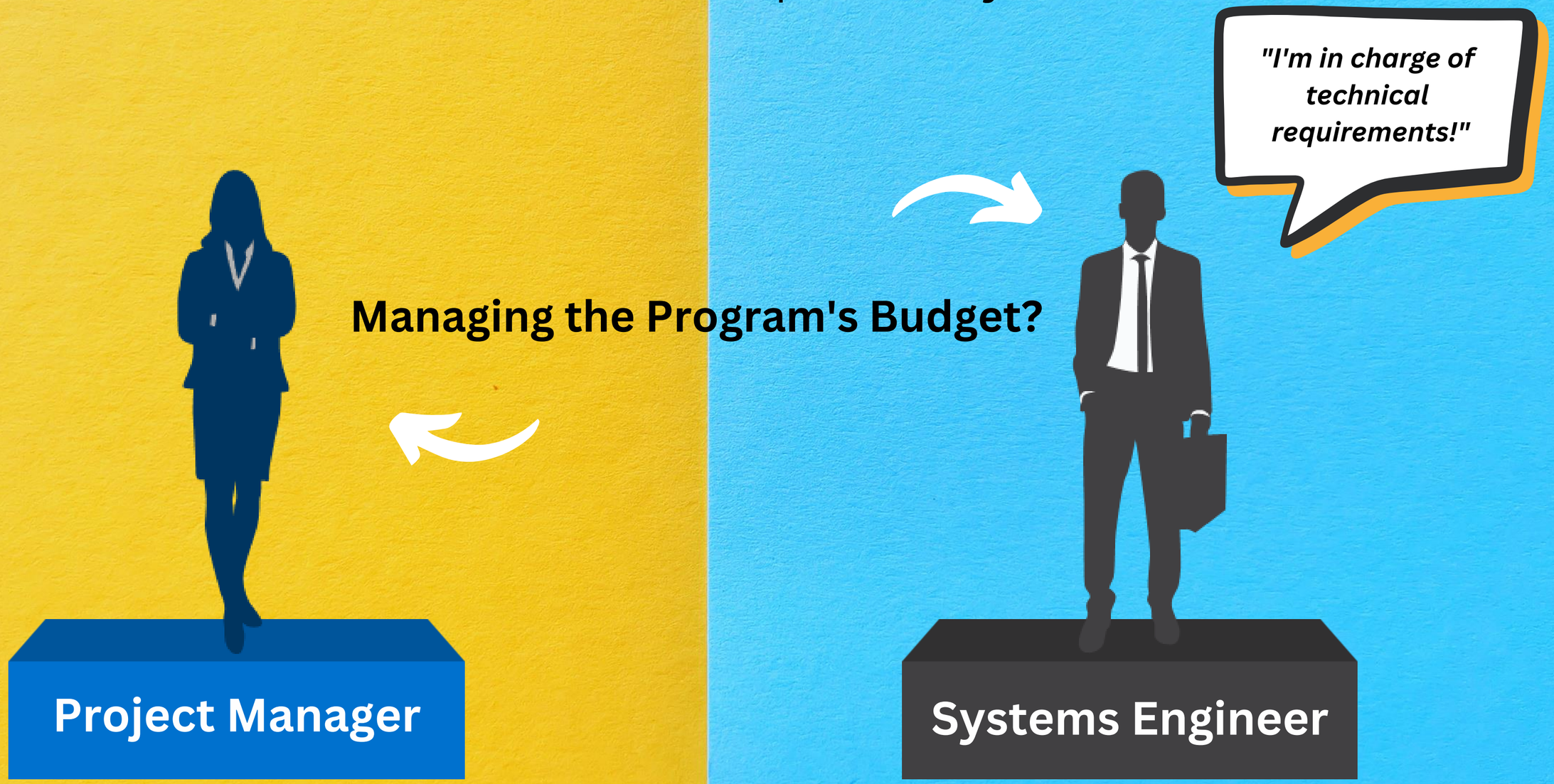
Project Manager



Systems Engineer

EXERCISE:

"Who Has the Responsibility?"



EXERCISE:

"Who Has the Responsibility?"

"I manage the project's budget!"



Project Manager



Responsibilities:

- Technical Requirements

Systems Engineer

EXERCISE:

"Who Has the Responsibility?"

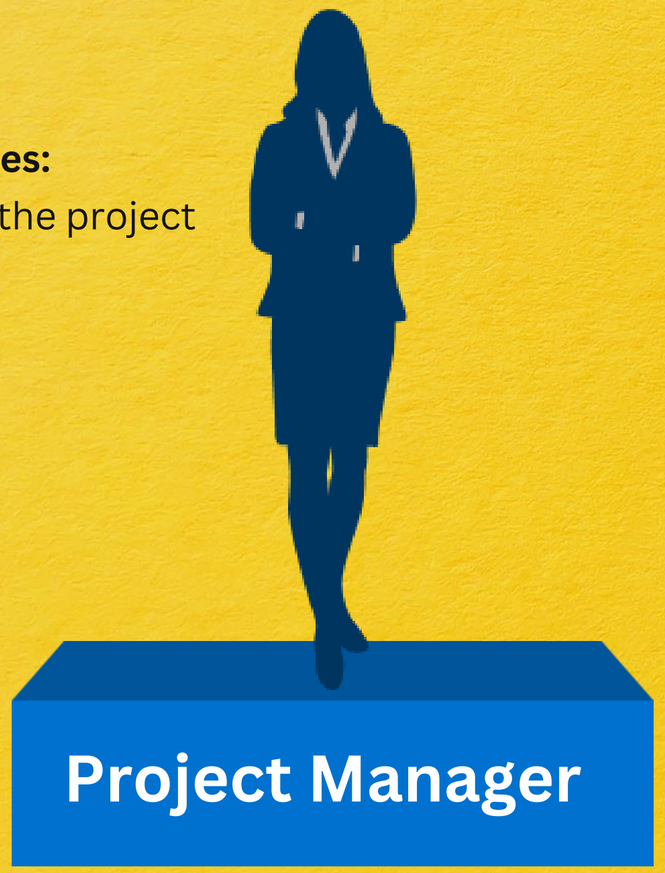
Life Cycle Planning?

External Supplier Relations?

Program/Project Risk?

Responsibilities:

- Managing the project budget



Project Manager



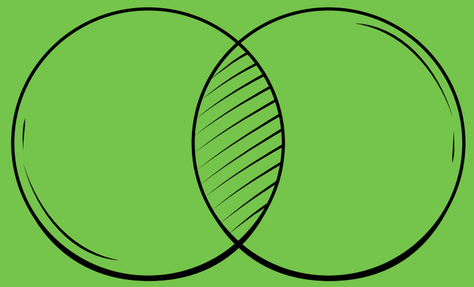
Systems Engineer

Responsibilities:

- Technical Requirements

EXERCISE:

"Who Has the Responsibility?"



Life Cycle Planning

External Supplier Relations

Program/Project Risk

Responsibilities:

- Managing the project budget



Project Manager



Responsibilities:

- Technical Requirements

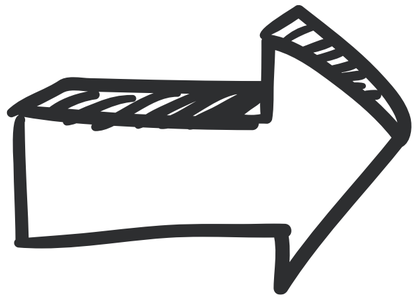
Systems Engineer

IRON TRIANGLE



HOW DO WE ACHIEVE A VISION OF INTEGRATED PROJECT MANAGEMENT AND SYSTEMS ENGINEERING?

- Who controls scope?
- How do we meet budget?
- Who is responsible for delays?



Successful delivery of stakeholder value requires contribution, collaboration, and cooperation across disciplines.



Source: Comstock Images



OVERLAPPING RESPONSIBILITIES:

THE SYSTEMS ENGINEER VIEW

SOMETIMES:

- THE PROJECT MANAGER IS THE TECHNICAL LEADER
- THE SYSTEMS ENGINEER IS THE PROJECT MANAGER

SYSTEMS ENGINEERING VIEW:

- Systems engineering **integrates all disciplines and specialty groups into a team effort** forming a structured development process that proceeds from concept to production to operation.
- Systems Engineering considers both the business and technical needs of all customers with the goal of providing a quality product that meets the user needs. [1]

[1] Source: INCOSE Web Site

74images



OVERLAPPING RESPONSIBILITIES:

THE PROJECT MANAGER VIEW

Source: Pexels

PROJECT MANAGEMENT VIEW:

- Project managers play the lead role in **planning, executing, monitoring, controlling, and closing out projects.**

- They are accountable for the entire project scope, the project team and resources, the project budget, and the success or failure of the project. [2]

[2] Source: cio.com

WHAT CAUSES THE TENSION?

- Conflicting practices between the two roles
  - + Focus on achieving objectives defined by discipline
- Not valuing the other role
- Lack of planning for the integration of roles
- Roles and responsibilities not clear or respected
- Who works for who?
- Not having clearly defined authority
- Failing to communicate a common set of objectives and vision
- Unclear communication



How Do We Manage Unproductive Tension?

Source: FatCamera/Getty Images Signature

TANGIBLE EFFECTS OF UNPRODUCTIVE TENSION



Source:https://project-management.com/how-to-avoid-project-failure-effective-scheduling



Source: LawrenceSawyer/Getty Images Signature



Source: gregory_lee/Getty Images Pro

INTEGRATING THE ROLES

The Team Recognizes their Shared Objectives

The Team Understands the Objectives and How Each Contributes to Them

The Team Understands Each Other's Role

The Team Respects All the Roles and Their Associated Contributions

The Team Values "Collaboration" over "Competition"

PROJECT MANAGER AND SYSTEMS ENGINEER ARE DISTINCT ROLES – WITH SOME IMPORTANT OVERLAP

Project Managers (PM) view their responsibilities as:

- Overall Results
- Goals & Objectives
- Program & Project Risk
- External Supplier Relations
- Lifecycle Planning

Systems Engineers view their responsibilities as:

- Technical Requirements
- Systems Definition
- Systems Requirements
- Configuration Management

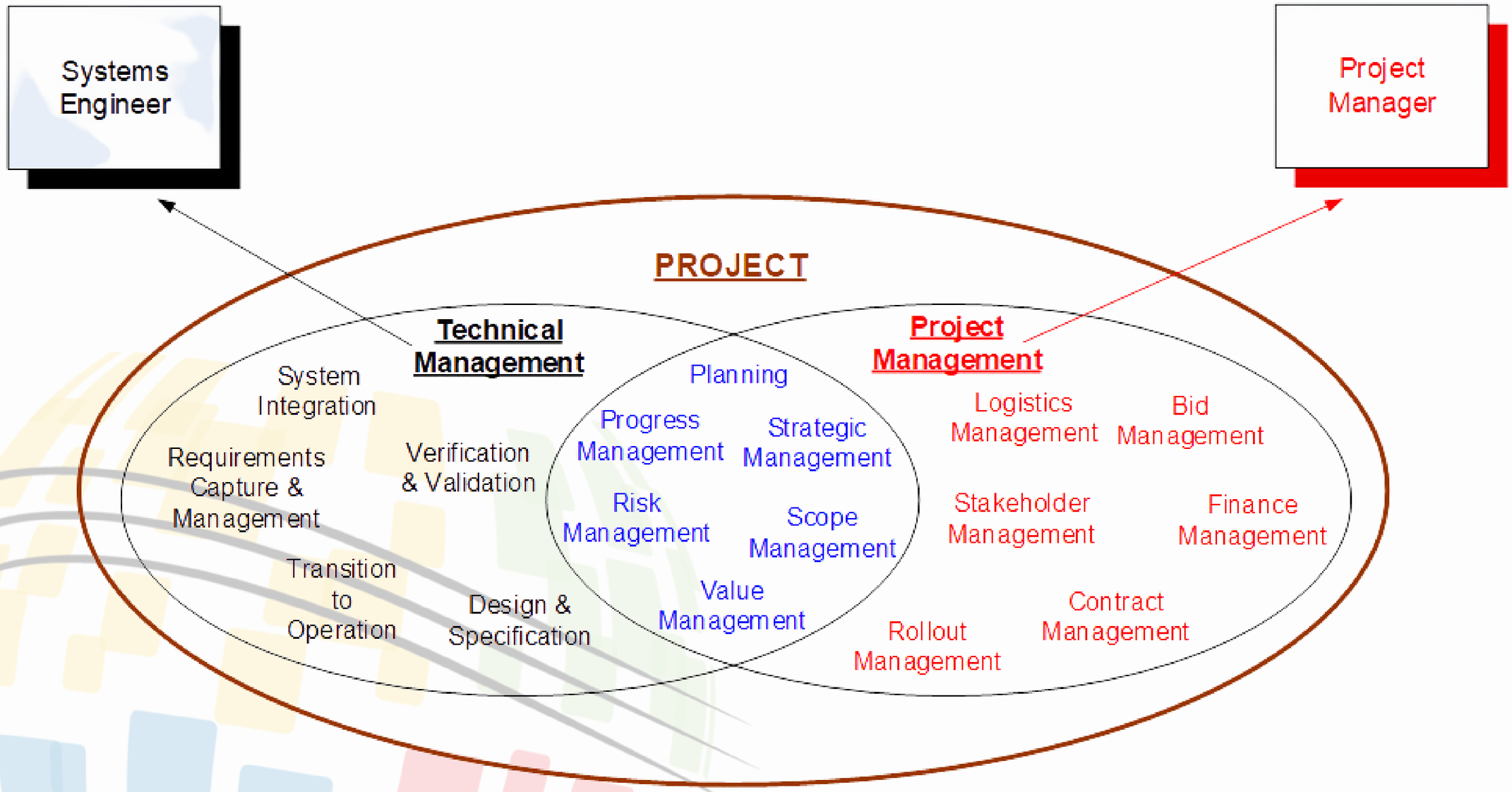
Both roles are responsible for:

- Program/Project Risk
- External Supplier Relations
- Quality Management
- Lifecycle Planning

The integration must clarify how

- **Responsibility can be effectively shared** for risk management, external suppliers, quality management and lifecycle planning; and
- **Communication optimized** for the other domains of responsibility.

WHAT ARE THE PM AND SE INTERSECTIONS?



VIEW OF PM/SE INTEGRATION

Processes, Practices and Tools
- Use of combined standards
- Clear roles and responsibilities
- Use of leading practices
- Boundary spanning systems

Organizational Environment
- Promote the right culture
- Value knowledge sharing
- Reward and recognition
- Strong executive support

People Competencies
- Experience in different roles
- Education and certifications
- Leadership/comm. Skills
- Fast learning attitude

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- Education and certifications
- Leadership/comm. Skills
- Fast learning attitude

Effective Integration

Rapid and effective decision making

Effective collaborative work

Effective information sharing

Program Performance

Program schedule

Project budget

Client satisfaction

Client requirements

Source: Rebentisch et al (2017)

PUTTING THIS INTO PRACTICE



Processes, Practices, and Tools

- Enable communication and common understanding
- Define specific work activities
- Establish expectations for each person
- Coordinate and tack work efforts
- ID critical points where work efforts come together
- Facilitate problem identification and resolution
- Best practices



Organizational Environment

- Establish positive culture
- Grace and respect
- Narrow the cultural divide between PM and SE
- Team building
- Develop respect for views and opinions across disciplines
- Establish working relationship between PM and SE management
- Build trust between executives and project team



Integration Competencies in Staff Members

- Develop standard role definitions and communicate
- Develop integration competencies and teaming behaviors on project staff
- Manage integration competencies in the workforce at individual and organizational level

PUTTING THIS INTO PRACTICE



Contextual Factors

- Tailor management approach to project realities
- Develop and own project culture to influence behavior throughout the project life cycle
- Stakeholder and team alignment
- One view of the project
- Transparency
- Engagement - Community



Integration as Organization Characteristic

- Combine PM and SE practices, tools and techniques
- Establish culture to meet common objectives

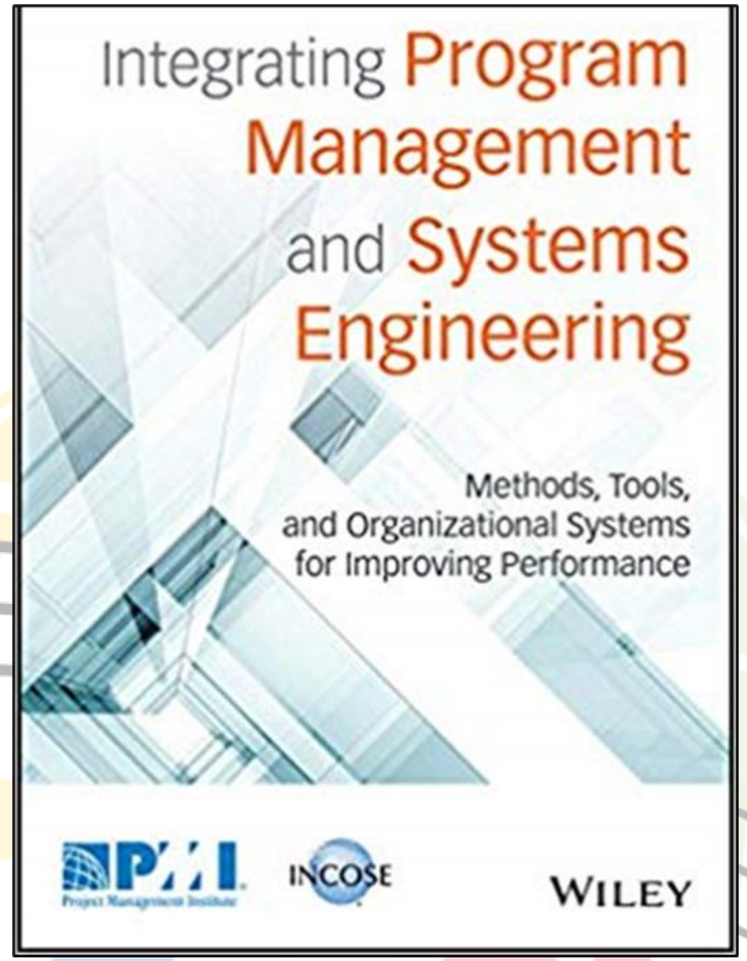


Program Performance

- Higher integration yields better cost and schedule metrics
- More predictable outcomes
- More resilience to schedule pressures

PMI AND INCOSE RECOGNIZE THE ISSUE

PM-SE Integration WG *Purpose*



- PMI and INCOSE have been working together for over 10 years, and have identified specific value for integration between PM and SE.
- 2011 Reference: Toward a New Mindset - https://www.pmi.org/learning/library/bridging-gap-program-management-systems-engineering-6213
- PMI and INCOSE recently co-authored a book: https://www.amazon.com/Integrating-Program-Management-Systems-Engineering/dp/1119258928

RECOGNITION

“On behalf of PMI, I congratulate the MIT-PMI-INCOSE team on their receipt of the Shingo Research and Professional Publication Award for their work on ‘The Guide to Lean Enablers for Managing Engineering Programs,’” said Mark A. Langley, president and CEO of Project Management Institute (PMI). “This team clearly demonstrated the added value that can be delivered through integrated program management and systems engineering.”

https://www.incose.org/events-and-news/incose-and-se-news/2013/06/20/mit-pmi-incose-team-receives-the-shingo-prize-for-the-guide-to-lean-enablers-for-managing-engineering-programs-

PM-SE Integration WG

IS2024










Source: Geber86/Getty Images Signature

SUMMARY



- A complex relationship exists between project managers and systems engineers
- Each discipline needs to understand their role and work together to establish boundaries
- Cooperation and collaboration lead to project success

REFERENCES

- J.W. Boswell, F.T. Anbara, and J.W. Via, “Systems Engineering and Project Management: Points of Intersection, Overlaps, and Tensions”, 2017 Portland International Conference on Management of Engineering and Technology (PICMET)

- Nelson, Marvin, “Integrating Program Management and Systems Engineering”, MIT Consortium for Engineering Program Excellence

- Rebentisch Eric (Editor) – Integrating Program Management and Systems Engineering Methods, Tools and Organizational Systems for Improving Performance

- Van Gemert, Dennis, “Systems Engineering the Project” PMI Global Congress, 2013

- INCOSE Webinar Series, “What PMI and INCOSE are doing to advance the Future of PM-SE Integration”, April 2021



QUESTIONS?

Source: 9dreamstudio/Getty Images

THANK YOU!

Let's continue the conversation.

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badge

Identity without secrets™

Tina Srivastava, PhD

Innovator, Entrepreneur, Author, and Technologist

United States · Contact info

1,694 followers · 500+ connections

Badge Inc.

Massachusetts Institute Technology



Mark Kaufman · 2nd

Department Head at MITRE

Columbia, Maryland, United States · Contact info

491 connections

MITRE

University of Maryland

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10-11 October 2019
Utrecht, The Netherland

PM-SE Integration Session

Jean-Claude Roussel (Co-chair of INCOSE PM-SE WG)
John Lomax (Co-chair of INCOSE PM-SE WG)

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10-11 October 2019
Utrecht, The Netherland

Workshop Agenda

10:00	**Welcome / Introduction**	**(JC/John/Michiel)**
10:15	PM-SE Integration WG Overview	(JC)
10:30	PM-SE Integration WG Initiatives	
	- Project Breakdown Structures	(JC)
	- Strategic Technical Planning	(John)
	- Needs for new initiatives	(All)
11:00	Break-out sessions	(All)
12:15	Conclusion	(JC/John/Michiel)
12:30	End of the session	

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Introduction: Jean-Claude Roussel

- Co-Chair of PM-SE Integration Working Group
- Served on the Board of Directors of INCOSE (Technical Director and EMEA Sector Director)
- Systems Engineering Senior Expert with 37 years of experience in different Aeronautic and Space Programs within Airbus
- Location: France
- Email address: jc.roussel6231@gmail.com
- INCOSE ESEP

Introduction: John Lomax

- Co-Chair of PM-SE Integration Working Group
- Systems Engineer with over 30 years of experience at Airbus, BAE Systems
- Location: U.K.
- Email address: john.lomax@airbus.com
- INCOSE CSEP and INCOSE CAR

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Workshop Outcomes

Identify and encourage contributions from the EMEA Sector for the PM-SE Integration WG

New initiatives from EMEA Sector to the PM-SE Integration WG

New members from EMEA Sector to the PM-SE Integration WG

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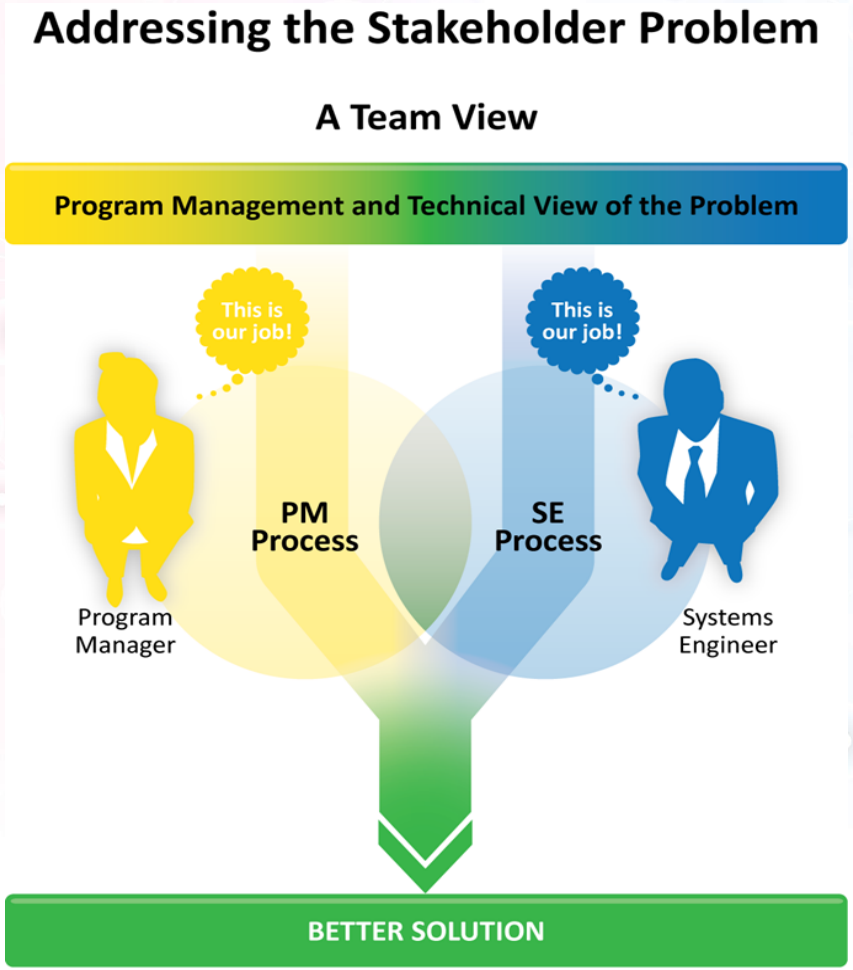
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PM-SE Integration WG
Background

INCOSE International Council on Systems Engineering

MIT Consortium for ENGINEERING PROGRAM EXCELLENCE

PMI Project Management Institute

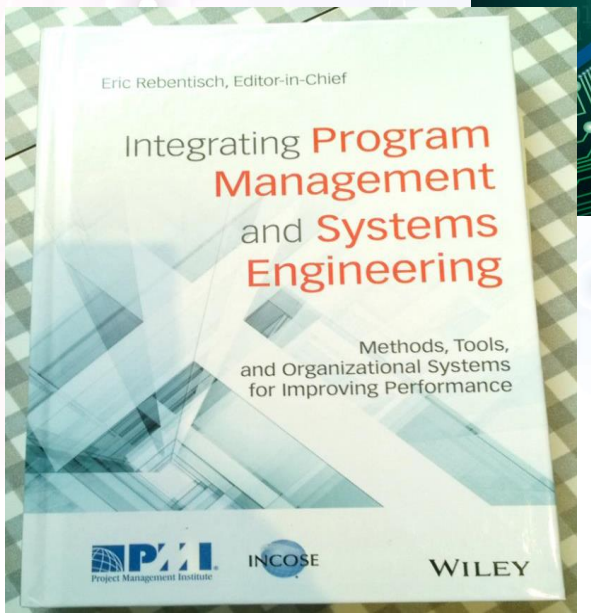


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PM-SE Integration WG
History overview

- **2011**
  - Strategic Alliance Agreement signed by INCOSE/PMI
  - Joint white paper, “Toward a New Mindset: Bridging the Gap between Program Management and Systems Engineering” published in *INSIGHT* and *PM Network*
  - MIT Lean Advancement Initiative collaboration on “lean program management” study
- **2012**
  - Formation of alliance long-term collaboration plan
  - The Guide to Lean Enablers for Managing Engineering Programs published
- **2013**
  - The Guide to Lean Enablers wins Shingo Research Prize
  - First phase of PM/SE Integration study released at INCOSE IS
- **2014**
  - Second and third phases of PM/SE Integration study complete
  - PM/SE Integration LinkedIn Community launched
- **2015**
  - PM/SE Integration book project initiated.
- **2016**
  - PM/SE Integration WG created at INCOSE IS 2016

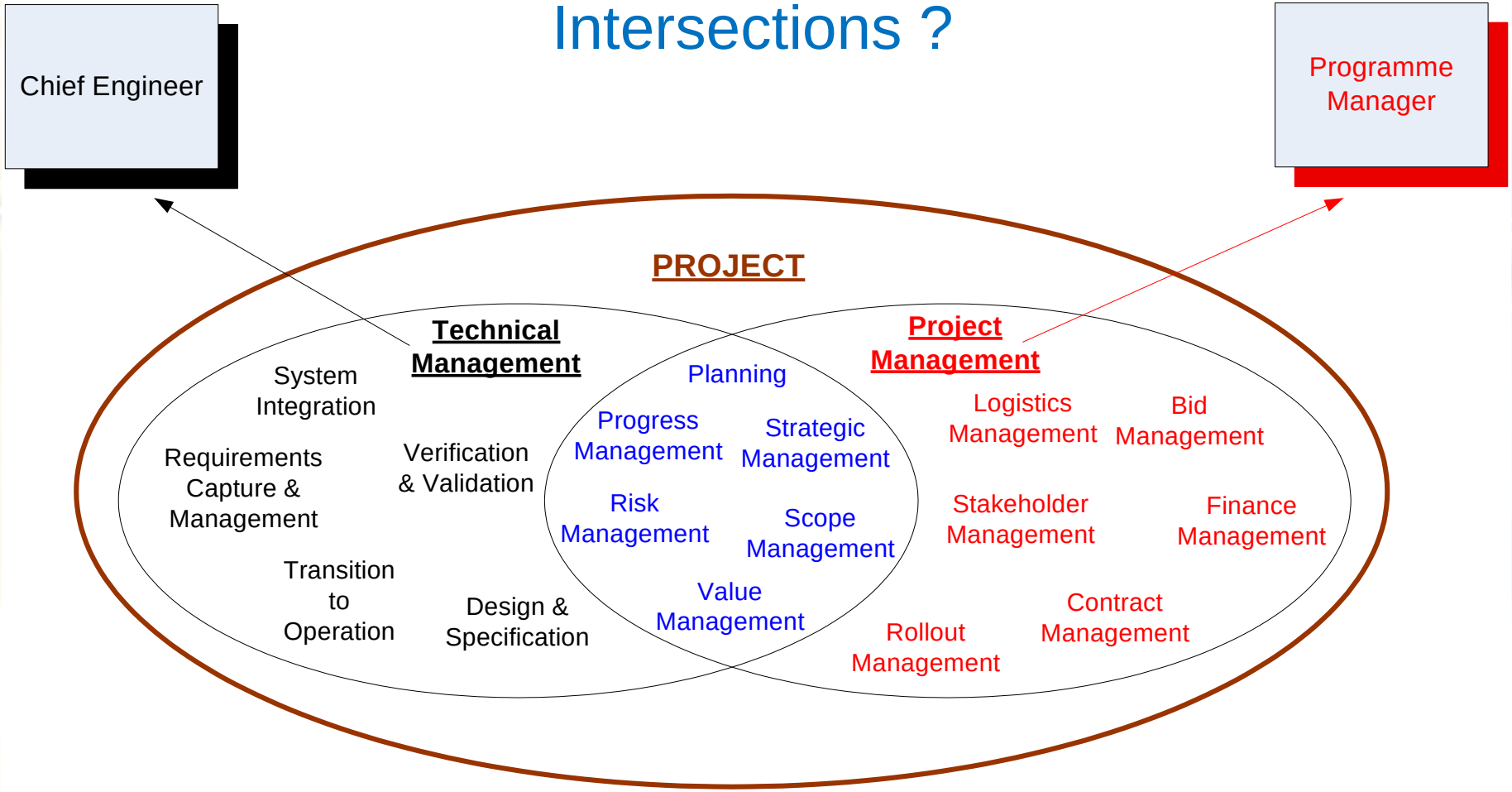




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PM-SE Integration WG *Findings*

Where are the PM and SE Intersections ?



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PM-SE Integration WG *Findings*

Program Manager and System Engineer are distinct roles – with some important overlap

Program Managers (PM) view their responsibilities as:	**Chief Systems Engineers (CSE)** view their responsibilities as:	**Both** roles are responsible for:
• Overall Results • Goals & Objectives • Program & Project Risk • External Supplier Relations • Lifecycle Planning	• Technical Requirements • Systems Definition • Systems Requirements • Configuration Management	• Program/Project Risk • External Supplier Relations • Quality Management • Lifecycle Planning

The integration must clarify how

- **Responsibility can be effectively shared** for risk management, external suppliers, quality management and lifecycle planning; and
- **Communication optimized** for the other domains of responsibility.

Joint MIT/PMI/INCOSE survey – White paper presented at the 23rd INCOSE Annual International Symposium, Philadelphia, June 2013

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PM-SE Integration WG
Purpose

Identify and promote opportunities associated with the effective integration of the Systems Engineering and Project/Program Management disciplines.

- Explore the linkages necessary to create effective integration and collaboration between systems engineers and program managers.
- Be the intersection point where systems engineers, program/project managers collaborate and integrate their efforts.

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PM-SE Integration WG
Goals

- Facilitate collaboration between systems engineering and program management communities.
- Demonstrate the value of integrating systems engineering and program management to develop better solutions that drive strategic business results and outcomes.
- Produce useful deliverables that support effective integration and practice of collaborative systems engineering and program management.
- Provide thought leadership on open integration challenges between program management and systems engineering.
- Bring external thinking into the systems engineering and program management communities to facilitate thinking outside of the box.
- Represent a think tank for free thinking and engagement around critical issues associated with program management and systems engineering.
- Draft guidelines and/or influence existing ones (e.g. PMBok, SEBoK, etc.) based on experience and exchanges on PM/SE integration and collaboration.

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PM-SE Integration WG
Scope

Our scope encompasses activities relating to defining, capturing, evolving, and communicating PM/SE integration best practices. This may include training material, guideline material, recommendations for industry best practices and standards, and shared output with industry working groups from other organizations.

Additionally, also in scope is joining efforts with other INCOSE working groups such as Requirements, Risks, Leans SE, Agile SE, etc… where appropriate, to ensure subject matter expertise is seamlessly integrated into various aspects of the systems engineering process. Exploration of common problems and/or practices also falls within scope.

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PM-SE Integration WG
Composition and Identification

- Co-Chairs : Tina Srivastava / Jean-Claude Roussel / John Lomax
- Webmaster/IT Director (email list, create our INCOSE website) : Gretchen Peacock / Rachel White

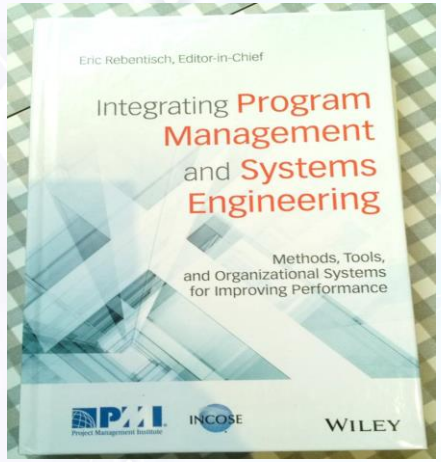
Number of Members	90
IW 2019 Participants	37

INCOSE Connect Address	https://connect.incose.org/WorkingGroups/pm-se%20integration/SitePages/Home.aspx
INCOSE Web Page	http://www.incose.org/ChaptersGroups/WorkingGroups/process/pm-se-integration

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PM-SE Integration WG *Outcomes*

- Book Published: *Integrating Program Management and Systems Engineering: Methods, Tools, and Organizational Systems for Improving Performance*
  - Collaboration of PMI/MIT/INCOSE



- Planned
  - PMBoK update
  - SEBoK update
  - SE Handbook update
  - PM/SE Integration Best Practices Guidelines
  - Recommendations for ISO Standards on PM/SE Integration

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PM-SE Integration WG
Initiatives

- MOU PMI-INCOSE update – *Tina Srivastava*
- Comparison of PM BoK and SEBoK - *TBD*
- Project Breakdown Structures – *Jean-Claude Roussel*
- Strategic Technical Planning – *John Lomax*
- Education – *Theodore J. Ferrell*

PM-SE Integration WG
MOU PMI-INCOSE Update

INCOSE

PMI
Project Management Institute

INCOSE IW 2019 Activity

- *Review proposed updates to MOU*
- *Establish plans for joint activity in 2019 / 2020*

1. Concentrate on reaching key influencers- those who can actually drive change in the way PM and SE effort is integrated within their organizations or throughout their sphere of influence.
2. Establish the means by which the two organizations will reach this intended audience, defining required actions / events / responsibilities.
3. Leverage the INCOSE PM-SE Integration Working Group to identify projects of mutual interest, identify and connect like-minded parties within the PMI community.

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PM-SE Integration WG
Compare PMBoK and SEBoK

Scope: Compare global SE bodies of knowledge (BoKs e.g. SE Hbk, SEBoK) with global BoKs - PMA PMBoK, APMA, PMA

Who is leading : TBD

Who is contributing : TBD,…

Why is it important : Aids SE and PM interaction

Key elements: Identification of Gaps and Commonalities between PM and SE

Extensions / additions opportunities based on "new ideas" from the other sources, resulting in efficient and effective collaboration environments

Timeframe: **Volunteers needed!**

Outcomes: A useful INCOSE product guidebook

Resources and References: https://connect.incose.org/WorkingGroups/pm-se%20integration/SitePages/Home.aspx

WG Involvement: Collaborate with Life Cycle Mgt WG, Competency WG eventually

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Workshop Agenda

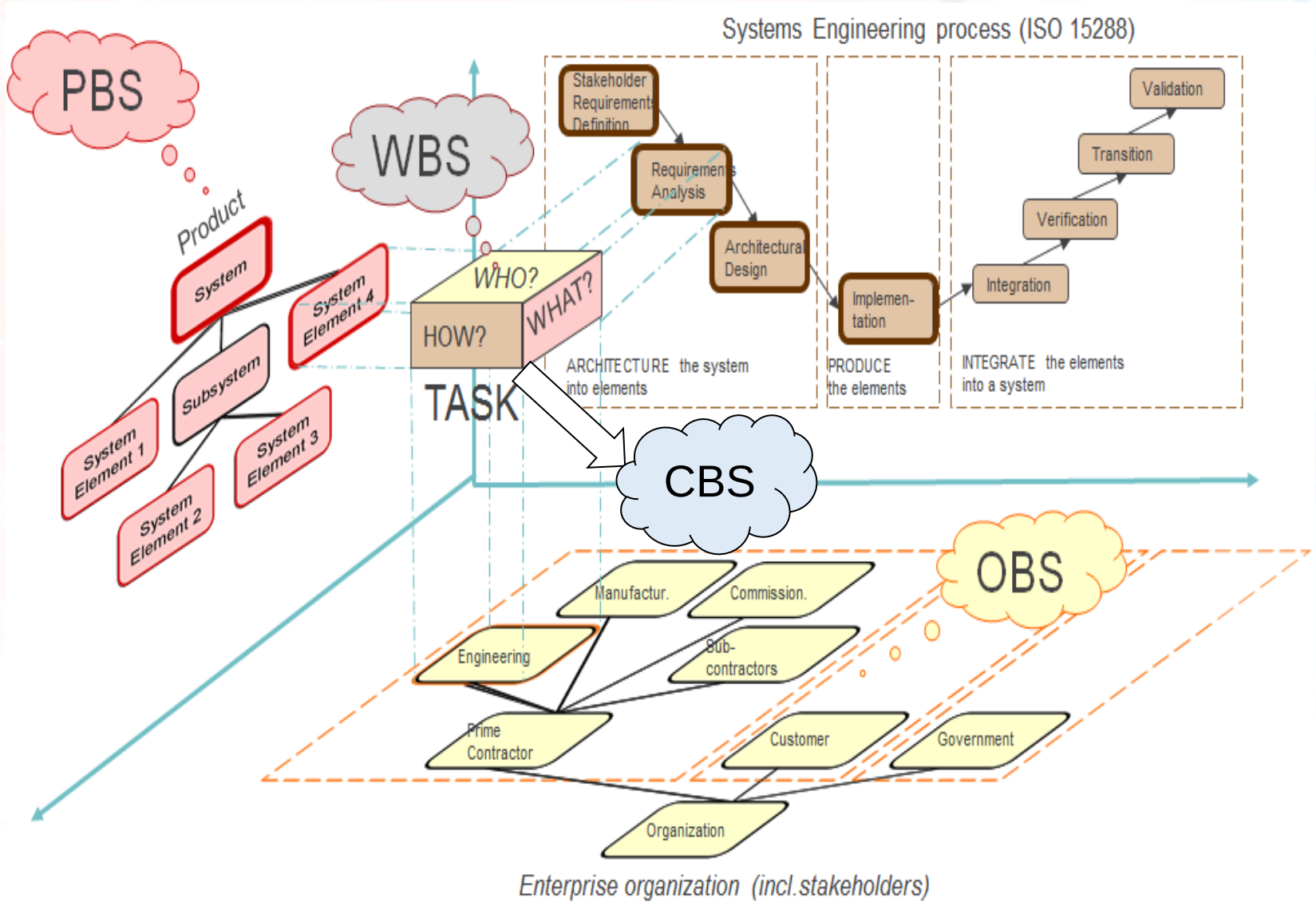
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Project Breakdown Structures

PM-SE Integration WG Initiative

Conceptually the relationship between breakdowns is like this



The PBS flows from the FBS and feeds the WBS/OBS/CB

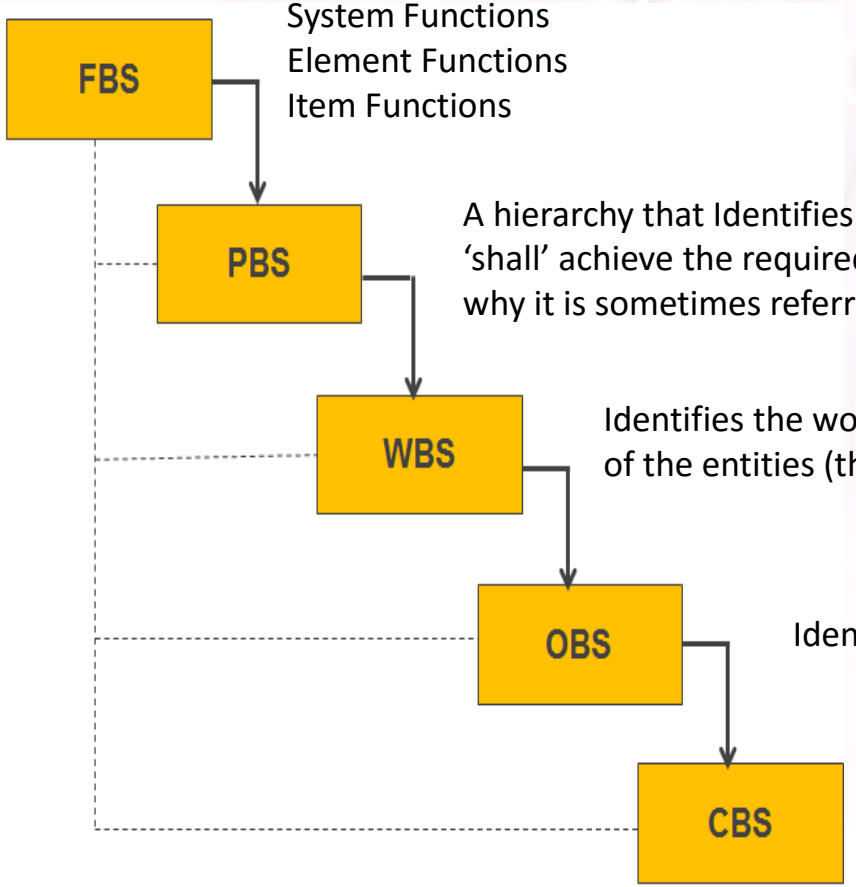
WHY : The Functions
Function Breakdown Structure

WHAT : The Product
Product Breakdown Structure

HOW : The Works
Work Breakdown Structure

WHO : The Organisation
Organisation Breakdown Structure

HOW MUCH : The Costs
Cost Breakdown Structure



The FBS is a hierarchy of
Capabilities for Mission Performance
Business Functions
Organisational/Stakeholder Functions
System Functions
Element Functions
Item Functions

These all have to be attributed to the corresponding level in the PBS

A hierarchy that Identifies the entities and their decomposition that 'shall' achieve the required functions in the hierarchy of the FBS. (This is why it is sometimes referred to as the requirements hierarchy)

Identifies the work to be performed in the development of the entities (this would map to the Develop processes)

Identifies who will be doing work

Structures the development work packages

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Project Breakdown Structures

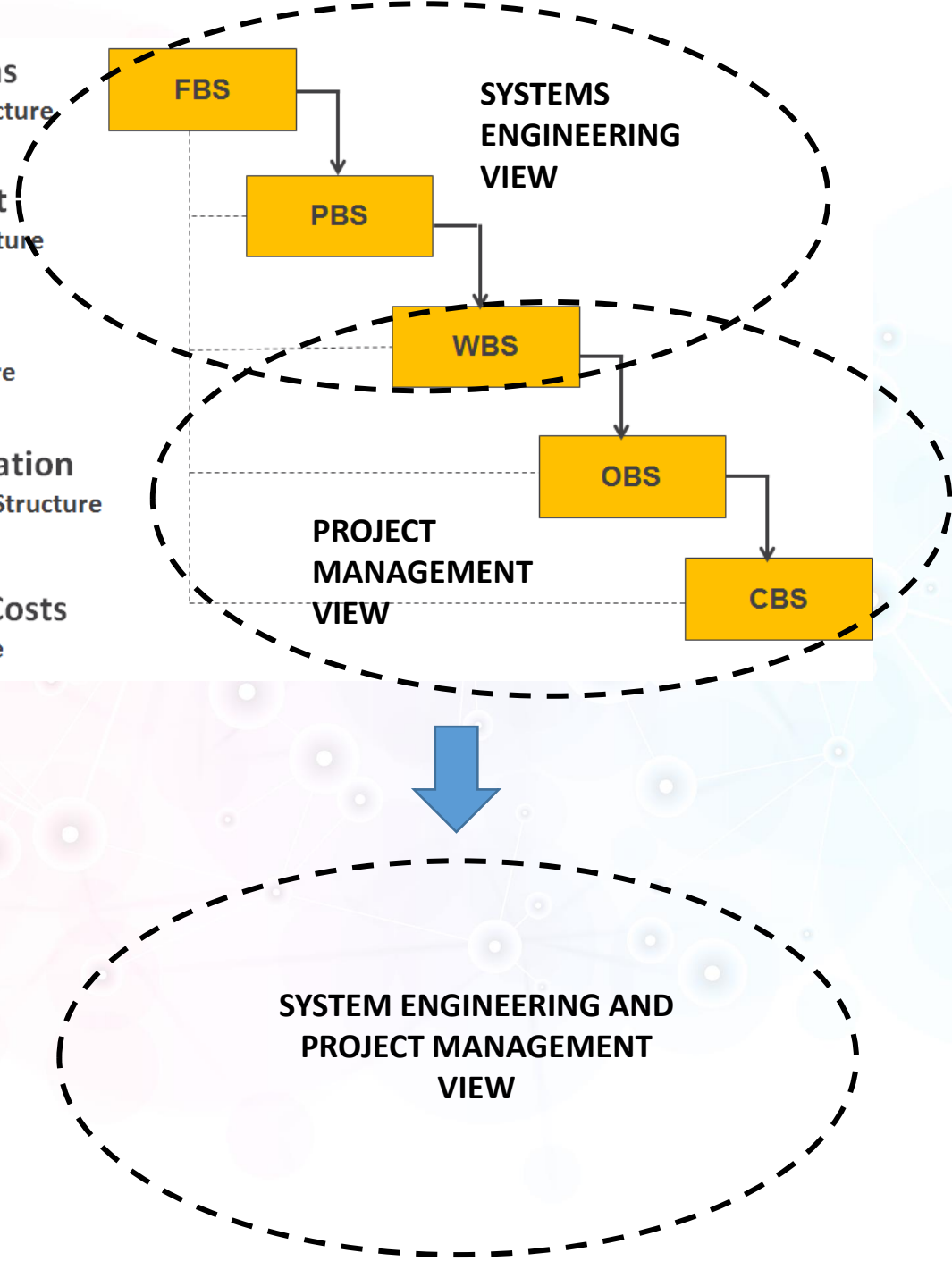
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Project Breakdown Structures

Initiative details

Scope: Establish consistencies between different breakdown structures (PBS,WBS,..) all along the life cycle

Who is leading : Jean-Claude Roussel

Who is contributing : Gary Smith (Airbus UK),
AFIS WG (CT MIS) PjBS initiative
Severin Drogoul (ISO TC 20) - Author of ISO 21511 (WBS)

Why is it important : Fundation and pre-requisite for PM-SE integration.
Basis for Project Planning

Key elements: Present description of Breakdown Structures in PMBoK and SE Handbook
Update proposal for coordination between PM and SE ref
Addition of missing structures description (FBS,..)

Timeframe: **Volunteers needed!**

Outcomes: Inputs for SE Handbook and PMBoK update

Resources and References: ISO 21511 (WBS), ISO 27026 (Breakdown of Project Management Structures)

WG Involvement: AFIS WG (CT MIS), INCOSE Life Cycle Mgt WG

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Project Breakdown Structures

Initiative details

Potential Volunteers to contribute :

- Gary Smith (Airbus, UK)
- John Lomax (Airbus, UK)
- Rob Vingerhoeds (ISAE, France)
- Samuel Boutin (Knowledge Inside, France)
- Gilles Beuzelin (AREVA, France)
- Gilles Roudie (CS, France)
- Severin Drogoul (ISO TC 20, France)
- Susan Ronning (EBE Consukting, USA) – *Contact at IW 2019*
- Tim Wiseley (Sandia Nat Lab, USA) – *Contact at IS 2019*
- Rachel White (CENTAURI, USA) – *Contact at IS 2019*
- Francesco Dazzi (CTAO, Italy) – *Contact at IS 2019*
- …

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Workshop Agenda

10:00	Welcome / Introduction	(JC/John/Michiel)
10:15	PM-SE Integration WG Overview	(JC)
10:30	PM-SE Integration WG Initiatives	
	- Project Breakdown Structures	(JC)
	- Strategic Technical Planning	**(John)**
	- Needs for new initiatives	(All)
11:00	Break-out sessions	(All)
12:15	Conclusion	(JC/John/Michiel)
12:30	End of the session	

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Strategic Technical Planning

PM-SE Integration WG Initiative

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Strategic Technical Planning

PM-SE Integration WG Initiative

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Strategic Technical Planning

- A common experience

Proposal Phase

Contract Signature

Realisation Phase

Responsibility: under SALES/MARKETING

Target: Order Intake

Mission Accomplished



Time

As contracted

Cost Quality

surprise



Responsibility: under PROJECT MANAGEMENT

Target: achieve project goal in time – cost – quality



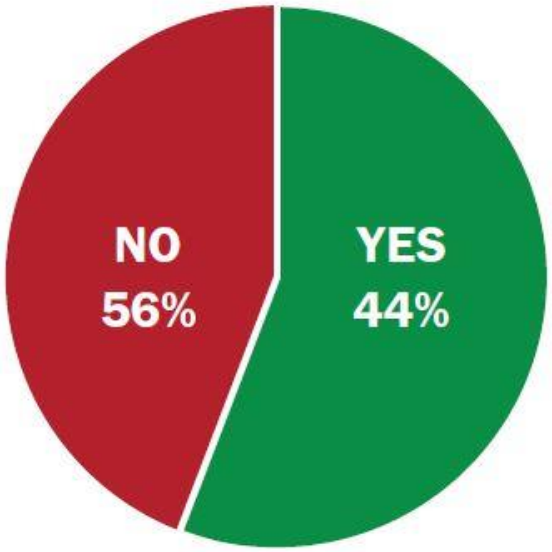
Time

Project which is revealed

Cost Quality

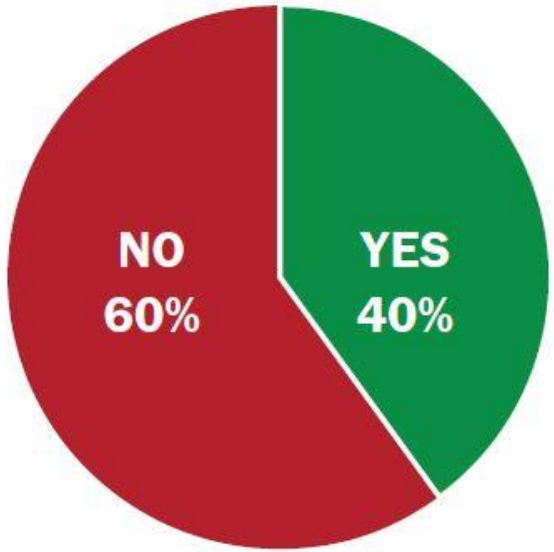
Strategic Technical Planning
- CHAOSReport

ONBUDGET



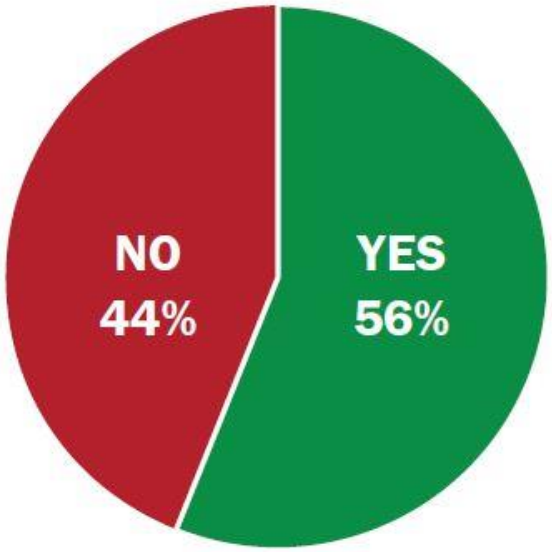
The percentage of projects that were OnBudget from FY2011–2015 within the new CHAOS database.

ONTIME



The percentage of projects that were OnTime from FY2011–2015 within the new CHAOS database.

ONTARGET



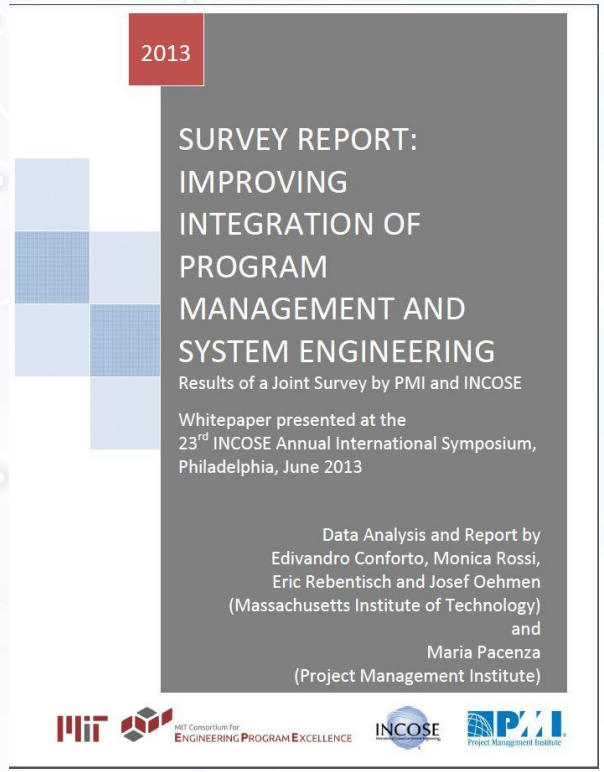
The percentage of projects that were OnTarget from FY2011–2015 within the new CHAOS database.

CHAOSReport - Standishgroup

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Strategic Technical Planning
- INCOSE-PMI-MIT Alliance

- In January 2011, International Council on Systems Engineering (INCOSE) and Project Management Institute (PMI®) formed a strategic alliance to advance the integration of the systems engineering and program management disciplines.
- In October 2012, the organizations conducted a joint survey to better understand the roles of the Program Manager and Chief systems Engineer and to gauge their current level of integration.
- Massachusetts Institute of Technology (MIT) provided strategic support in analyzing, reviewing and finalizing the survey results with INCOSE and PMI

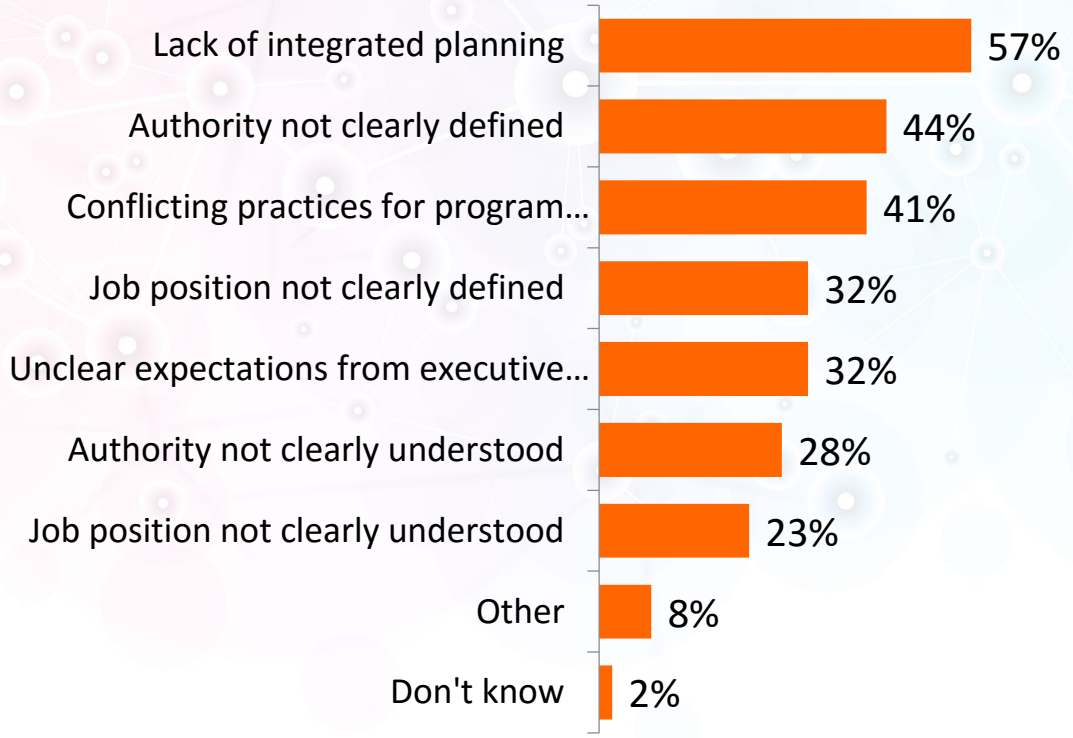


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Strategic Technical Planning
- Survey Report - Results

- Survey of 177 programme/project managers and chief engineers
- About three out of ten found that there is some (26%) or significant (3%) unproductive tension between program management and systems engineering.
- Chief Systems Engineers are significantly more likely to feel that there is unproductive tension between the roles at their organizations than program managers.

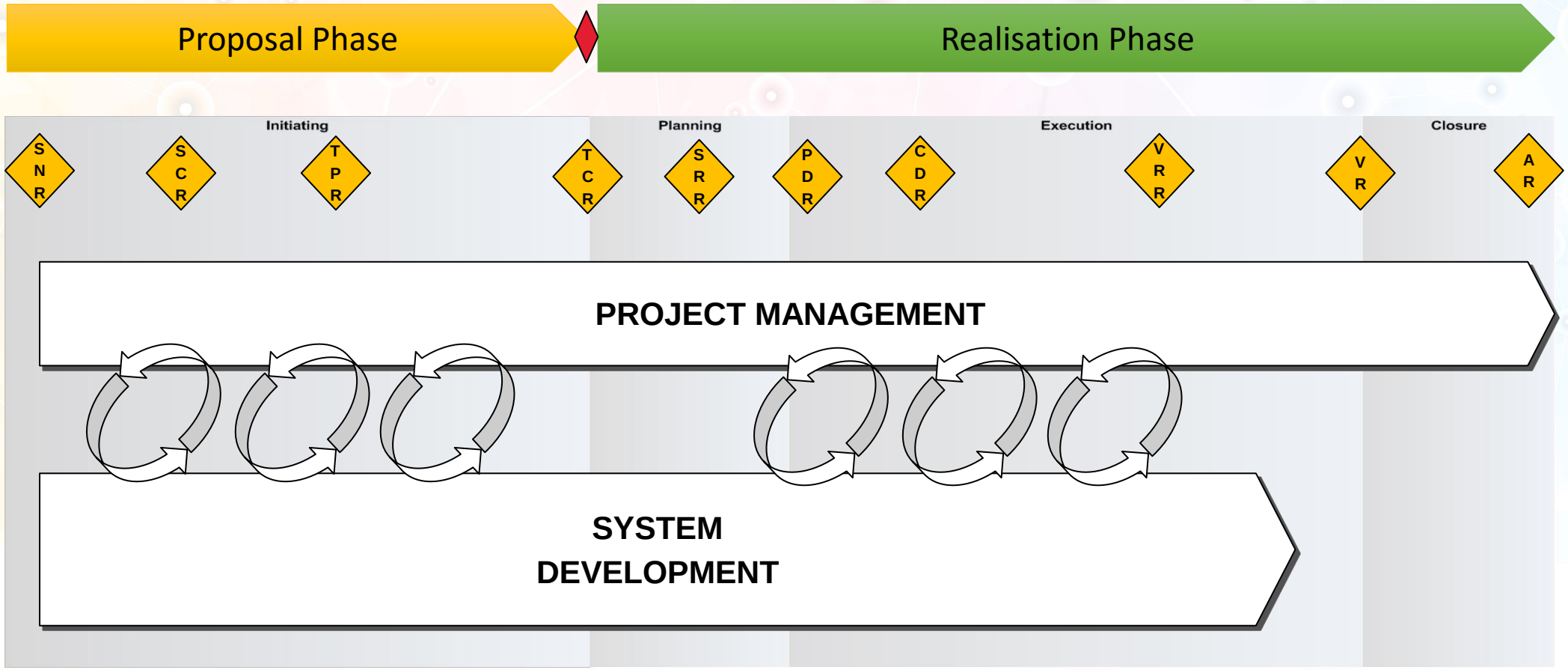
Q23. You identified that there is unproductive tension that affects team or program performance. Please describe the applicable source of the tension.



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Strategic Technical Planning

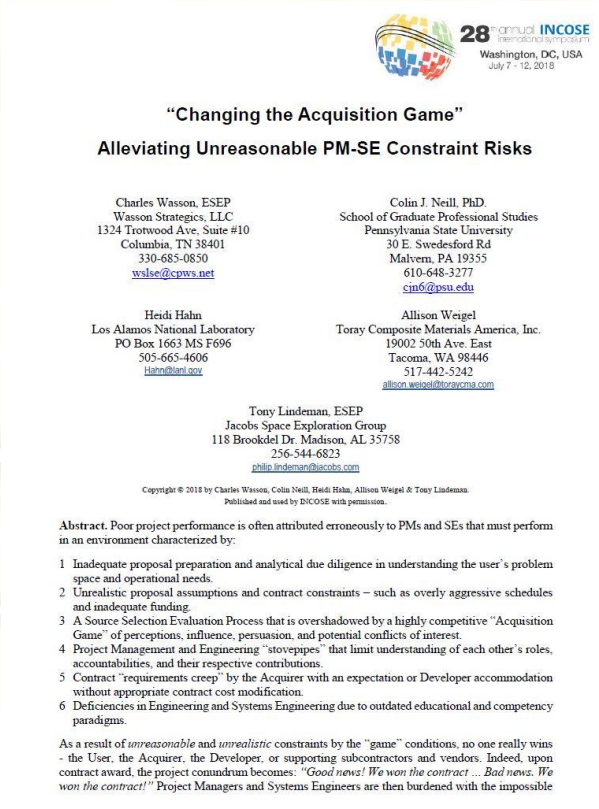
- Strategic Technical Planning Initiative based on the lack of Integrated Planning



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Strategic Technical Planning

- Some findings from the group..



28th annual INCOSE international symposium
Washington, DC, USA
July 7 - 12, 2018

"Changing the Acquisition Game"

Alleviating Unreasonable PM-SE Constraint Risks

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Abstract. Poor project performance is often attributed erroneously to PMs and SEs that must perform in an environment characterized by:

1 Inadequate proposal preparation and analytical due diligence in understanding the user's problem space and operational needs.
2 Unrealistic proposal assumptions and contract constraints – such as overly aggressive schedules and inadequate funding.
3 A Source Selection Evaluation Process that is overshadowed by a highly competitive "Acquisition Game" of perceptions, influence, persuasion, and potential conflicts of interest.
4 Project Management and Engineering "stovepipes" that limit understanding of each other's roles, accountabilities, and their respective contributions.
5 Contract "requirements creep" by the Acquirer with an expectation or Developer accommodation without appropriate contract cost modification.
6 Deficiencies in Engineering and Systems Engineering due to outdated educational and competency paradigms.

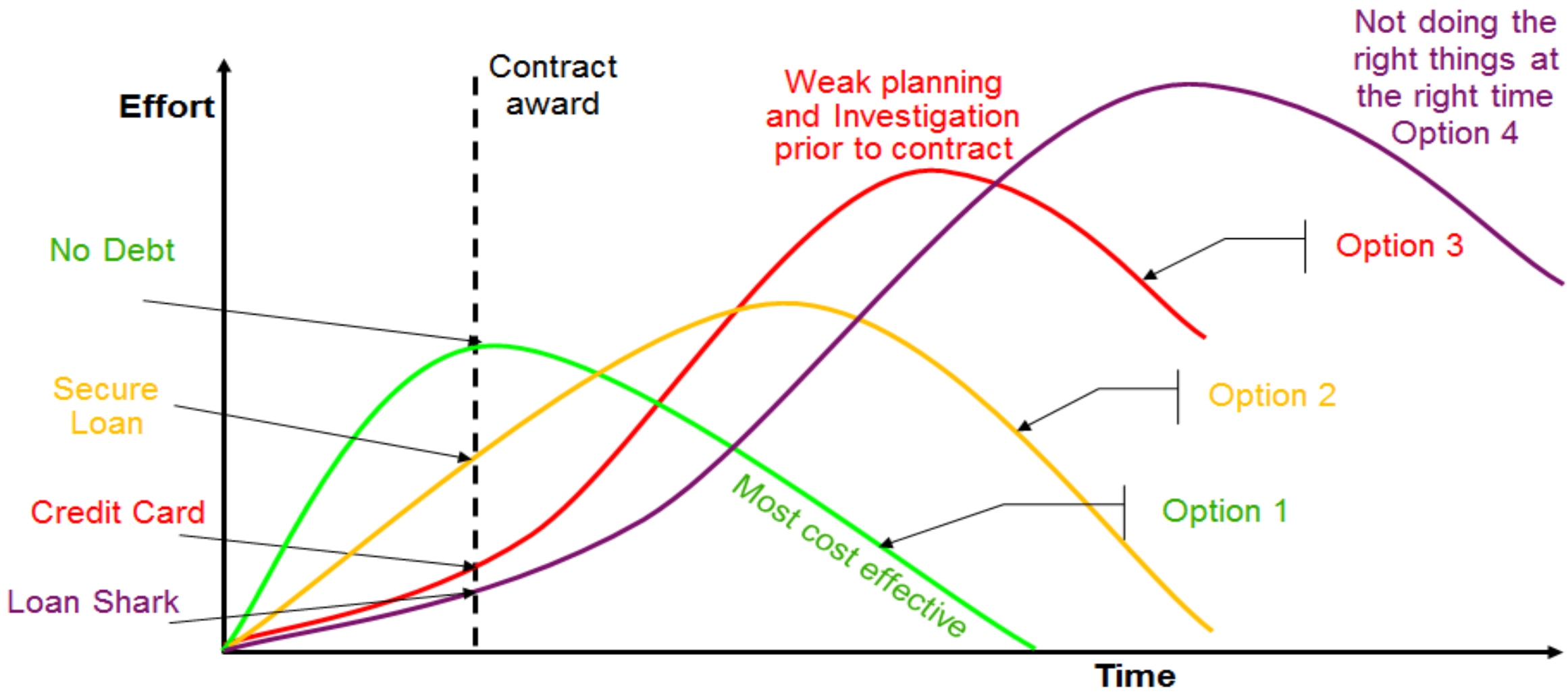
As a result of *unreasonable* and *unrealistic* constraints by the "game" conditions, no one really wins - the User, the Acquirer, the Developer, or supporting subcontractors and vendors. Indeed, upon contract award, the project conundrum becomes: *"Good news! We won the contract ... Bad news. We won the contract!"* Project Managers and Systems Engineers are then burdened with the impossible

Poor project performance is often attributed **erroneously** to PMs and SEs that must perform in an **environment** characterized by:

1. A Source Selection Evaluation Process that is overshadowed by a highly competitive "Acquisition Game" of perceptions, influence, persuasion, and potential conflicts of interest.
2. Inadequate proposal preparation and analytical due diligence in understanding the User's problem space and operational needs.
3. Unrealistic proposal assumptions and contract constraints – such as overly aggressive schedules and inadequate funding.
4. Project Management and System Engineering Silos that limit understanding of each other's roles, accountabilities, and their respective contributions.
5. Changing Contract requirements by the Acquirer with an expectation of Developer accommodation without appropriate contract cost modification and Developer willingness to accept new requirements to offset late delivery schedules.

Strategic Technical Planning

- Impacts of weak planning

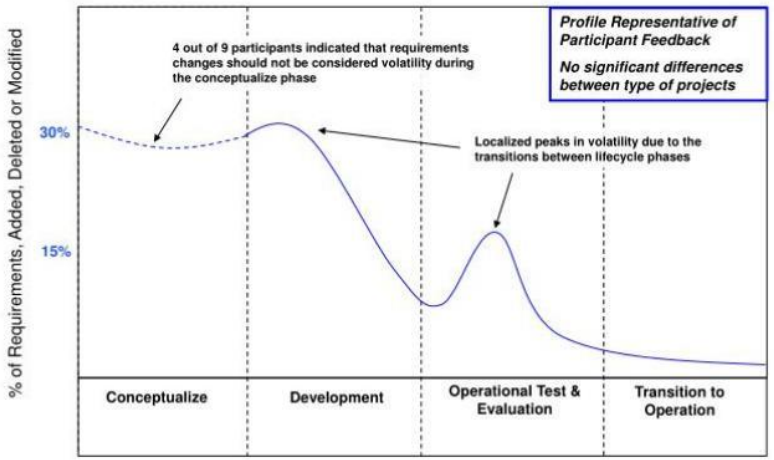


Strategic Technical Planning

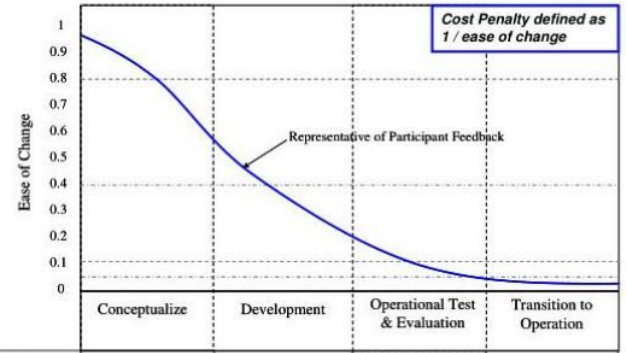
- COSYSMO studies fyi

$$PM_{NS} = A \cdot \left(\sum_{k} \left(w_{e,k} \Phi_{e,k} + w_{n,k} \Phi_{n,k} + w_{d,k} \Phi_{d,k} \right) \right)^{E} \cdot \prod_{j=1}^{14} EM_{j}$$

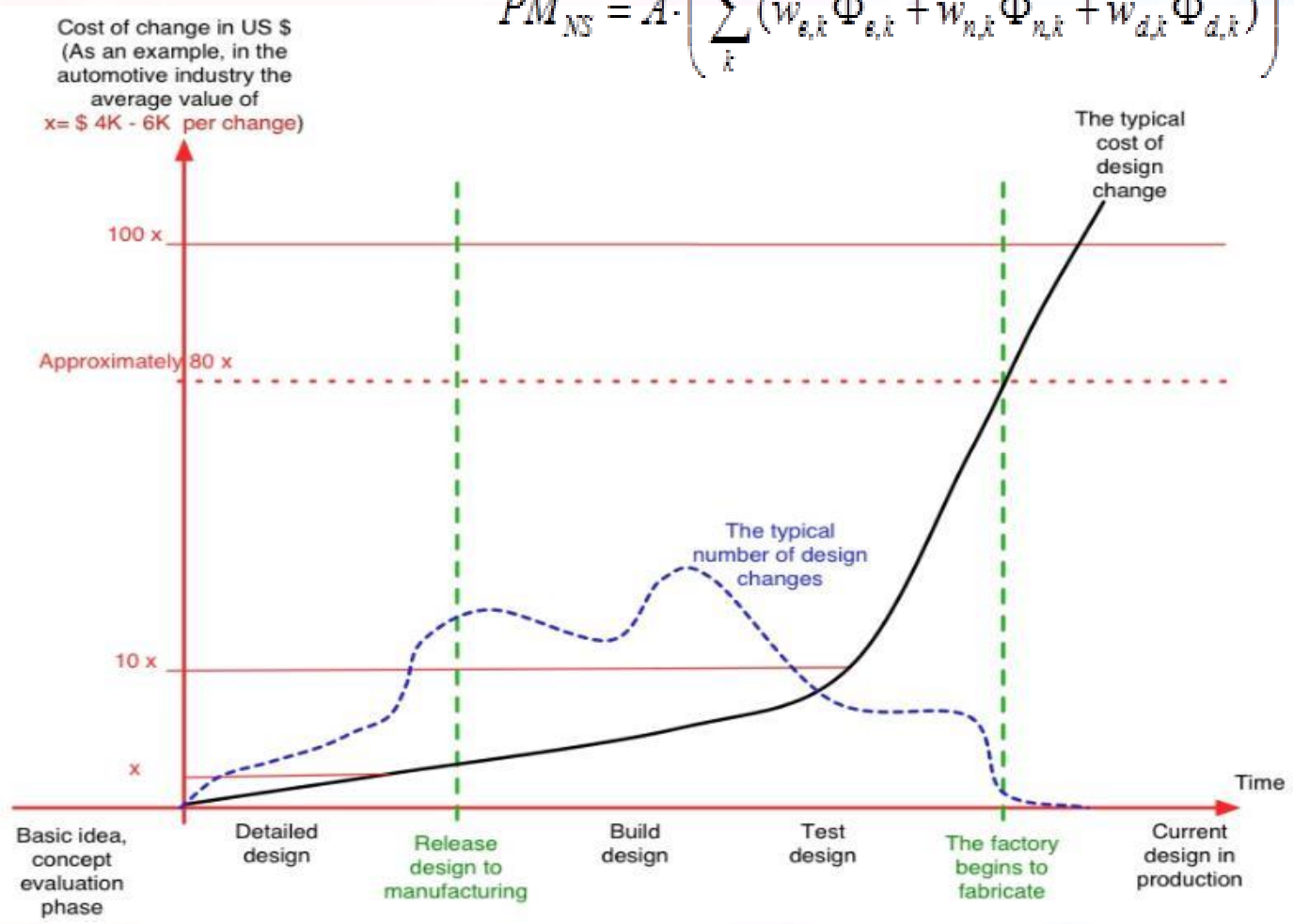
Expected Requirements Volatility Profile



Ease of Change Profile



Average Ease of Change Factor (Estimated)	0.8	0.4	0.1	0.05
Average Cost Penalty (Estimated)	1.25	2.5	10	20



It gives an estimate of the number of person-months it will take to staff systems engineering resources on hardware and software projects.

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Strategic Technical Planning

- Initiative details

Scope: Identify key Strategic Technical Planning factors that contribute to project technical, technology, cost, and schedule performance risk & success. Identify and prioritize PM-SE Integration performance risk issues within each factor.

Who is leading : John Lomax

Who is contributing/volunteering : Randy Iliff, John Coleman, Allison Weigel, Heidi Hahn, Karl Geist, …

Timeframe: 2017- 202X - based on the publications/alignments with the INCOSE Hndbk, PMBoK, SEBoK etc.

Resources & References: https://connect.incose.org/WorkingGroups/pm-se%20integration/SitePages/Home.aspx

WG developments:

- IS2018 Paper Submitted - “Changing the Acquisition Game”: Alleviating Unreasonable PM-SE Constraint Risks
- IS2018 Panel Discussion Proposed – “Changing the Acquisition Game”

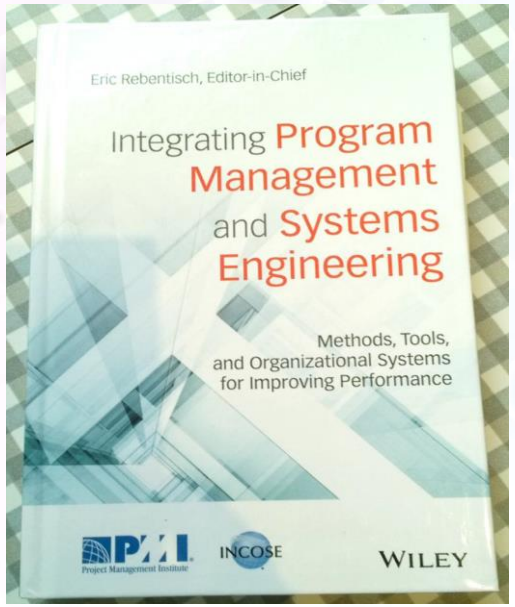
Expected Outcomes: PM-SE Integration best practices guidelines

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Strategic Technical Planning
- Initiative details contd…

Next Steps:

- Engage with Volunteers…
- Review current progress and assumptions…due to change of personnel/responsibilities/scope…
- Develop understandings/solutions to address the performance risks & issues by :
  - *Identifying Strategic Technical Planning Factors*
  - *Utilise existing material…*
    - *the 2018 Acquisition Game paper findings*
    - *the Integrating PM and SE book - Part IV - Calls to Action*
    - *Studies and Papers…*
  - *Utilise Your experience…*
- Attend the next STP Initiative webex by the end of the year tbd.
- Develop a workable plan and deliver PM-SE Integration best practices guidelines…



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Las Vegas, NV
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Integrating Systems Engineering with Project Management: a Current Challenge!

Rui XUE, Claude BARON
Philippe ESTEBAN, Daniel PRUN

LAAS ENAC



Purpose

- Too many projects still fail even using best practices in each domain (engineering, project management, marketing, cost management…)
- Project managers rely on standards which sometimes use practices not in line with those of the System Engineering domain
- To improve the companies 'competitiveness, a close cooperation between processes related to system development and project management is key to achieve performance and success.
- This paper develops this theory and present two ongoing projects that aim at integrating both domains.



Contents

1. Current situation and motivations for integrating Systems Engineering with Project Management
   - State of industrial practices
   - Needs: methods and tools supporting cooperation between systems engineers and managers
2. State of the art in research
3. A first methodological step: cooperation of processes through standards
4. An initiative towards a tool: the DECWAYS project
5. Conclusion and perspectives



1. Current situation

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- Several issues to lead a project in the extended enterprise context: numerous participants & stakeholders, various objectives, many disciplines and technologies.
- Systems Engineering (SE) and Project Management (PM) are two critical aspects in the success of projects (Boarder 1995, Chaos 2013, Sharon et al. 2011).
- Companies pay attention to SE and to PM processes separately, but rarely consider both jointly.
- Systems engineers and project managers think their works are separate (Conforto et al. 2013).
- Compartmentalization of processes => incoherencies

Urgent need of cooperation between SE and PM !



Sate of industrial practices

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- Companies need methods and tools to guide their industrial processes

- They already use some:
  - Many of them rely on standards and PLM tools. However, PLM tools only help for technical activities (Christi 2011).
  - Some major industrial groups developed their own (AIRBUS, Dassault Systems). However they do not consider PM and SE jointly, neither they offer decision support to drive the project

- This is not sufficient for tomorrow ’s competiveness:
  - The goal by 2025 is to reduce expenses in the domain of "Work of the automated knowledge" (management, engineering, finance…) by an order of 5000 billion U.S. dollars annually! (McKinsey Global Institute 2013)

A close attention has to be paid to the integration of SE with PM because it is fully in line with current concerns.



Motivation and research approach

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- **Objectives**: improve processes cooperation to help project managers during system development
  - avoid and early detect inconsistencies
  - make joint and coherent decisions

- **To make processes cooperate**:
  - analyze the adequacy of processes between SE and PM
  - develop a method and tool to bridge the gap between domains

- **Approach**:
  1. study SE and PM standards to evaluate the compatibility/gap between them,
  2. select those with the highest level of compatibility.

- This paper presents a first step toward this goal: analyze of SE standards and evaluation of their ability to manage processes



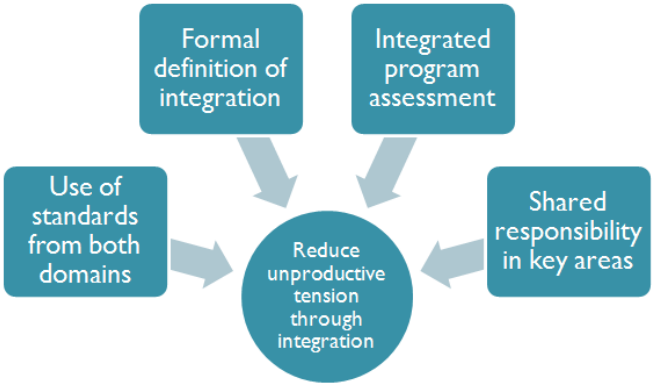
2. State of the art of research

- Integrating systems engineering and project management has only been considered in the beginning of 21th Century (Sharon et al. 2011).
- In January 2011, INCOSE and PMI (Project Management Institute) decided to strengthen the integration of SE and PM to overcome barriers between systems engineers and project managers.
- In May 2012, a guide to lean enablers for managing engineering program was published (Oehmen et al 2012).
  - Section 3: “integrating project management and systems engineering” Identifies 10 challenges, 43 enablers, 268 sub-enablers
- In October 2012, INCOSE, PMI and MIT conducted a survey to better understand the responsibilities of systems engineers and project managers (Conforto et al. 2013).
  - 680 chief system engineers and program managers
  - Findings: see next slide



State of the art of research

- Results of (Conforto et al. 2013):
  - Identified sources of "tension" between SE and PM:
    - lack of integrated planning,
    - authority not clearly defined & understood
    - conflicting practices,
    - Job position not clearly defined & understood…
  - highlighted how critical SE and PM integration is to reduce tensions
  - Identified 4 ways of improvement:
    - Use of standards from both domains
    - Formal definition of integration
    - Integrated program assessment
    - Shared responsibilities



3. A first way: cooperation of processes through standards

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- To improve cooperation between processes, we explored the first way 'Use standards from both domains'
  - As several standards exist, which one to choose?
  - The ones that are the most compatible….

1. **A first step** is evaluating "How do SE standards consider the management of processes?"
   ⇒ We analyzed 3 SE standards (ANSI/EIA-632, IEEE-1220 and ISO/IEC-15288)
   ⇒ We defined 4 comparison criteria: coverage, level of abstraction, focus and added the ratio of SE management processes.

2. **Second step** is: "How compatible are SE standards with PM standards?"
   ⇒ We compare SE standards with PM standard (PMBoK)



1st step: comparison of SE standards

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- We defined 4 comparison criteria based on the 3 defined by (Sheard 1998):
  - **Coverage** of system life-cycle phases or stages: only development or larger?
  - **Level of abstraction**: generic processes or specialized procedures?
    ⇒linked to flexibility and expendability
  - **Focus**: consider system, product, process, hardware, software, human, procedures…?
  - **Part of processes dedicated to management**: percentage of processes dedicated to management?



Comparison of SE standards

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	ANSI/EIA-632:1998	ISO/IEC-15288:2008	IEEE-1220:2005
System life cycle	• Assessment of opportunities • Investment decision • System concept development • Subsystem design and pre-deployment • Development, operations, support and disposal	• Conception • Development • Production • Utilization • Support • Retirement	• System definition • Preliminary design • Detailed design • FAIT [fabrication, assembly, integration, and test] • Production • Support
Level of abstraction	Medium level	Highest level - process description	Lowest level - task description level
Focus	Enterprise-based systems	Product-oriented systems	Engineering activities necessary to guide product development
% SE Mngt Processes	3/13	12/25	1/14



Comparison of SE standards

- Considering the comparison of norms with respect to general criteria, no standard seems to be the best

- Each standard has a specific profile and addresses different features

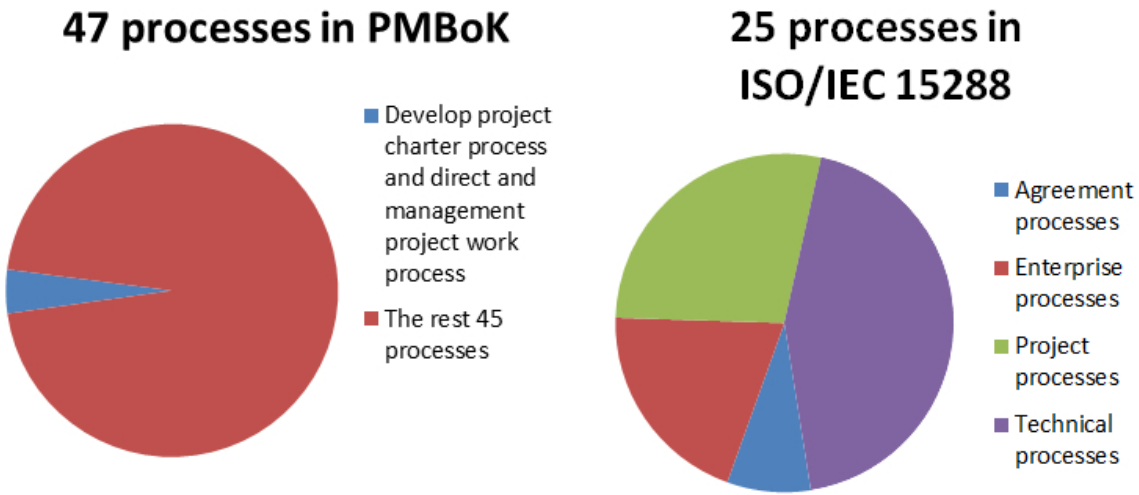
- The ISO/IEC-15288:2008 seems to consider most the management of SE processes



2nd step: Comparison of ISO with PMBoK

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- Early findings:
  - **PMBok → ISO 15288**: all processes of PMBoK are related to the 3 non technical process groups of ISO 15288
  - **ISO 15288 → PMBok**: no obvious process or activity in ISO 15288 corresponds to develop project charter process and direct and management project work process of PMBoK



4. An initiative towards a tool: the DECWAYS project

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- **Aim**:
  - A tool for project management
  - For better project monitoring and control:
    - Help in early detection problem
    - Support decision making

- **Based on:**
  - a formalization of an integrated project and system evaluation process
  - ISO 15288 and PMBok standards
  - a supervision based on shared indicators aggregating SE and PM information for a joint assessment of options, diagnosis and decisions
  - a pro-active decision model

- **Previous project** : ATLAS Project (2008-2011)
  - Feasibility study
  - Industrial interest



DECWAYS project

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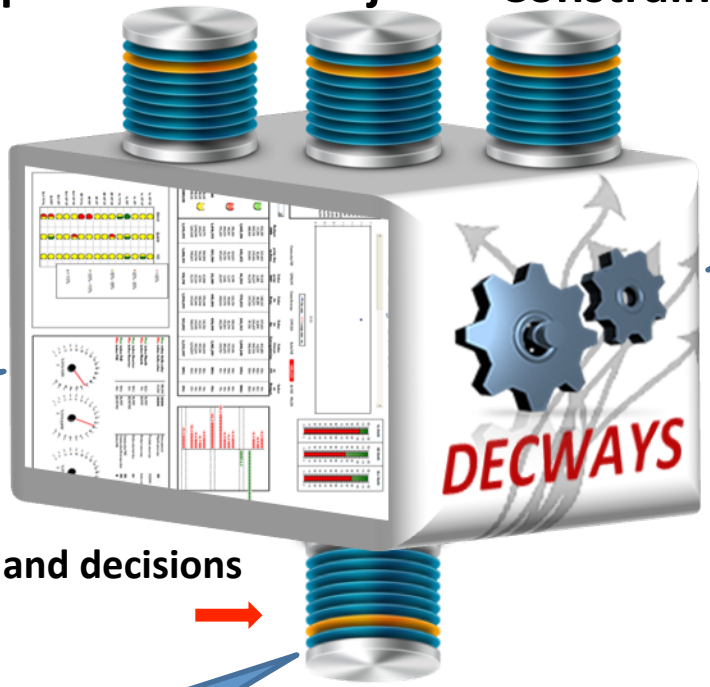


Shared responsibilities

Data from requirements tools (DOORS, Reqtify, …)

Shared data

Requirements **Project** **Constraints**



interoperability monitoring

Dashboards, visualize indicators & conflicts

Validate data consistency, detect and manage conflicts

indicators

Data base : events and decisions history

storage



Joint evaluation



General conclusion

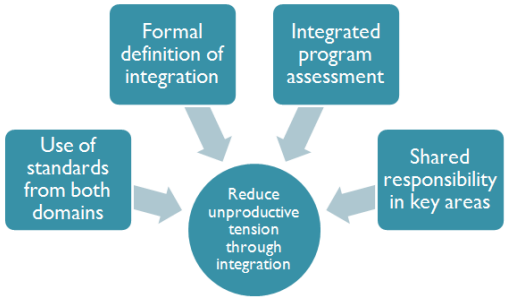
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- Cooperation between SE and PM processes is necessary for the success of projects.
- Integrating SE and PM now lies at the very heart of current research and economic / industrial concerns.
  - Recently INCOSE & PMI have devoted much attention to this
  - The DECWAYS project also addresses this issue
- A first means to make processes cooperate is to use standards from both domains.
  - Choosing standards is not trivial…
- On the tool side: DECWAYS aims at facilitating the management of projects by providing
  - visibility to the progress of project to all stakeholders,
  - a formal decision-making process and choice traceability.



Perspectives

- Extend the analysis to other references (guide or compendium of best practices) such as SEBoK or INCOSE Handbook, and ISO 21500 for PM
- Patent registered for DECWAYS: development to continue
- Explore other ways among those suggested by the project INCOSE-PMI and consider how to associate them to improve performance and coordination in SE projects



- Extend this cooperation to other enterprise processes: marketing, finance, …

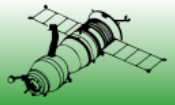


To read more

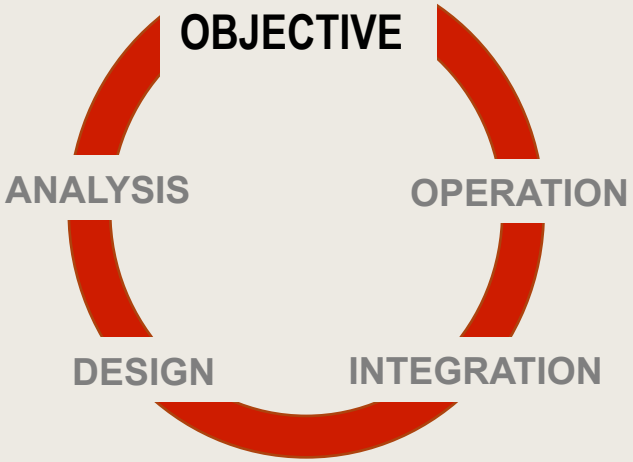
- Rui XUE, Claude Baron, Philippe ESTEBAN, “Managing Systems Engineering Processes: a Multi-Standard Approach”, IEEE International Systems Conference,6 pages, 30/03/2014 – 02/04/2014, Ottawa, Canada.
- Rui XUE, Claude Baron, Philippe ESTEBAN, “Aligning systems engineering and project management standards to improve the management of processes”, 23rd international conference on systems engineering, 19-21, August, 2014 Las Vegas, USA.
- Rui XUE, Claude Baron, Philippe ESTEBAN, “Towards the success of design projects by the alignment of processes in collaborative engineering”, a Joint conference on mechanical design engineering and advanced manufacturing, 6 pages, 18-20/06/2014, Toulouse, France.
- Claude BARON, Philippe ESTEBAN, Rui XUE, Daniel ESTEVE, Michel MALBERT, “Specifications of a method and tool to support the management of systems engineering projects”, International Conference on Engineering, Technology and Innovation, 7 p. , 23-25/06/2104, Bergamo, Italy.



Thank you!
Questions?



Presentation to IS 2014

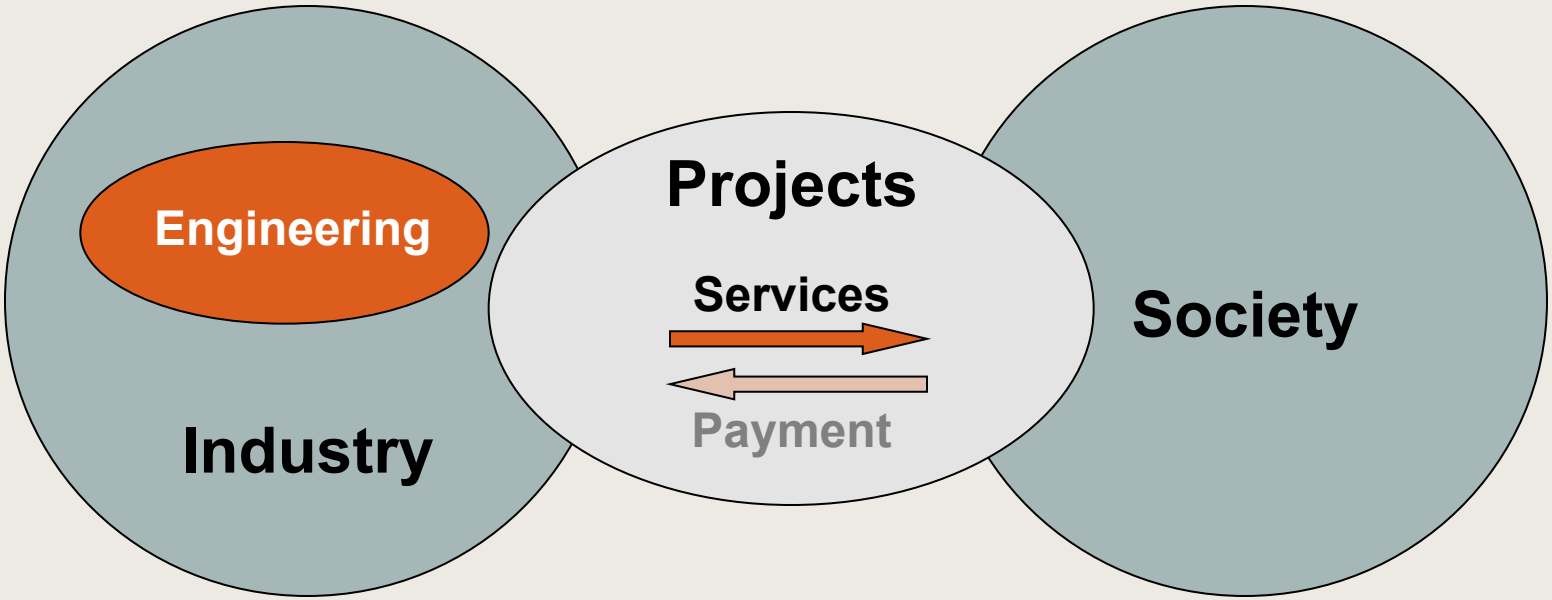
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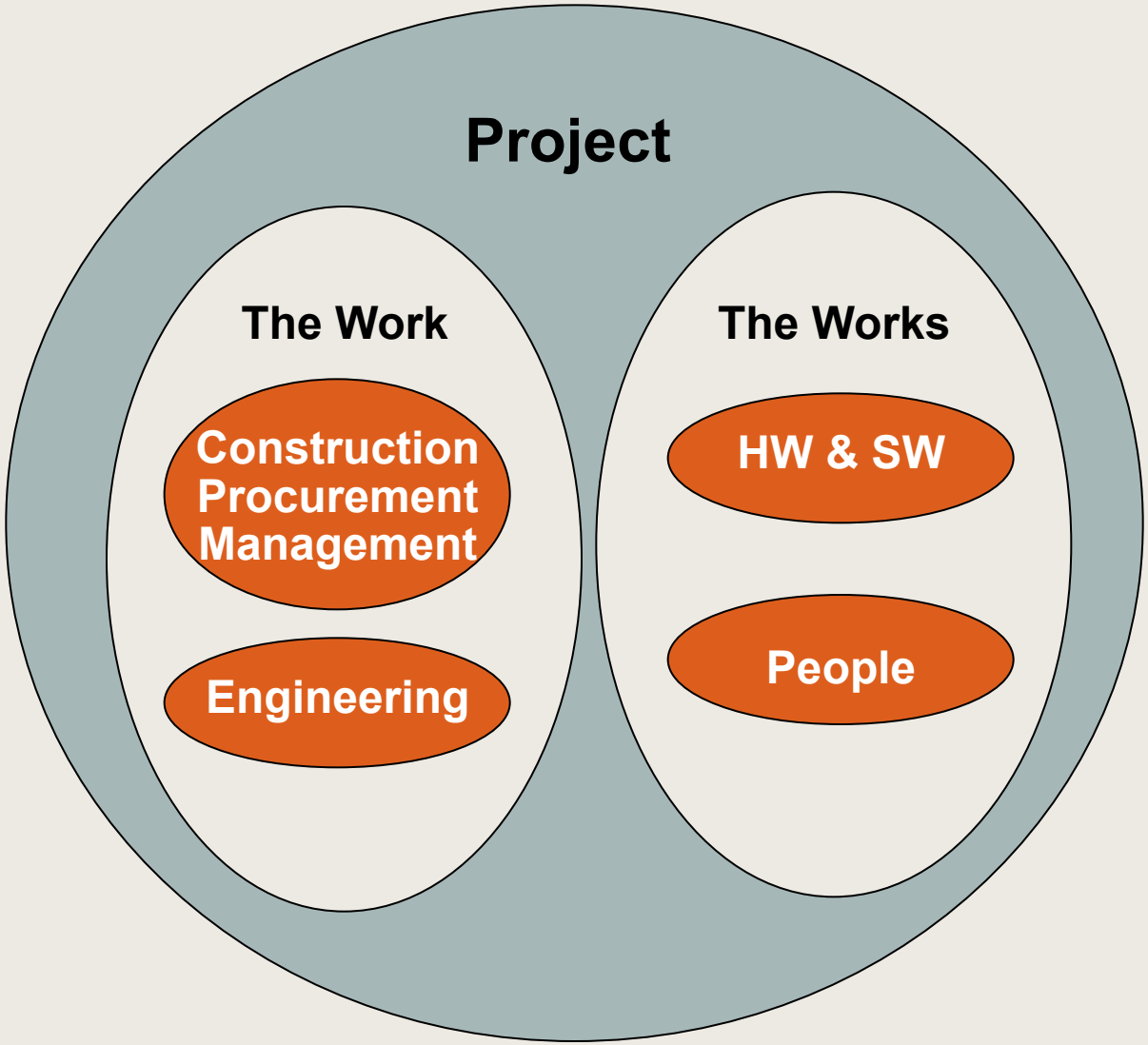
Erik W. Aslaksen

Gumbooya Pty Ltd

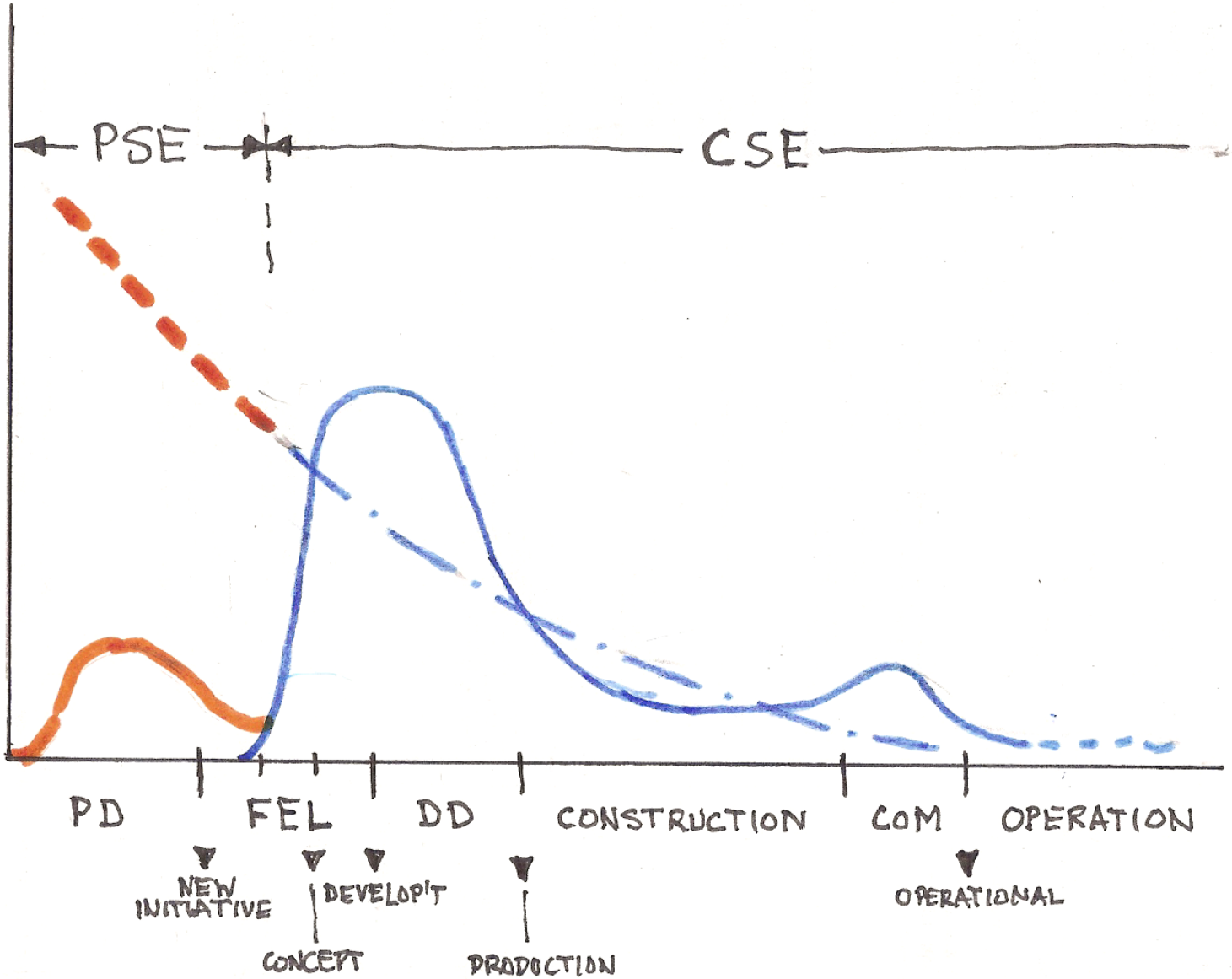
Systems and Projects

- A brief description of the high-level view of engineering and systems engineering on which my paper is based
- A discussion of comments raised by the reviewers
- A further issue relevant to the reviewers' comments


Engineering
Industry
Projects
Services
Payment
Society



Service → Society


PSE
CSE
PD
FEL
DD
CONSTRUCTION
COM
OPERATION
NEW INITIATIVE
DEVELOPIT
CONCEPT
PRODUCTION
OPERATIONAL

Will introducing PSE make any significant difference?

a. It will integrate engineering into other project activities
b. It will allow optimisation of overall project cost-effectiveness
c. It will improve the scheduling of activities and information flow

Which are the barriers to implementation of PSE?

a. There are costs associated with implementing PSE that make it appear not cost-effective.
b. There are professional barriers – in particular, considerations regarding liability – that make it difficult to integrate across professions.
c. It is seen as a threat to the considerable investment in CSE.

Language issues:

- Project vs. enterprise (Handbook: enterprise = organization. Organisation can execute many projects, and has support systems that are used in all projects) Not the same *in general*.
- Service, as used here (defined by society) vs. as used in SW engineering, e.g. service-oriented architecture (= functionality of self-contained SW part)
- Service vs. capability. Service is defined by society (users), capability is the functionality the system (Works) in order to support the provision of the service.

Language issues (cont'd):

- Project architecture vs. enterprise architecture. The latter is an IT analysis function, and relates to the structure of a company's business processes and the resulting information flows. My intention is that the project architecture is a system architecture.
- SE vs. PM at the project level. I believe leaving the architecting of the project to the PMs is one of the reasons for poor project performance (cost and schedule overrun). An alternative is to teach systems architecting to PMs (can be problematic).

An important comment: “The fundamental purpose of engineers is to build things that serve a function. The author is proposing Systems Thinking rather than the engineering or technical aspects of SE.”

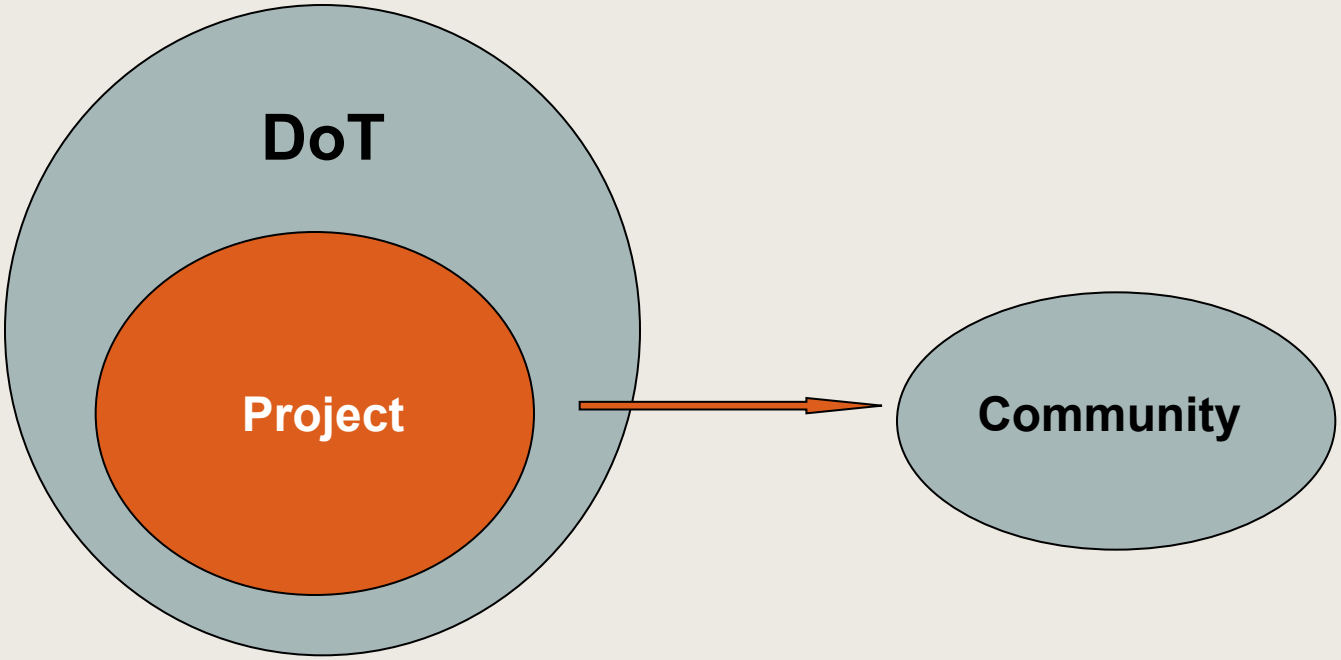
My view: Systems Thinking is the general application of the system concept to handling complexity. Systems Engineering is a formalisation and detailed development of the application of the system concept to engineering (embodied in the SEBOK and Handbook), and that same methodology (*not* Systems Thinking) can be applied at the project (top) level to “engineer” and optimise the project, considered as a complex system.

The fundamental purpose of engineers is to contribute to the best of their abilities to ensuring project success.

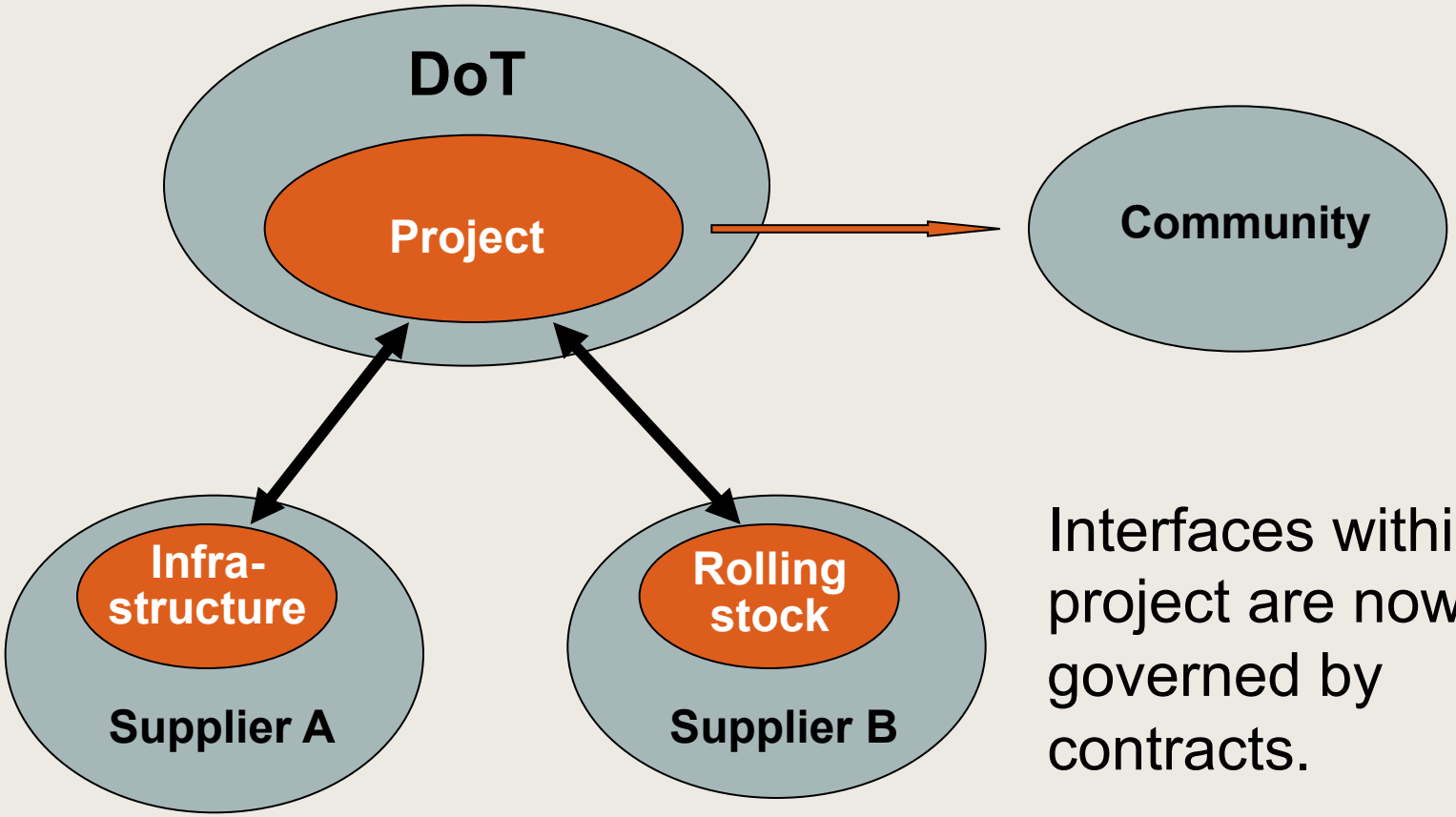
The importance of contracts

An example: Providing public transport services to a (new) suburb.

One (very unlikely) approach:



A more likely approach:



Interfaces within the project are now governed by contracts.

Questions and Discussion



32nd Annual INCOSE international symposium

hybrid event

Detroit, MI, USA
June 25 - 30, 2022

Presenter, Eric B. Dano, Ph.D.
BAE Systems, Electronic Systems (ES)
eric.b.dano@baesystems.com

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Using Design Structure Matrices (DSMs) to Derive System Architectures

What is a DSM ?

Design Structure Matrix (DSM) Definition (a.k.a. N^2 Dependency Matrix, Dependency Structure Matrix, etc.)

Tool used to optimize a grouping of Tasks (schedule or process applications), Components or functions (system architecture applications) or Teams (organizational applications) based on defined dependencies between elements to produce an optimal time sequence of activities or grouping of components for a given system application.

DSM Types

Static [1] – "Represent system elements existing simultaneously, such as components of a product architecture or groups in an organization. Usually solved using clustering algorithms."

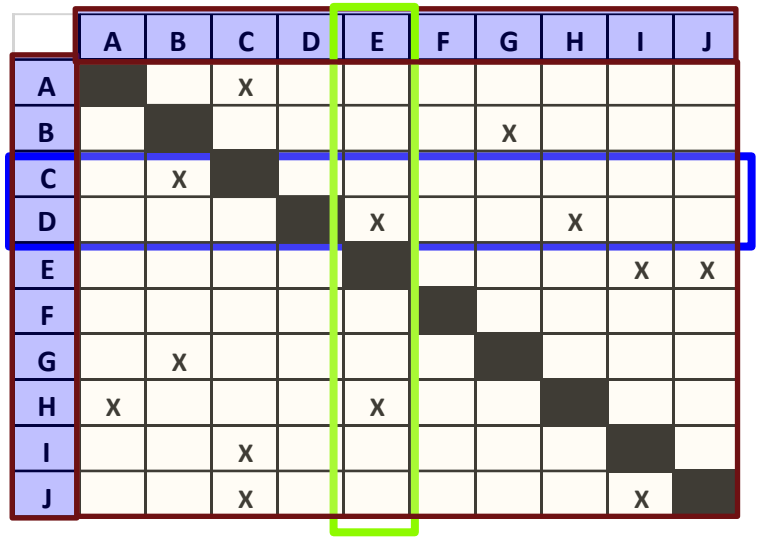
Time Based [1] – "The ordering of the elements in the system represent a flow through time, with upstream activities preceding down stream activities. "Feed-forward" and "feed-back" are used to describe interfaces.

[1] T. Browing, 2001.

DSM Matrix Basics

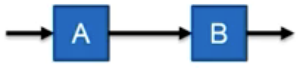
- The top row and left most column list the elements/tasks/teams to be considered
  - The diagonal is in black because no element is dependent on itself
  - The element sequence currently goes from A to J but will be optimized based on the dependencies defined by the Xs
- Each Row shows the “Needs” (i.e. must occur after the element in the current Row)
  - EX1: Element C “Needs” only B. Since it is currently after B, it is fine
  - EX2: Element D “Needs” E & H which both “Provide” to D. Therefore, Element D must be moved later in the sequence (after E & H).
    - » Note that all X’s above the diagonal have this issue and will need to be optimized
- Each Column shows the “Provides” (i.e. must occur before the element in each checked Row)
  - EX3: Element E “Provides” to D & H. It will need to be moved to before D

Example DSM

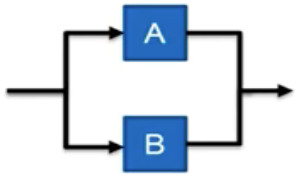


Interaction/Interdependency Types

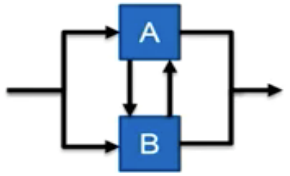
- **Dependent**
  - There is a dependence between the two elements/tasks
  - They must be performed sequentially
- **Independent**
  - There is NO dependence between the two elements/tasks
  - They may be performed in parallel
- **Interdependent**
  - Each element/task relies on out put from the element/task
  - The two elements/tasks are coupled



Dependent
-i.e. sequential



Independent
-i.e. parallel



Interdependent
-i.e. coupled

Example DSM Appearance

	A	B
A		
B	X	

B needs A before it can start

	A	B
A		
B		

A and B can be started in parallel

	A	B
A		X
B	X	

A and B must be done simultaneously

Static DSM Example: System Architecture of a Software Defined Radio (SDR) Based System

Derive an Architecture in 5 Easy Steps !

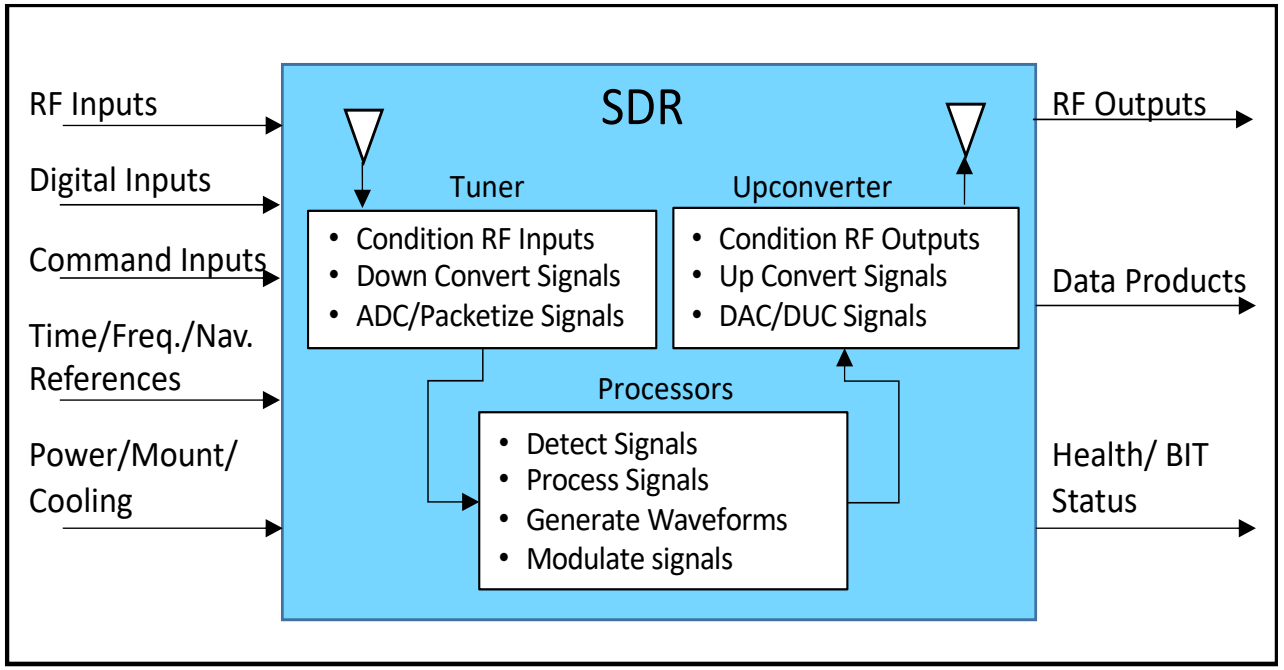
1) Define ConOps and required system capabilities (operational, support, etc.)

2) Perform Functional Architecture/ Functional decomp-osition with defined interdependencies

3) Perform Logical Architecture/Allocate functions to format based on required performance

4) Perform Logical Architecture/High level Aggregation of commonly allocated functionality

5) Perform Physical Architecture/Partition functions to system elements and perform low level aggregation of functionality



A Software Defined Radio will be used in this example

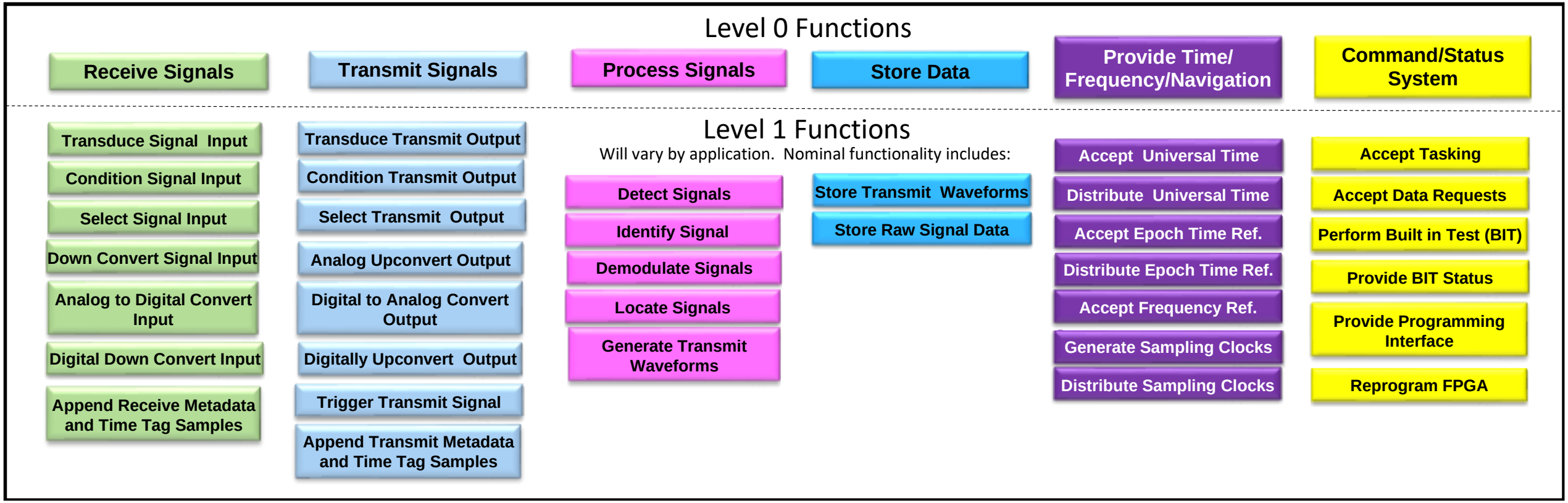
1. Define ConOps and Required System Capabilities

- The architecture process starts with the “hand-in” of the customer specified Concept of Operations (ConOps), Key Performance Parameters (KPPs), Key System Attributes (KSAs) and value statements.
  - The application of option generation techniques is critical during the concept exploration phase and should include holistic systems thinking to find highest level objectives, using analogies to create options, dynamic system modeling and simulation [2], the use of heuristics [3] and proven design patterns for software [4].
- The SDR based system ConOp is to have the capabilities to receive signals, process signals, transmit signals, store data and provide time/frequency/navigation.
  - The ConOps must be further expanded to include supportability, human machine interface, cyber, testability, safety, production, etc. to ensure the full set of ConOps are understood prior to commencing functional decomposition of the system.
  - System architect must ensure a multi-disciplinary solution is obtained [5].

ConOps definition is performed prior to populating the DSM

2. Perform System Functional Decomposition

- The level 0 functionality is defined as part of the functional architecture process
- Level 0 functions are then decomposed into Level 1 sub-functions which will be used in the architecture derivation process [6], [7]



Apply Functional Breakdown to DSM Matrix

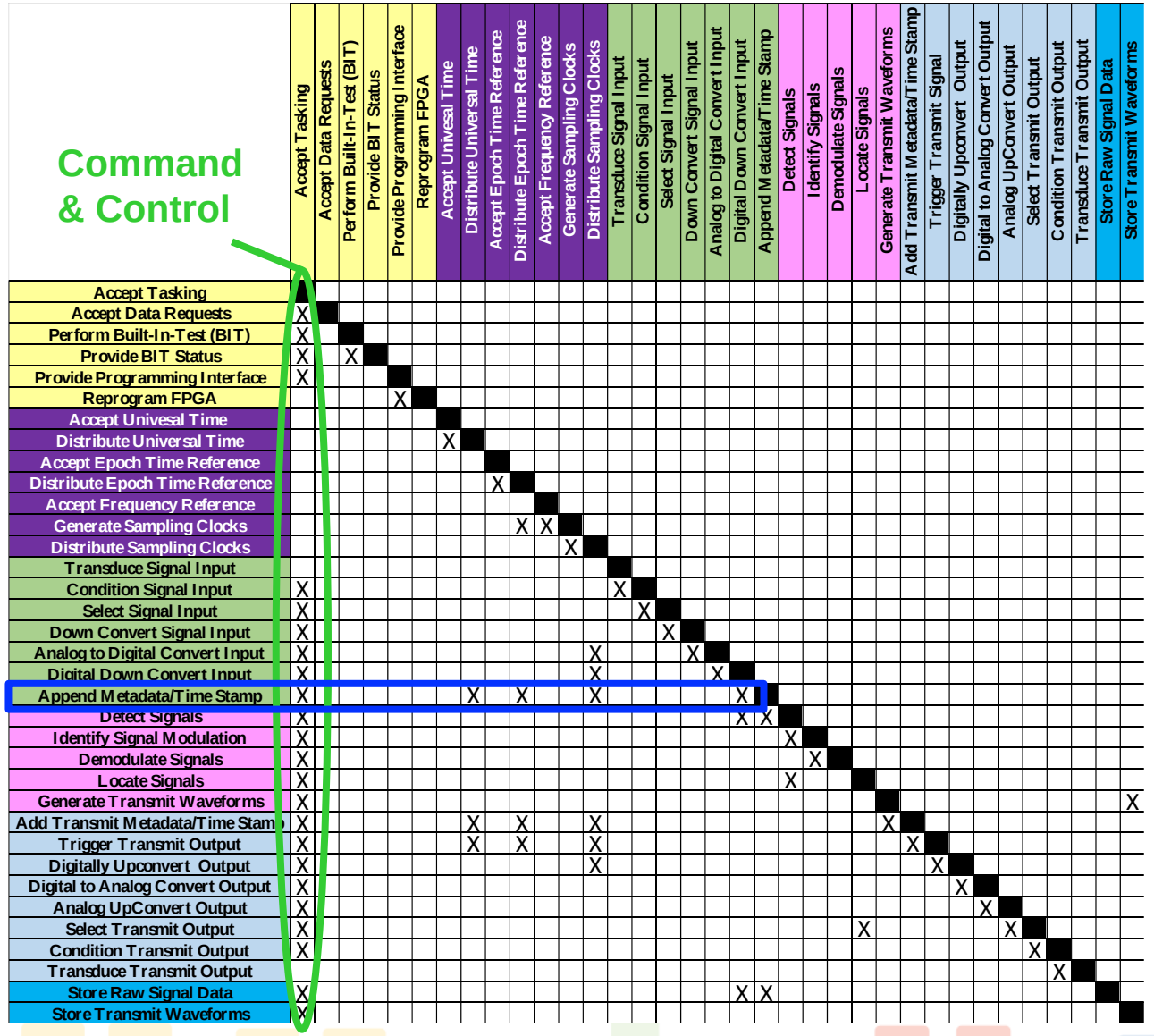
- Level 1 functionality is placed along the X and Y axises
- Diagonal is blacked out
- Level 1 functionality is usually sufficient to derive the system architecture and define system level modularity

Functional Decomp	
	Command/Status System
	Provide Time/ Frequency Reference
	Receive Signals
	Process/Generate Signals
	Transmit Signals
	Store Data

	Accept Tasking	Accept Data Requests	Perform Built-In-Test (BIT)	Provide BIT Status	Provide Programming Interface	Reprogram FPGA	Accept Univesal Time	Distribute Universal Time	Accept Epoch Time Reference	Distribute Epoch Time Reference	Accept Frequency Reference	Generate Sampling Clocks	Distribute Sampling Clocks	Transduce Signal Input	Condition Signal Input	Select Signal Input	Down Convert Signal Input	Analog to Digital Convert Input	Digital Down Convert Input	Append Metadata/Time Stamp	Detect Signals	Identify Signals	Demodulate Signals	Locate Signals	Generate Transmit Waveforms	Add Transmit Metadata/Time Stamp	Trigger Transmit Signal	Digitally Upconvert Output	Digital to Analog Convert Output	Analog UpConvert Output	Select Transmit Output	Condition Transmit Output	Transduce Transmit Output	Store Pre-D Data	Store Transmit Waveforms
Accept Tasking																																		
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Store Transmit Waveforms																																		

Define Functional Dependencies to Matrix

- X's show interdependencies between the derived Level 1 functions [8], [9].
- This process is focused on modularity (i.e. static DSM) and is not adjusted for order of events (i.e. Time-based DSM)
- EX1: See that metadata/ time stamping relies on:
- EX2: See that metadata/ time stamping relies on:
  - Tasking
  - UTC time message distribution,
  - Epoch Time (1PPS) distribution
  - ADC/DAC clocks distribution



3. Perform Allocation of Functionality

- Allocation is done to optimize performance of the various functions
  - Most functions can be performed using multiple allocations
- Allocations mostly driven by required:
  - Latency
  - Throughput
  - Fidelity
  - Cost
  - Leverage

- Allocation Heuristics (lessons learned) and required performance are used to properly allocate functions

	Hardware (H)	FPGAs (F)	GPUs (G)	GPPs/Software (S)
STRENGTH	• Good for generic fixed capabilities • Common open standards and interfaces exists • Relatively low cost	• Highly reconfigurable parallel architecture permits multiple operations to be performed simultaneously • Embedded multipliers and memory enable instantiation of extremely fast filters and synthesizers • Programmable data paths allow for processing a wide variety of data types • Low latency operations	• Excellent for processing intensive algorithms (multi-parallel processing) • Baselined to floating point operations • Fast memory access • Rapid commercial GPU upgrade cycle	• Highly versatile; can implement an almost limitless number of applications • Embedded math logic makes for efficient use of processing resources • Excellent for decision making and branching • Well suited for information management and control
WEAKNESS	• Fixed capabilities, can't be reconfigured • Requires additional components for extended frequencies • Relatively large Size, Weight, and Power (SWaP)	• Relatively inefficient for branching or decision-making operations (these consume large numbers of gates) • Large and fast devices are expensive • High-precision math operations may consume many resources	• High power draw • High heat dissipation • Some must be paired with an interface GPP • Limited vendors	• May be comparatively slow at simple fixed-point math operations, due to inherently serial processing nature • Only able to perform a low number of tasks per clock cycle • Higher latency operations

Allocated Functionality

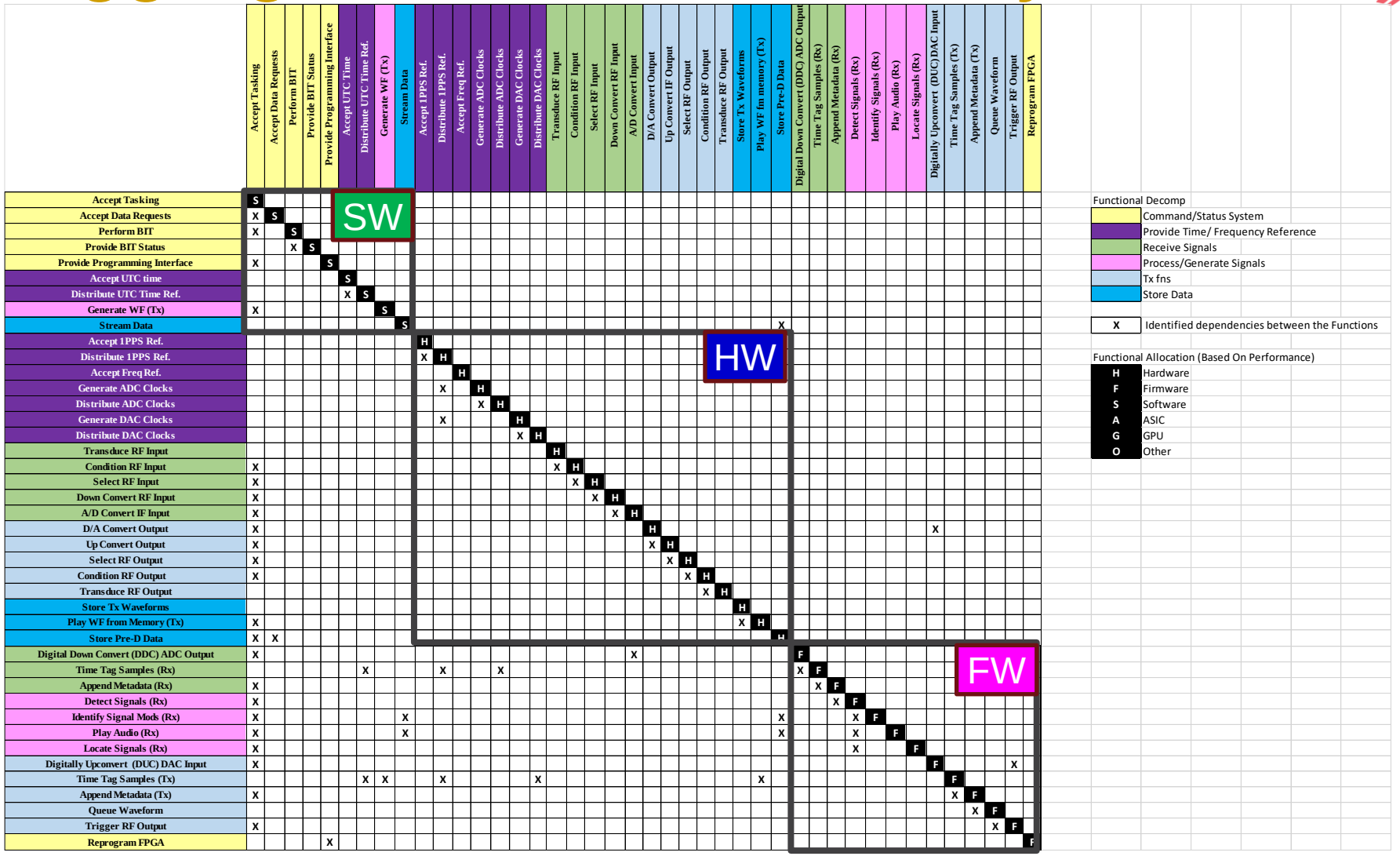
Allocation Key:

- F – Firmware
- H – Hardware
- S – Software
- A – Application Specific Integrated Circuit (ASIC)
- G - Graphical Processing Unit (GPU)
- O - Other

	Accept Tasking	Accept Data Requests	Perform Built-In-Test (BIT)	Provide BIT Status	Provide Programming Interface	Reprogram FPGA	Accept Univesal Time	Distribute Universal Time	Accept Epoch Time Reference	Distribute Epoch Time Reference	Accept Frequency Reference	Generate Sampling Clocks	Distribute Sampling Clocks	Transduce Signal Input	Condition Signal Input	Select Signal Input	Down Convert Signal Input	Analog to Digital Convert Input	Digital Down Convert Input	Append Metadata/Time Stamp	Detect Signals	Identify Signals	Demodulate Signals	Locate Signals	Generate Transmit Waveforms	Add Transmit Metadata/Time Stamp	Trigger Transmit Signal	Digitally Upconvert Output	Digital to Analog Convert Output	Analog UpConvert Output	Select Transmit Output	Condition Transmit Output	Transduce Transmit Output	Store Raw Signal Data	Store Transmit Waveforms
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Add Transmit Metadata/Time Stamp	X							X		X			X											X	F										
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Transduce Transmit Output																															X	H			
Store Raw Signal Data	X																		X	X													H		
Store Transmit Waveforms	X																																	H	

4. Perform Aggregation of Functionality

- Aggregation is done to optimize the grouping of the allocated functions to aid modularity definition in the system and provide [10]:
- **High Cohesiveness** - Large similarity in well-defined functions performed within a module
  - Enables Commonality and Reuse
- **Low Coupling** - Module functionality does not constrain functionality in any other module
  - Reduces complexity, eases testability, catalyst for rapid capability insertion, etc.



Software Defined Radio (SDR) Based System
Case 1: Large Platform
Case 2: Small Platform

SDR Characteristics for Functional DSM Methodology Use Cases

Case 1 – Large Platform	Case 2 – Small UAV Platform
• High precision - Geolocation • Multiple Receive Array(s) • Multiple Receive Channels • Multiple Receive Bands • N-Channel Direction Finding • Multiple Transmit Channels • Multiple Transmit Bands • Multiple Transmit Array(s) • Large Radiated Power – Stand-Off • Significant signal distribution	• Lower Precision – Situational Awareness • Two Receive Antennas • Two Receive Channels • One Receive Band • 2 Channel Direction Finding • One Transmit Channel • One Transmit Band • One TX antenna • Low Radiated Power – Stand-In • Direct Signal Cabling

Up to this point both platforms have the same architecture

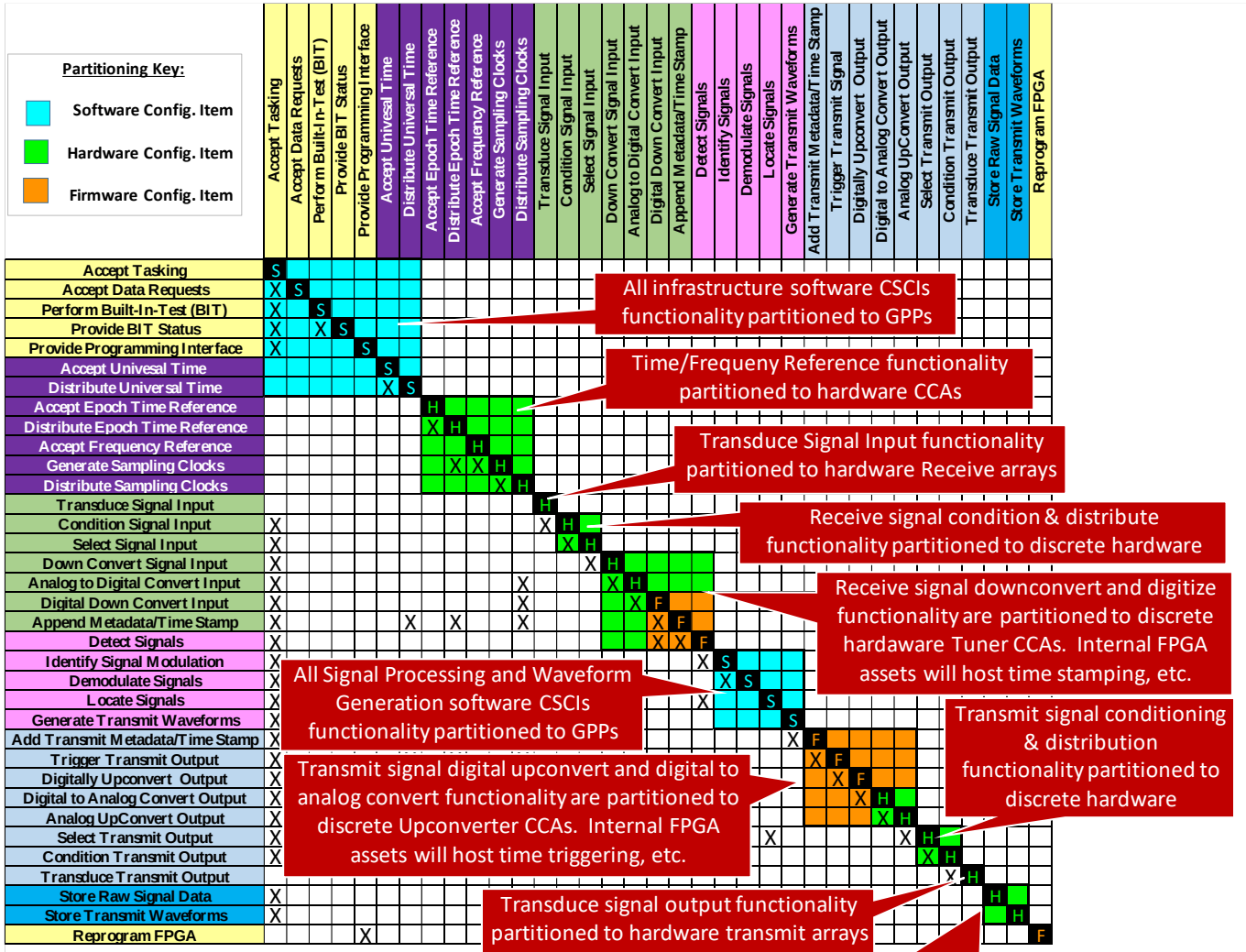
5. Perform Partitioning of Functionality

- Partitioning groups aggregated functions into a specific system element(s) and ultimately defines the modularity of a system [11], [12]
  - The thinking behind this step is often missed!!!
- Partitioning is determined based on:
  - Heuristics
  - CONOPs
  - Make/buy decisions
  - Top Level Requirements
  - State of COTS technologies/State of internal technologies/Leverage
  - Alignment with Open Standards
  - Architecture Trades/Analysis
  - Modular Open System Approach (MOSA) [13]

The System Architect works with SMEs to ensure an optimal system concept is defined

Partitioned Functionality – Case 1 Large SDR System

- Case 1 – Large SDR system
  - High Rx Sensitivity
  - Rx Arrays
  - Multiple Receive Channels
  - Multiple Receive Bands
  - N-Channel DF
  - Multiple Transmit Channels
  - Multiple Transmit Bands
  - Tx Arrays
  - Large Tx ERP
  - Significant RF distribution, compensation, calibration RF power detection, etc.

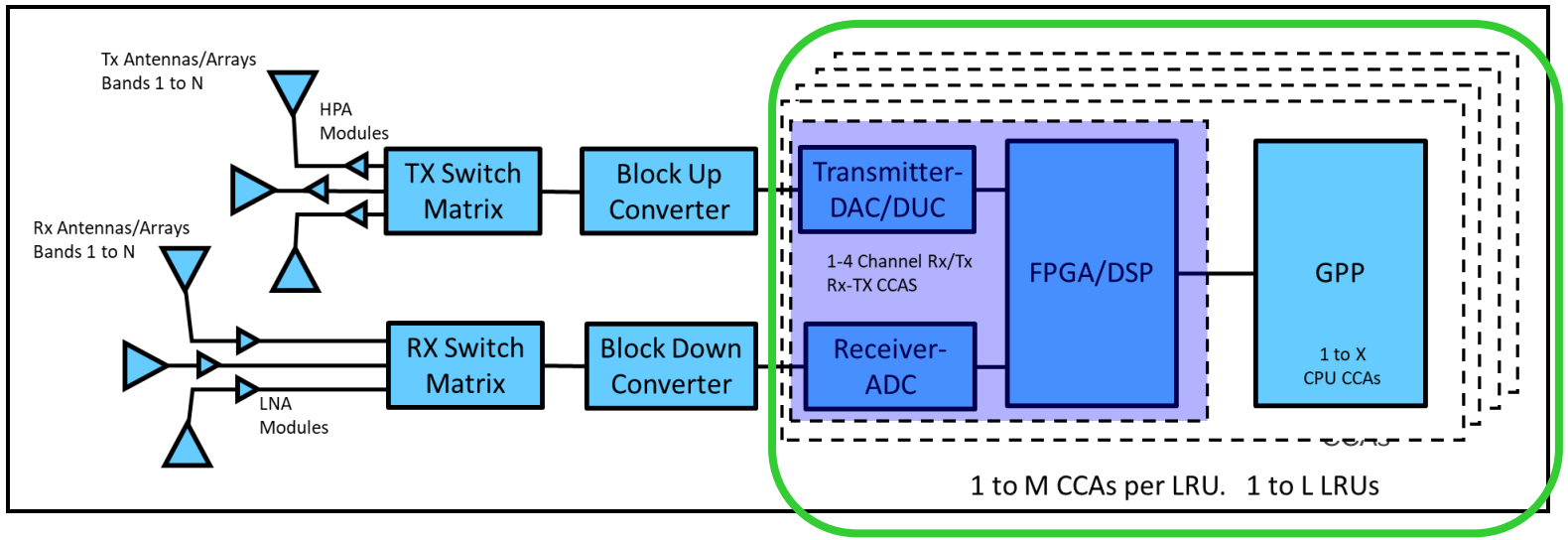


CCA = Circuit Card Assembly
CSCI - Computer Software Configuration Item
GPP = General Purpose Processors
COTS = Commercial Off-The-Shelf

Modularity at the Box and Card Level

Use of several open standards

Case 1 Large SDR System (Cont.)




BAE SYSTEMS

SYS6315 SIGINT Sensor
Eclipse SIGINT Products

The SYS6315 is a 4U, 19-inch rack mount ultra-wideband Signals Intelligence (SIGINT) sensor.

Part of a family of software-defined radios, the SYS6315 provides 15 OpenVPX slots for Radio Frequency (RF) receivers and processing cards housed within a 19-inch rack mount, air-cooled chassis. The front loaded card cage allows for easy maintenance without removing the chassis from the rack. A nominal configuration includes 14 RF channels with 80 MHz of instantaneous bandwidth, three single board computers, and two graphic processing units. All cards are conduction cooled.

Key features and benefits

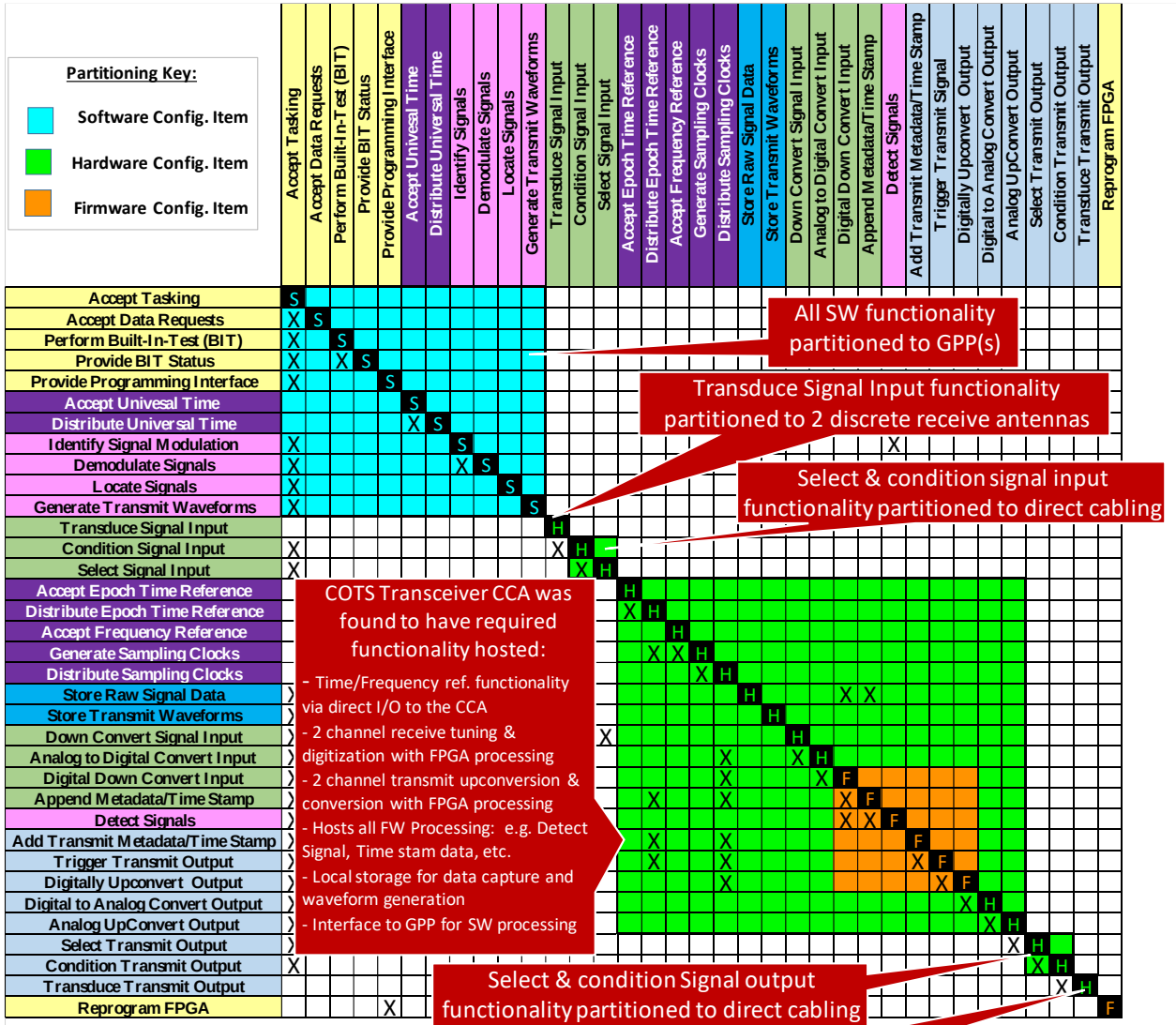
- Modular, open system architecture complies with VITA-46, -48, -49 and -67 standards, enabling interoperability among platforms and systems
- 14 independent 80 MHz RF channels for:
  - Independent operation for staring or scanning with up to 1,120 MHz of instantaneous bandwidth
  - Grouped for up to eight phase coherent RF channels to support direction finding
- Three single board computers with third generation Intel® Core™ i7 processors and high-speed PCIe connections
- Optional two graphic processing units providing 640 cores of NVIDIA® Maxwell™ graphics processing power
- Hosts a software baseline built on open architecture principles that supports emerging standards such as REDHAWK, TOA, OMS, SOSA, JICD 4.2, and VITA-49

www.baesystems.com

Architecture is scalable and can GROW to include the required number of Rx and Tx LRUs

Partitioned Funct. – Case 2 Small (UAV) SDR System

- Case 2 – Small UAV SDR System
  - Less sensitivity
  - One Receive Channel
  - One Rx Antenna
  - One Transmit Channel
  - One TX antenna
  - Less ERP
  - Direct RF Cabling

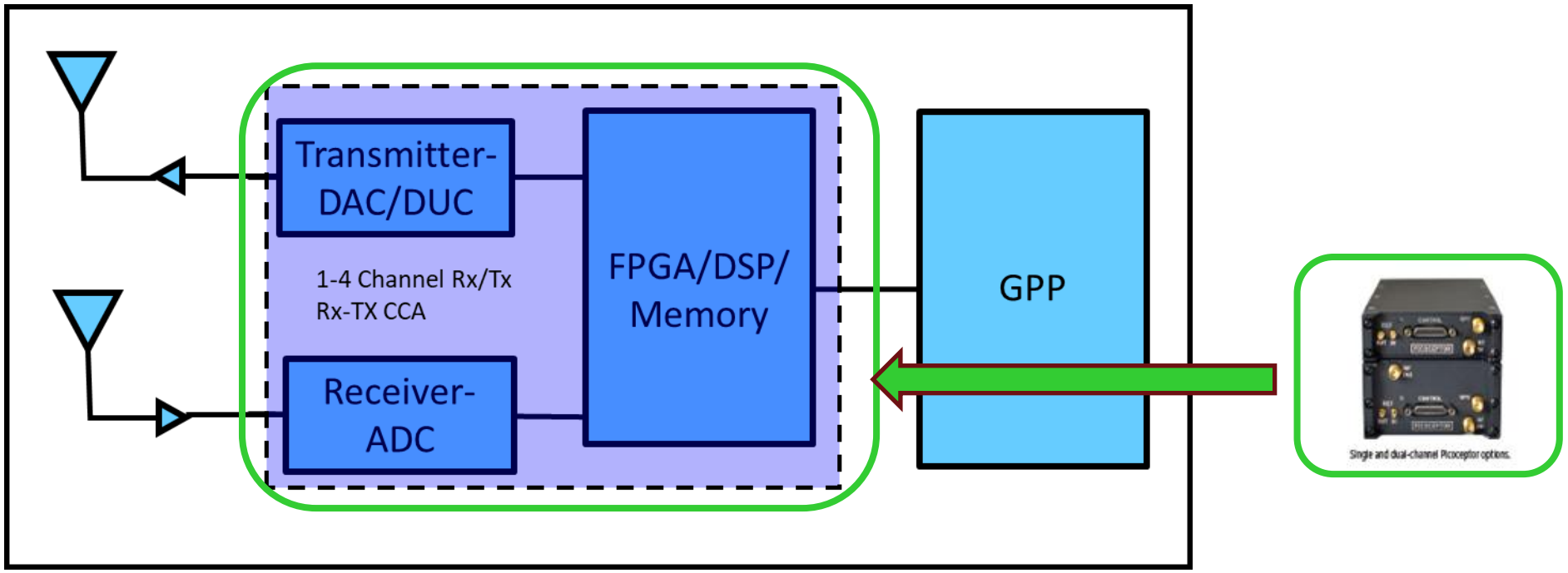


CCA = Circuit Card Assembly
CSCI - Computer Software Configuration Item
GPP = General Purpose Processors
COTS = Commercial Off-The-Shelf

Modularity at the Brick

Use of some open standards

Case 2 Small UAV SDR (Cont.)



Architecture is scalable and can SHRINK to a low SWaP Transceiver with all Functionality

DSM Conclusions

- A 5-step architecture development approach was shown using functional (static) DSMs
  - The resulting architecture was optimized for modularity with high cohesion and low coupling between partitioned functionality
- The functional DSM approach had the advantage of:
  - Reinforcing key steps in the architectural process
  - Easily determining the complex interdependencies between functions
  - Performing iterative allocation, aggregation and partitioning (optimizes system modularity)
  - The ability to easily develop and assess alternative architectures/scale during partitioning
- The DSM derived architecture outputs (configuration items and interfaces) can be analyzed using the MOSA Key Open Sub-System (KOSS) tool (see paper) [14]
  - Led to further definition of the modularity required to reduce system cost and facilitate capability insertion over the system lifecycle (iterate with DSM archiitecture.
  - Shows alignment with the 5 MOSA Principles

Static DSMs provide a non-model based approach for performing/teaching system architecture



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hybrid event

Detroit, MI, USA
June 25 - 30, 2022

www.incose.org/symp2022

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[2] Madni, AM 2014, 'Generating novel options during system architecting: psychological principles, systems thinking, and computer-based aiding', *Systems Engineering*, vol. 17, no. 1, pp. 1-9.

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34th Annual INCOSE international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024



Integration between Program Management & Systems Engineering

Co-Chairs of PM-SE Integration WG:

Dr. Tina P. Srivastava (MIT Lecturer & Co-Founder of Badge Inc.)

John Lomax (Airbus, ESEP)

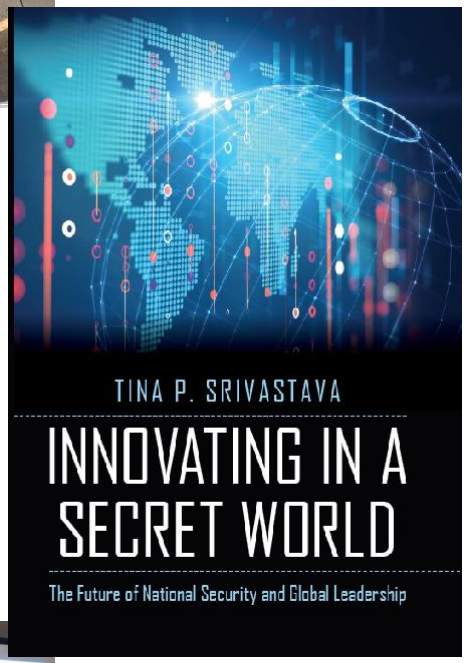
PM-SE Integration WG Co-chair

Dr. Tina Srivastava

tinaps@alum.mit.edu



- MIT Aeronautics and Astronautics Engineering
- S.B., M.S., PhD from MIT
- Former Chief Engineer, Raytheon, Electronic Warfare
- Co-Founder of MIT security company, Badge Inc.
- Author of *Innovating in a Secret World*
- MIT Lecturer: Pilot, Aerodynamics, 16.687
- Previously served on INCOSE Board of Directors, Officer





PM-SE Integration WG Co-chair



John Lomax
john.lomax@airbus.com

- Certified ESEP
- Ex-Certification Advisory Group (CAG) Member
- Systems Engineer with over 30 years of experience at Airbus Defence and Space
- Location: U.K.





Source: Minerva Studio

Source: Zurijeta

EXERCISE:

"Who Has the Responsibility?"

EXERCISE:

"Who Has the Responsibility?"

Technical Requirements?



Project Manager



Systems Engineer

EXERCISE:

"Who Has the Responsibility?"

"I'm in charge of technical requirements!"

Managing the Program's Budget?



Project Manager

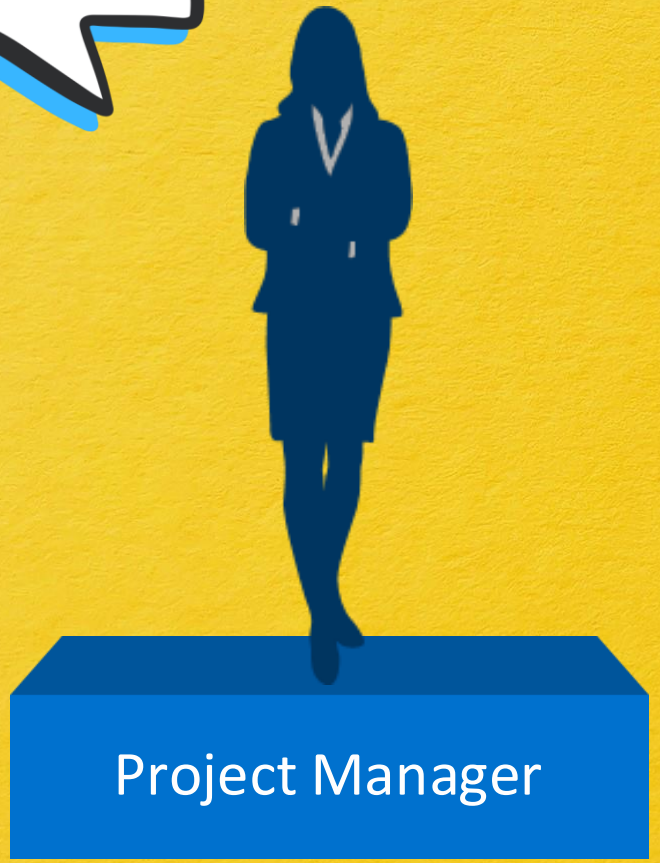


Systems Engineer

EXERCISE:

"Who Has the Responsibility?"

"I manage the project's budget!"



Project Manager



Systems Engineer

Responsibilities:

- Technical Requirements

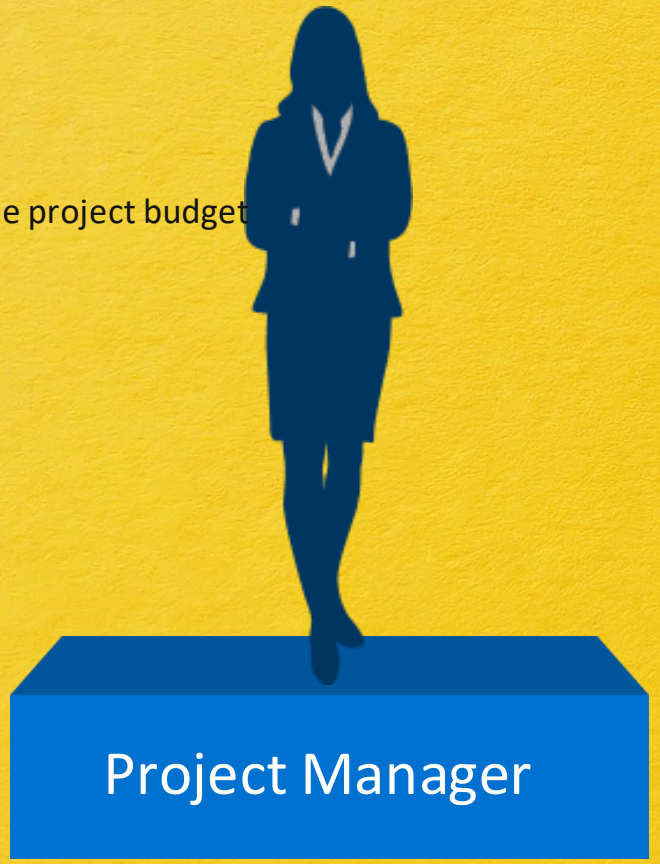
EXERCISE:

"Who Has the Responsibility?"

Life Cycle Planning?

Responsibilities:

- Managing the project budget



Project Manager



Systems Engineer

Responsibilities:

- Technical Requirements

EXERCISE:

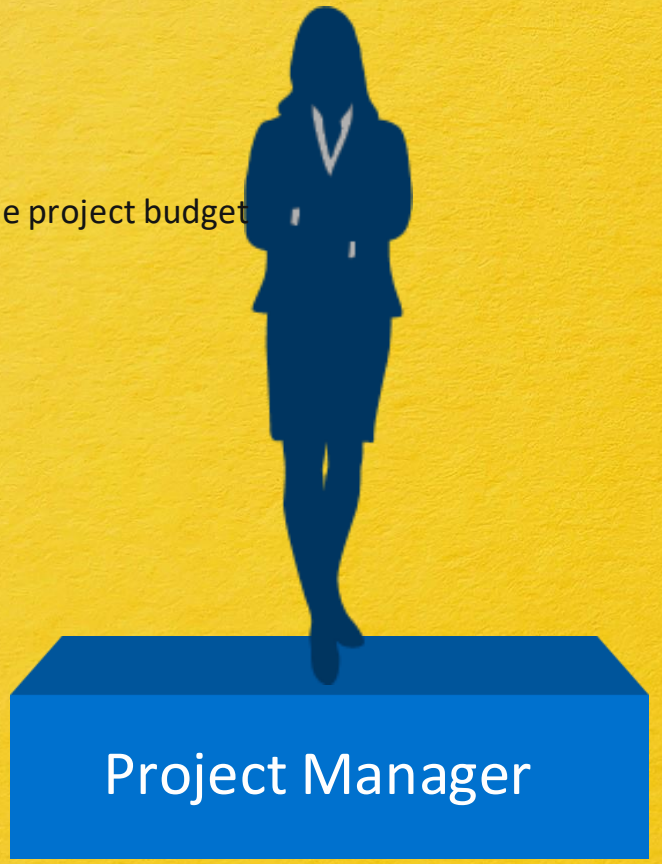
"Who Has the Responsibility?"

Life Cycle Planning?

External Supplier Relations?

Responsibilities:

- Managing the project budget



Project Manager



Systems Engineer

Responsibilities:

- Technical Requirements

EXERCISE:

"Who Has the Responsibility?"

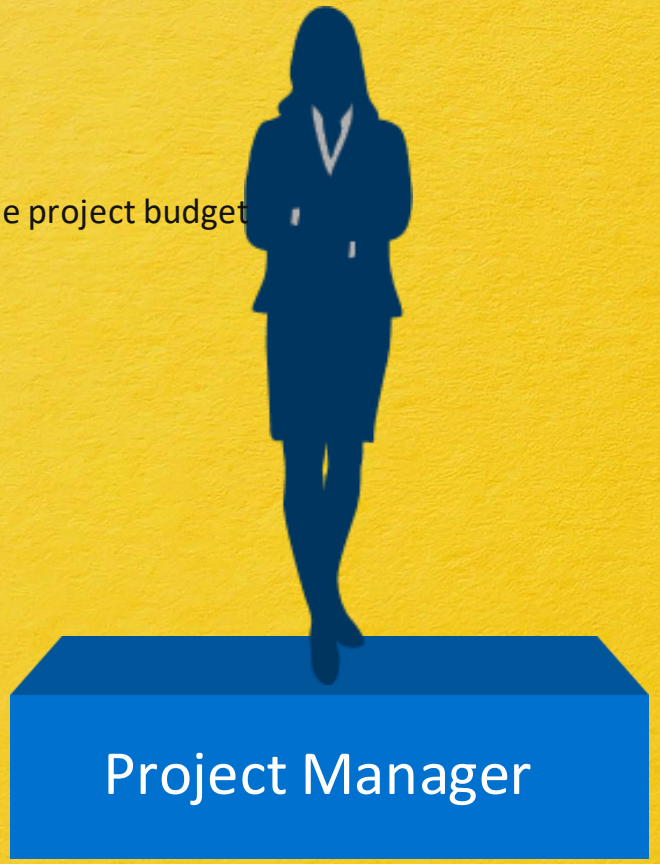
Life Cycle Planning?

External Supplier Relations?

Program/Project Risk?

Responsibilities:

- Managing the project budget



Project Manager



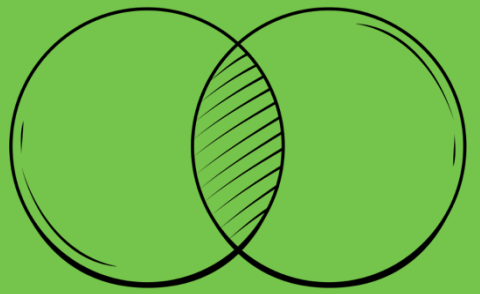
Systems Engineer

Responsibilities:

- Technical Requirements

EXERCISE:

"Who Has the Responsibility?"



Life Cycle Planning

External Supplier Relations

Program/Project Risk

Responsibilities:

- Managing the project budget



Project Manager



Responsibilities:

- Technical Requirements

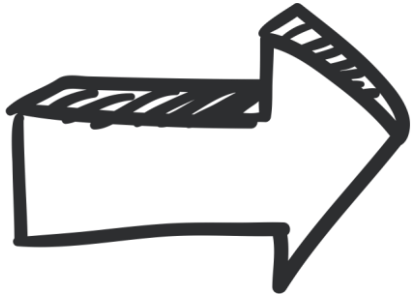
Systems Engineer

IRON TRIANGLE



HOW DO WE ACHIEVE A VISION OF INTEGRATED PROJECT MANAGEMENT AND SYSTEMS ENGINEERING?

- **Who controls scope?**
- **How do we meet budget?**
- **Who is responsible for delays?**



Successful delivery of stakeholder value requires contribution, collaboration, and cooperation across disciplines.



Source: Comstock Images



SOMETIMES:

- **THE PROJECT MANAGER IS THE TECHNICAL LEADER**
- **THE SYSTEMS ENGINEER IS THE PROJECT MANAGER**

SYSTEMS ENGINEERING VIEW:

- Systems engineering integrates all disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation.
- Systems Engineering considers both the business and technical needs of all customers with the goal of providing a quality product that meets the user needs. [1]

[1] Source: INCOSE Web Site



OVERLAPPING RESPONSIBILITIES:

THE PROJECT MANAGER VIEW

Source: Pexels

PROJECT MANAGEMENT VIEW:

- Project managers play the lead role in **planning, executing, monitoring, controlling, and closing out projects.**
- They are accountable for the entire project scope, the project team and resources, the project budget, and the success or failure of the project. [2]

[2] Source: cio.com

WHAT CAUSES THE TENSION?

- **Conflicting practices between the two roles**
  - **+ Focus on achieving objectives defined by discipline**
- **Not valuing the other role**
- **Lack of planning for the integration of roles**
- **Roles and responsibilities not clear or respected**
- **Who works for who?**
- **Not having clearly defined authority**
- **Failing to communicate a common set of objectives and vision**
- **Unclear communication**



How Do We Manage Unproductive Tension?

Source: FatCamera/Getty Images Signature

TANGIBLE EFFECTS OF UNPRODUCTIVE TENSION



Source:https://project-management.com/how-to-avoid-project-failure-effective-scheduling



Source: LawrenceSawyer/Getty Images Signature



Source: gregory_lee/Getty Images Pro

INTEGRATING THE ROLES

The Team Recognizes their Shared Objectives

The Team Understands the Objectives and How Each Contributes to Them

The Team Understands Each Other's Role

The Team Respects All the Roles and Their Associated Contributions

The Team Values "Collaboration" over "Competition"

PROJECT MANAGER AND SYSTEMS ENGINEER ARE DISTINCT ROLES – WITH SOME IMPORTANT OVERLAP

Project Managers (PM) **view their responsibilities as:**

- Overall Results
- Goals & Objectives
- Program & Project Risk
- External Supplier Relations
- Lifecycle Planning

Systems Engineers **view their responsibilities as:**

- Technical Requirements
- Systems Definition
- Systems Requirements
- Configuration Management

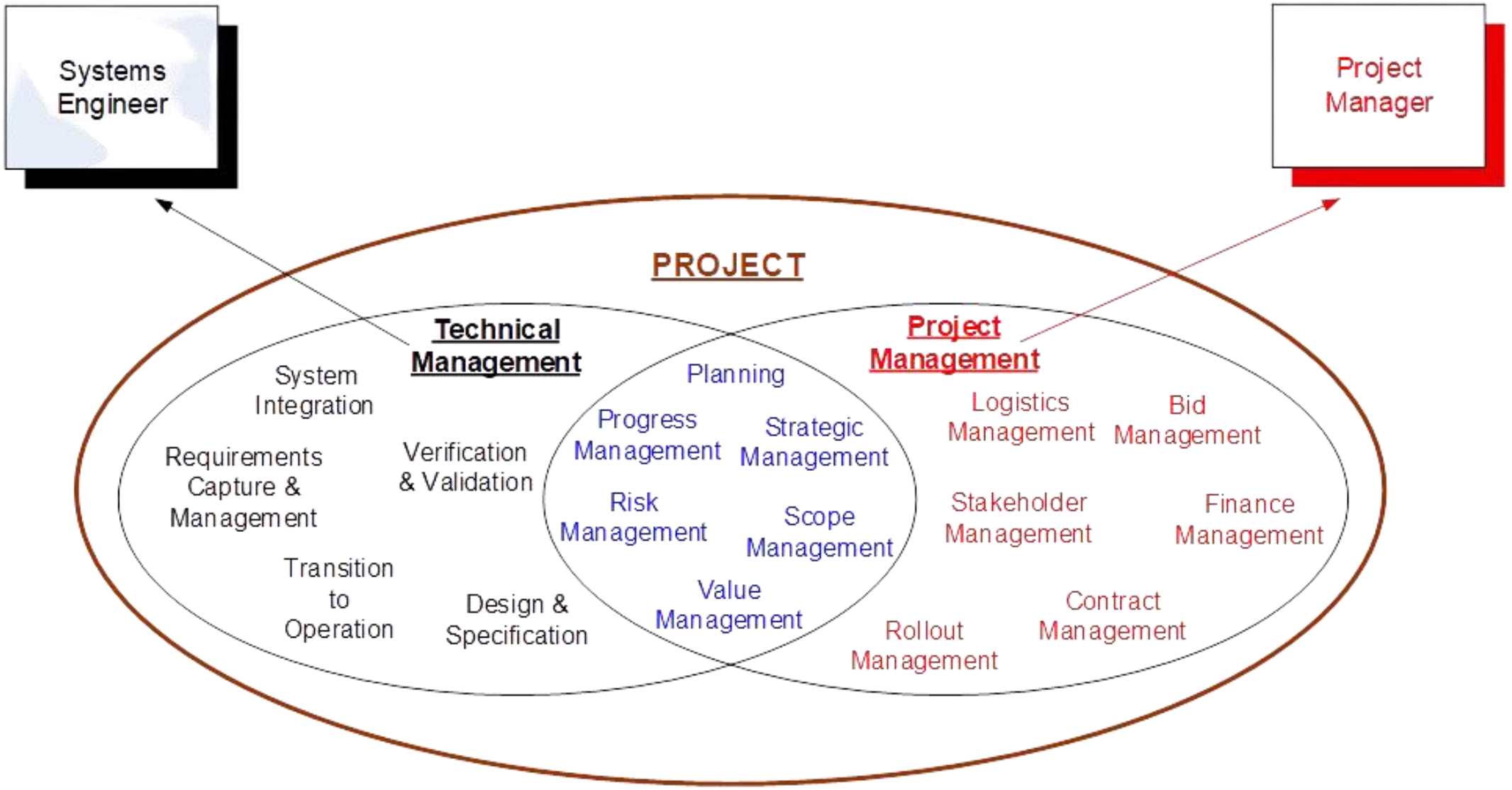
Both **roles are responsible for:**

- Program/Project Risk
- External Supplier Relations
- Quality Management
- Lifecycle Planning

The integration must clarify how

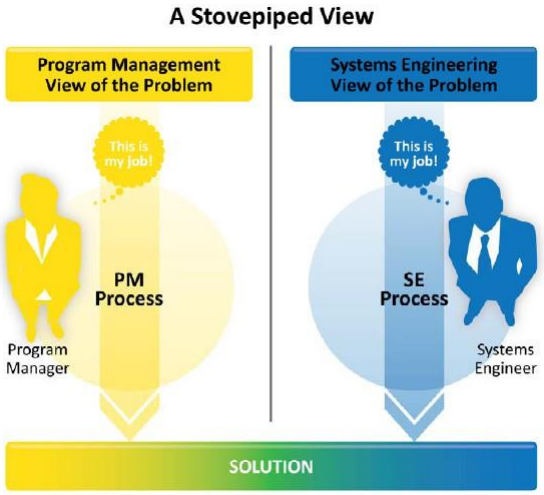
- Responsibility can be effectively shared for risk management, external suppliers, quality management and lifecycle planning; and
- Communication optimized for the other domains of responsibility.

WHAT ARE THE PM AND SE INTERSECTIONS?



Formation of the INCOSE/PMI Alliance: 2011

- 2011: Joint white paper, “Toward a New Mindset: Bridging the Gap between Program Management and Systems Engineering” published in *INSIGHT* and *PM Network*
  - Authors: PMI CEO Mark Langley| INCOSE President, Pres-Elect: Samantha Robitaille, John Thomas
- 2011: Strategic Alliance Agreement signed by INCOSE/PMI
  - Alliance was *closed* – (not open to general participation by members of PMI, INCOSE, or others)

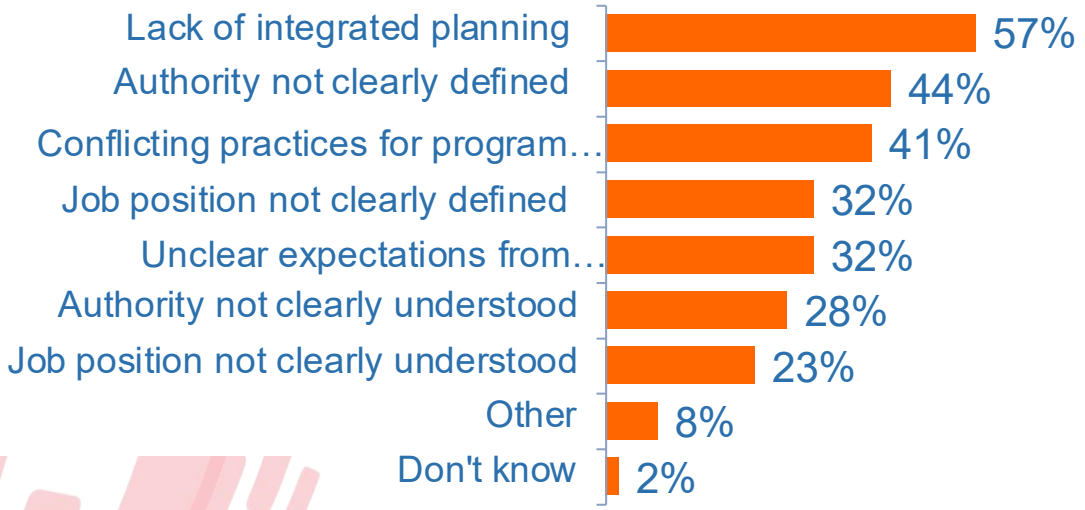


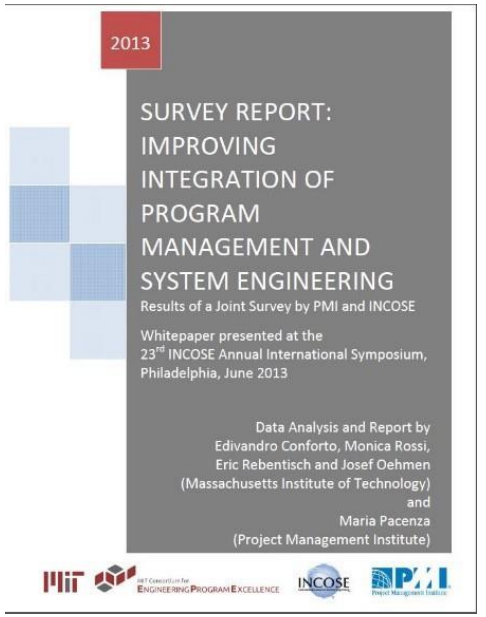


INCOSE/PMI Alliance: Joint Research

- 2012: PMI and INCOSE conducted a joint survey to better understand the roles of the **Program Manager and Chief systems Engineer** and to gauge their current level of integration.
- Massachusetts Institute of Technology (MIT) provided strategic support in analyzing, reviewing and finalizing the survey results with INCOSE and PMI

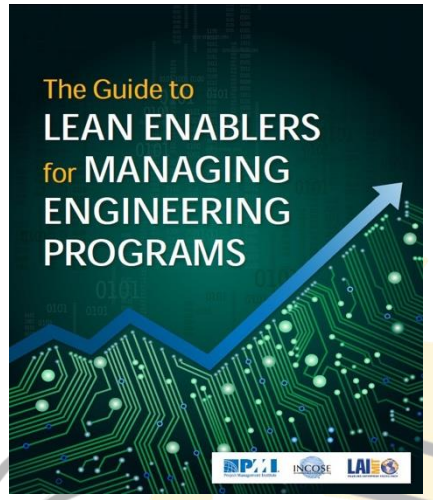
*Q23. You identified that there is **unproductive tension** that affects team or program performance. Please describe the applicable source of the tension*





INCOSE/PMI Alliance: Joint Research

– 2012: The Guide to Lean Enablers for Managing Engineering Programs



"On behalf of PMI, I congratulate the MIT-PMI-INCOSE team on their receipt of the ***Shingo Research and Professional Publication Award*** *for their work on 'The Guide to Lean Enablers for Managing Engineering Programs.* ***This team clearly demonstrated the added value that can be delivered through integrated program management and systems engineering****."*

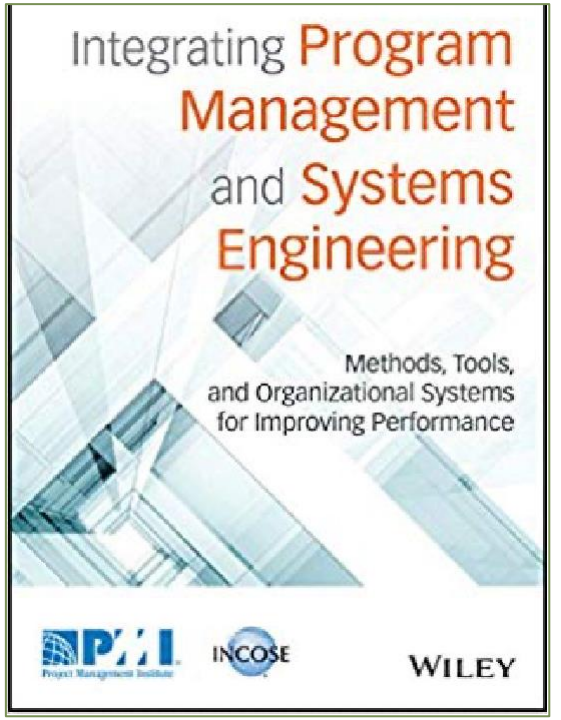
Mark A. Langley, President and CEO of PMI

INCOSE/PMI Alliance: Joint Research

- 2015-2017: INCOSE, PMI, MIT collaborated to publish a book titled: *Integrating Program Management and Systems Engineering.*
  - Book includes a **practical framework** for how to streamline project workflow, tools for assessing and deploying best practices.
  - **Case studies** detail how real-world companies have successfully implemented the framework to improve cost, schedule, and technical performance.

Book authors and editors:

- Eric S. Rebentisch
- Tina P. Srivastava
- Kenneth M. Zemrowski
- Virginia A. Greiman
- Edivandro Carlos Conforto
- Marin R. Nelson
- Stephen A. Townsend
- Eric S. Norman



The book is available for sale with an INCOSE membership discount on the **INCOSE Store**

Formation of PM-SE Integration WG

- 2016: *open* PM-SE Integration Working Group was formed
  - Co-chairs Jean-Claude Roussel, Tina Srivastava
  - Website: www.incose.org/pmse
- 2022: PM-SE Integration WG awarded INCOSE Working Group Award at IW 2022 for:
  - Collaboration with PMI
  - Contributions to the new *SE Handbook*, including new section on SE-PM, additions to sections (acquisition, portfolio management, etc.) – coordinating contributions from dozens of volunteers, members of INCOSE and PMI



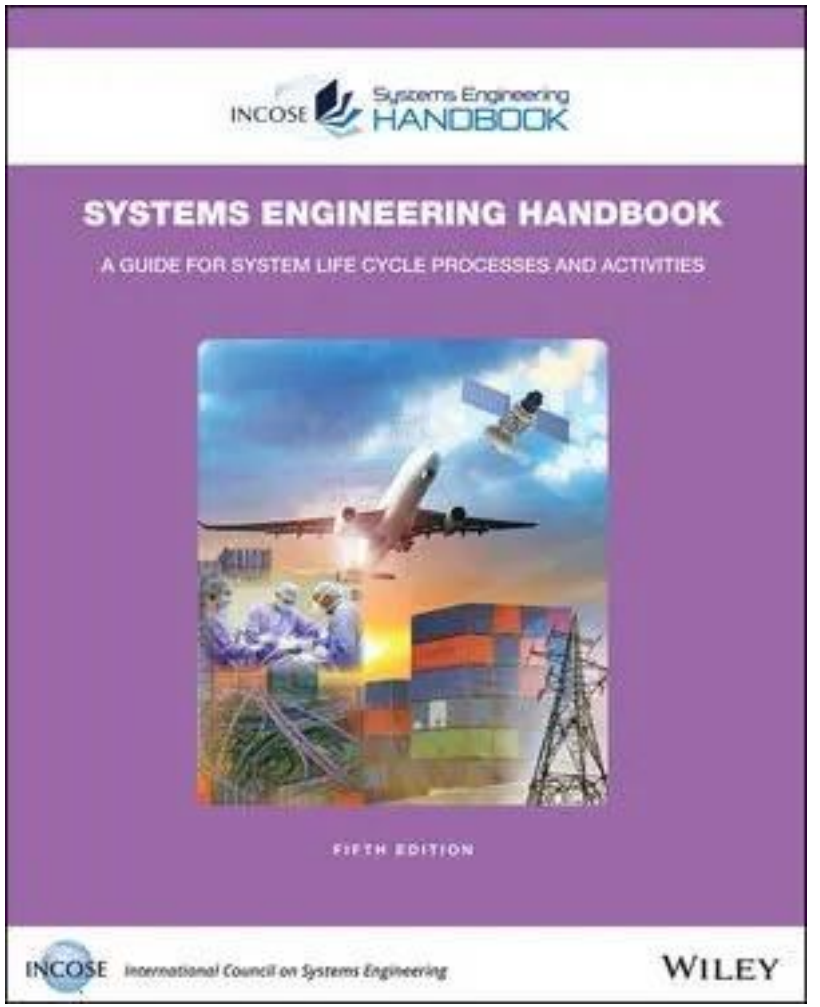
INCOSE Systems Engineering Handbook, 5th Edition

2. Agreement Processes
1. **Acquisition Process**
2. **Supply Process**

3. Organisational Enabling Process
3.3.3 Portfolio Management Process

4. Technical Management Process
1. **Project Planning Process**
2. **Project Assessment and Control Process**

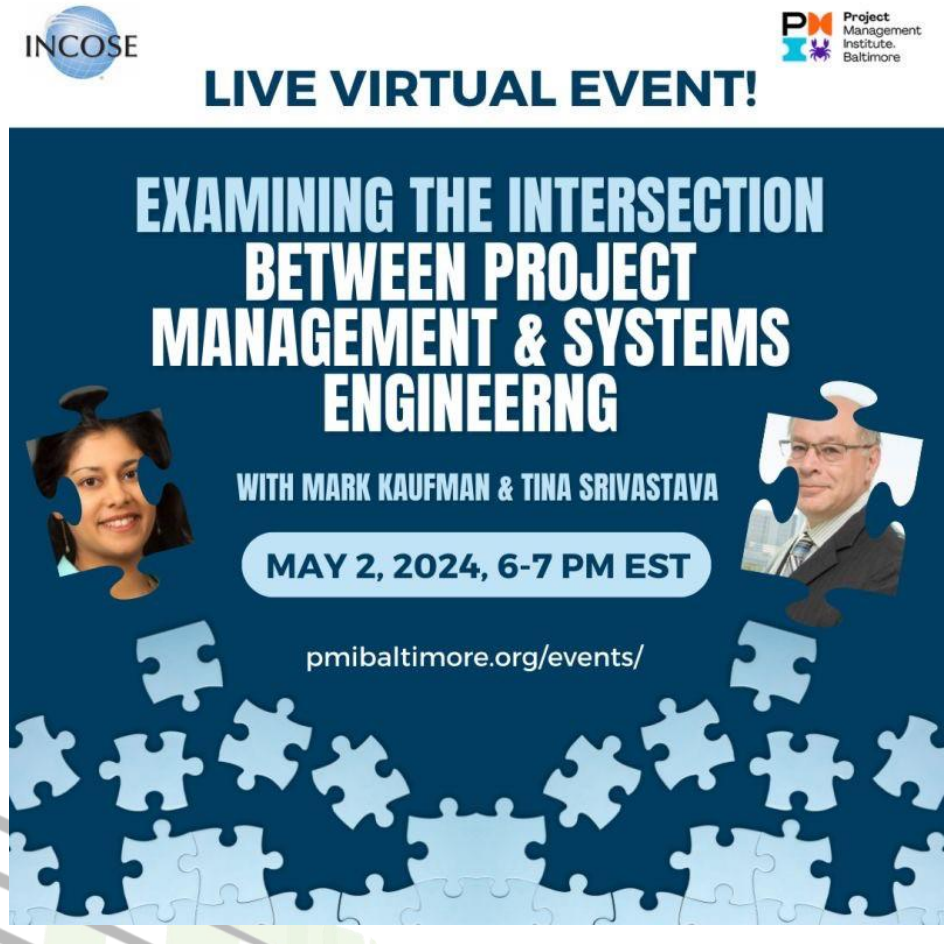
5.3 Systems Engineering Relationship with others disciplines
5.3.3 SE and Project Management (PM) – New



Recent PM-SE Activities



May 10th 2023 presentation to INCOSE WMA Chapter
Mark Kaufman and Dr. Tina P. Srivastava gave a well attended presentation to the INCOSE WMA Chapter. Our **PMI counterpart Matt Kwasiborski also participated**.



May 2, 2024 PMI Baltimore chapter hosted a live virtual event to examine the intersection between Project Management and Systems Engineering

Project Management Institute. Washington, DC

PMIWDC chapter at 2023 Professional Development Day - Dr. Tina P. Srivastava and Mark Kaufman presented at the event in **September 2023** in the Washington D.C. Metro Area. **PMI counterpart Matt Kwasiborski** attended.

INCOSE WMA
A SYSTEMS ENGINEERING ORGANIZATION

PM-SE Integration Working Group

Mission:

Identify and promote opportunities associated with the effective integration of the **Systems Engineering** and **Project/Program Management** disciplines.

- Explore the linkages necessary to create effective integration and collaboration between Systems Engineers and Program Managers.
- Be the intersection point where Systems Engineers, Program/Project Managers collaborate and integrate their efforts.
- Study the interface between Systems Engineering and Project Management domains and Tools. Especially relationship between Systems Engineering tools (MBSE, Requirement management) and tools supporting project management (scheduling, cost estimate models, portfolio management). This includes the digitalization/data models connection between the two domains.
- Support the SE Vision 2035.



Process Enablers

TechOps Domain

497

Members

2012

Established

Co-Chairs

Tina Srivastava

John Lomax

Samuel Boutin

IT Director

Molly Kovaka

pmse@incose.net

Inquiries

"Identify and promote opportunities associated with the effective integration of the Systems Engineering and Project / Program Management disciplines"

Homepage: www.INCOSE.org/pmse
Contact us: pmse@incose.net

PM-SE Integration WG

IW2024 Opening Plenary: WG Award!







2024
Annual INCOSE
international workshop
HYBRID EVENT
Torrance, CA, USA
January 27 - 30, 2024



Source: Geber86/Getty Images Signature

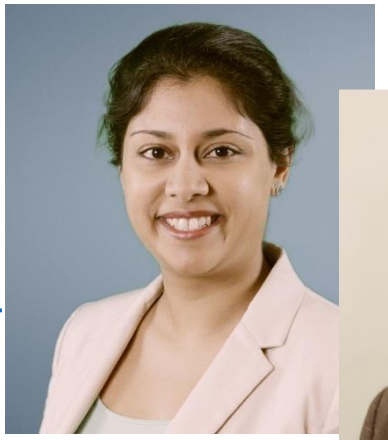
- A complex relationship exists between project managers and systems engineers
- Each discipline needs to understand their role and work together to establish boundaries
- Cooperation and collaboration lead to project success

REFERENCES

- J.W. Boswell, F.T. Anbara, and J.W. Via, “Systems Engineering and Project Management: Points of Intersection, Overlaps, and Tensions”, 2017 Portland International Conference on Management of Engineering and Technology (PICMET)
- Nelson, Marvin, “Integrating Program Management and Systems Engineering”, MIT Consortium for Engineering Program Excellence
- Rebentisch Eric (Editor) – Integrating Program Management and Systems Engineering Methods, Tools and Organizational Systems for Improving Performance
- Van Gemert, Dennis, “Systems Engineering the Project” PMI Global Congress, 2013
- INCOSE Webinar Series, “What PMI and INCOSE are doing to advance the Future of PM-SE Integration”, April 2021
- Srivastava, Tina; Kaufman, Mark. “Tensions and Opportunities: Program Management and Systems Engineering.” INCOSE International Symposium. July 2023

PM-SE Integration WG
Leadership

- Co-Chairs
  - Tina Srivastava (tinaps@alum.mit.edu)
  - Samuel Boutin (samuel.boutin@normalesup.com
  - John Lomax (john.lomax@airbus.com)





- Leadership Team
  - Steven Dam (steven.dam@specinnovations.com)
  - Mark Kaufman (mkaufman@mitre.org)
  - Tammy Tober (ttober@mitre.org)







34th Annual INCOSE international symposium

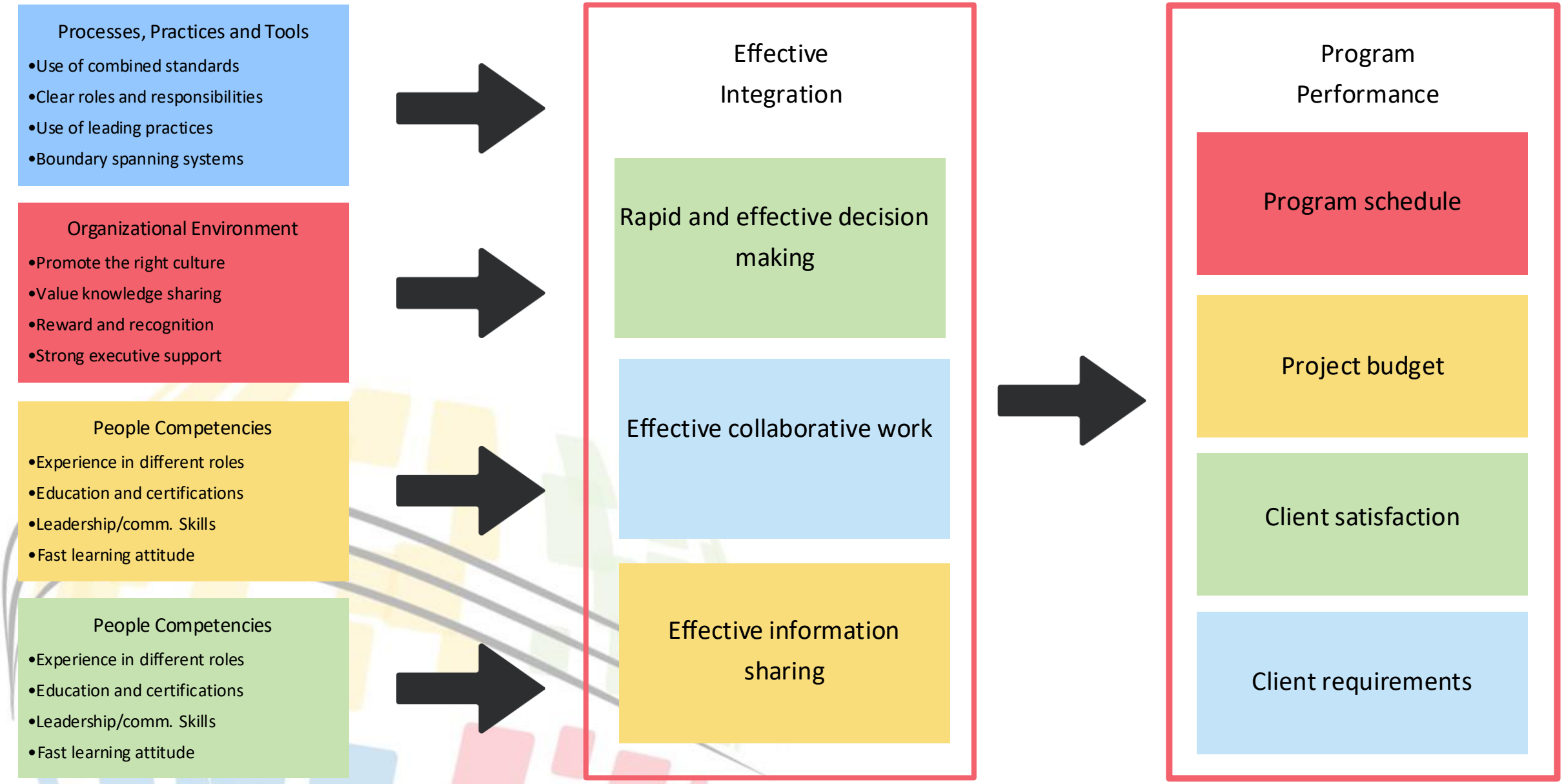
hybrid event

Dublin, Ireland
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www.incose.org/symp2024

#INCOSEIS

MOVING TOWARDS EFFECTIVE PM/SE INTEGRATION



Source: Rebentisch et al

PUTTING THIS INTO PRACTICE



Processes, Practices, and Tools

- Enable communication and common understanding
- Define specific work activities
- Establish expectations for each person
- Coordinate and tack work efforts
- ID critical points where work efforts come together
- Facilitate problem identification and resolution
- Best practices



Organizational Environment

- Establish positive culture
- Grace and respect
- Narrow the cultural divide between PM and SE
- Team building
- Develop respect for views and opinions across disciplines
- Establish working relationship between PM and SE management
- Build trust between executives and project team



Integration Competencies in Staff Members

- Develop standard role definitions and communicate
- Develop integration competencies and teaming behaviors on project staff
- Manage integration competencies in the workforce at individual and organizational level

PUTTING THIS INTO PRACTICE



Contextual Factors

- **Tailor management approach to project realities**
- **Develop and own project culture to influence behavior throughout the project life cycle**
- **Stakeholder and team alignment**
- **One view of the project**
- **Transparency**
- **Engagement - Community**



Integration as Organization Characteristic

- **Combine PM and SE practices, tools and techniques**
- **Establish culture to meet common objectives**



Program Performance

- **Higher integration yields better cost and schedule metrics**
- **More predictable outcomes**
- **More resilience to schedule pressures**

PM I SE Working Group

INCOSE

INCOSE IS 2026
June 13, 2026 – June 18, 2026
Pacifico Yokohama Conference Center

PM-SE Integration Working Group

Harmonizing Systems Integration and Program Management

Wednesday, June 17, 2026
3:00 PM Japan Standard Time



Frank Waldman



Tikajit Rai, PhD

PM-SE IWG: Harmonizing Systems Integration and Program Management

PMI SE Working Group

- Overview of the PM-SE IWG jointly led by INCOSE, PMI, the local chapters, and DSM
- Explore the System Architectures Integration Lab (SAIL) approach to successfully integrating DSM within your organization's technology ecosystem

Time	Topic	Presenters
3:00PM – 3:05 PM	PM-SE IWG introduction and updates	Tika Rai
3:05 PM – 3:30 PM	SAIL Approach for Integration	Frank Waldman
3:30 PM – 3:40 PM	Program Managing the Integration	Tika Rai
3:40 PM – 3:45 PM	Q&A, Closeout with the Upcoming events info, and Takeaway actions	Tika Rai

Frank Waldman (SAIL team member, CodeClinic)
Tika Rai, PhD (PM-SE IWG, INCOSE WMA)

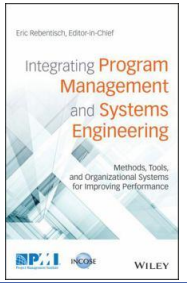
PM-SE IWG: Harmonizing Systems Integration and Program Management

PMI SE Working Group

PM-SE IWG Background

- 2012: PMI and INCOSE conducted joint survey
- 2016: PM-SE IWG launched during the INCOSE IS
- 2021: INCOSE and PMI Local level chapters around Washington DC, US, signs a Charter
- 2025 - 2026:
  - PMIWDC kicks off CoPs in Systems Thinking in PM, and PM-SE Collaboration
  - INCOSE IS hosts 'Empowering SEs and PMs: Unlocking the Potential of DSMs" webinar
  - DSM joins the IWG and the steering committee is formed
  - Two phase project in-progress



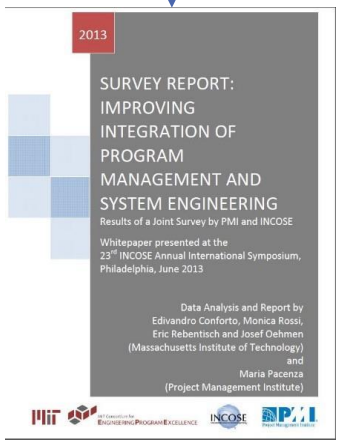




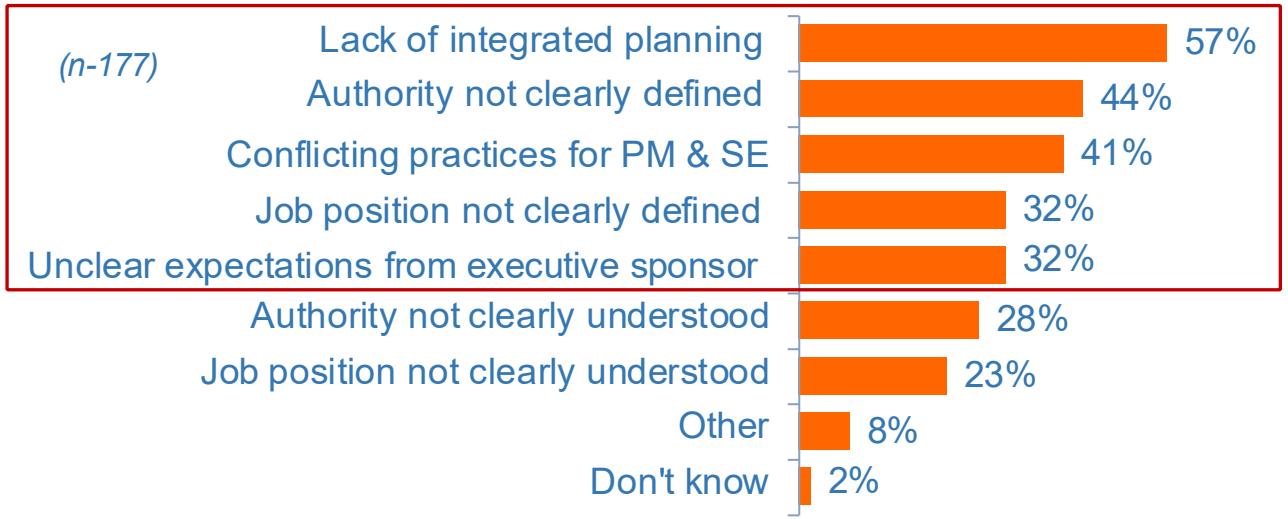
INCOSE/PMI Alliance: Joint Research

PMI SE Working Group

- 2012: PMI and INCOSE joint survey result
- Massachusetts Institute of Technology (MIT) provided strategic support in analyzing, reviewing and finalizing the survey results with INCOSE and PMI



Lack of integrated planning is the main source of tension

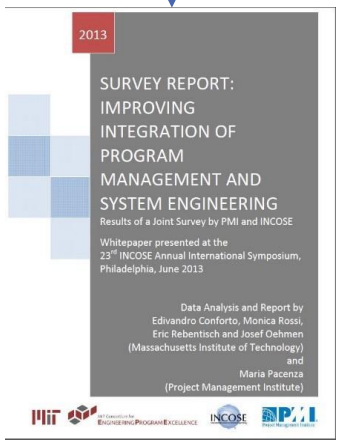


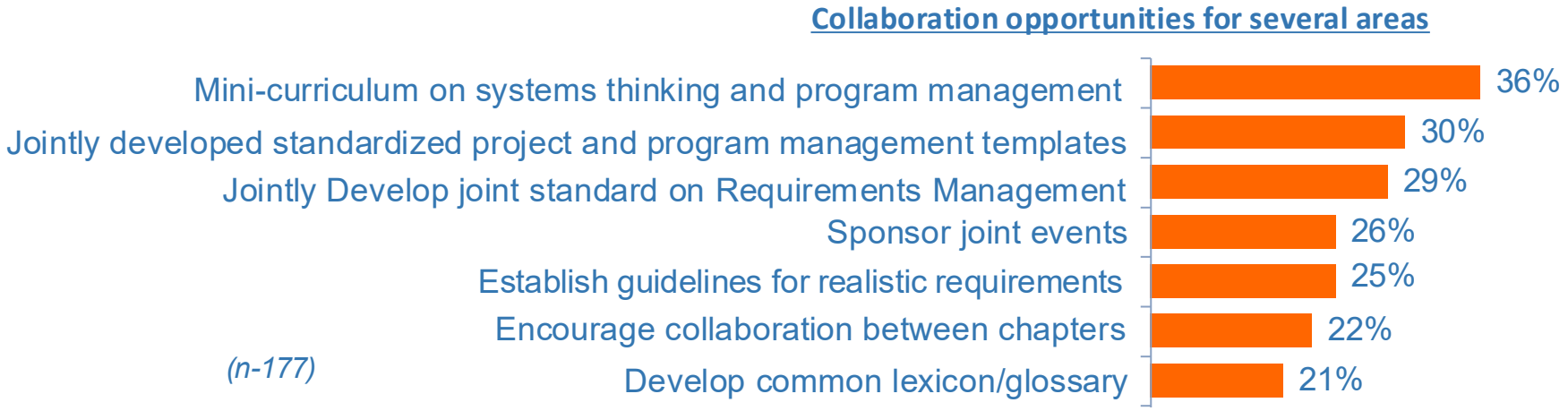
- *x□□↓…□oMathctrlProMathParatrmcmcsborderBoxaccf*
- *About 20% indicate no unproductive tension.*

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- *About 30% of respondents indicate some or significant unproductive tension.*
- *About 20% indicate no unproductive tension.*

Distinct Roles of PM and SE – with Some Important Overlaps

PM I SE Working Group

Project Managers' **view their responsibilities as:**	Systems Engineers' **view their responsibilities as:**	Both **roles are responsible for:**
• Overall Results • Goals & Objectives • Program & Project Risk • External Supplier Relations • Lifecycle Planning	• Technical Requirements • Systems Definition • Systems Requirements • Configuration Management	• Program/Project Risk • External Supplier Relations • Quality Management • Lifecycle Planning

- The **integration** must clarify how the responsibilities can be effectively shared for:
  - Risk management
  - External suppliers
  - Quality management
  - Lifecycle planning
- **Communication** optimized for the other domains of responsibility



Integration between Program Management & Systems Engineering

Co-Chairs of PM-SE Integration WG:

Dr. Tina P. Srivastava (MIT Lecturer & Co-Founder of Badge Inc.)
John Lomax (Airbus, ESEP)

PM-SE IWG: Harmonizing Systems Integration and Program Management

PM I SE Working Group

- **Formalizing** the full **Integration** is key
  - Better **integrating program management and SE** significantly lowers unproductive tension
  - **Fully integrated organizations** show **almost no or only minimal unproductive tension**
- **IWG's deliverables:** Jointly developed common Language, Process, and Templates
- Systems Architecture Integration LAB (SAIL) contributes to IWG's deliverables: Developing common Language, Process, and Templates



*S*ystem

*A*rchitectures

*I*ntegration

*L*ab



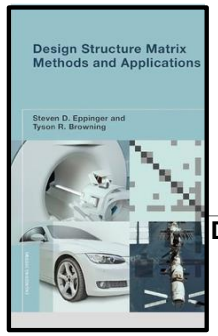
..a mobile lab for industry staff to experience the benefits of an integrated environment.

…the motivation
…the process
…the development
…the webinar
…the lab



NASA’s Artemis II crew captured this view of Earth setting on April 6, 2026, as they flew around the Moon.

…the motivation



DSM Methods & Applications 2012



'Is Integration part of SE?' AISE Webinar 2023



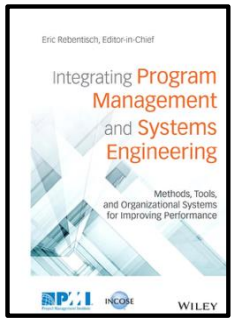
"Integrating systems across multiple domains"

27th International DSM Conference Sep 24-26, 2025

System Architectures Integration Lab(s) (SAIL)

2026

Target Audience
- Product Development
  - Project / Program Management
  - Engineering
- Production Phase
  - Industrial Engineers
  - Manufacturing Engineers



Integrating Program Management and Systems Engineering 2017

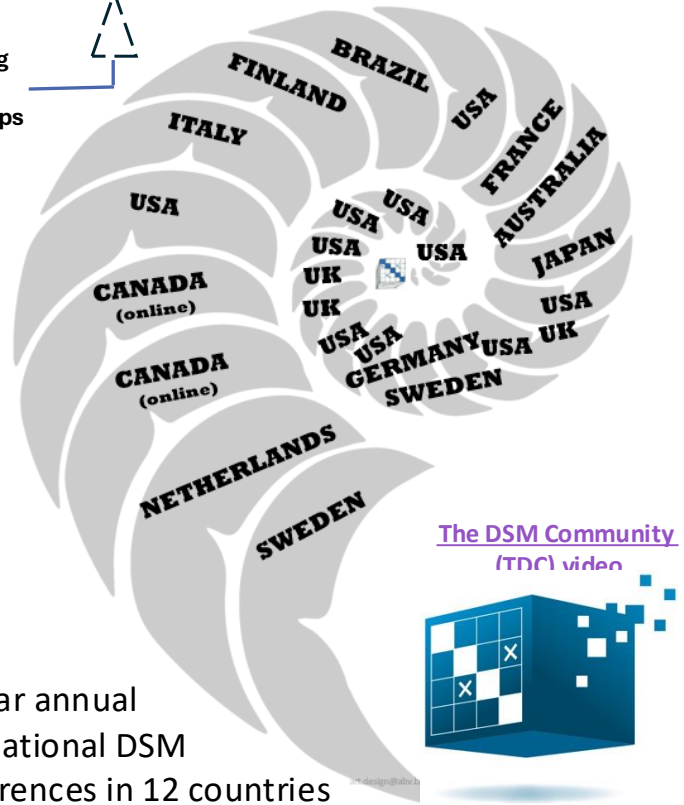
'Empowering PM &SE with DSM' March 19th Webinar 2025

Ongoing Sprint Workshops



At a 90-min March 19th, 2025 webinar (summarized on page 54 - 2025 Second Quarter INCOSE Newsletter) where 900 registered, and 400 attended, a question was asked from this group of professionals representing the PMI (Project Management Institute), DSM (Design Structure Matrix), and INCOSE (International Council On Systems Engineering) communities.

"Is there a lab environment where professionals can learn how to use this technology?"



The DSM Community (TDC) video

27-year annual International DSM Conferences in 12 countries thus far.

INTEGRATION Environment

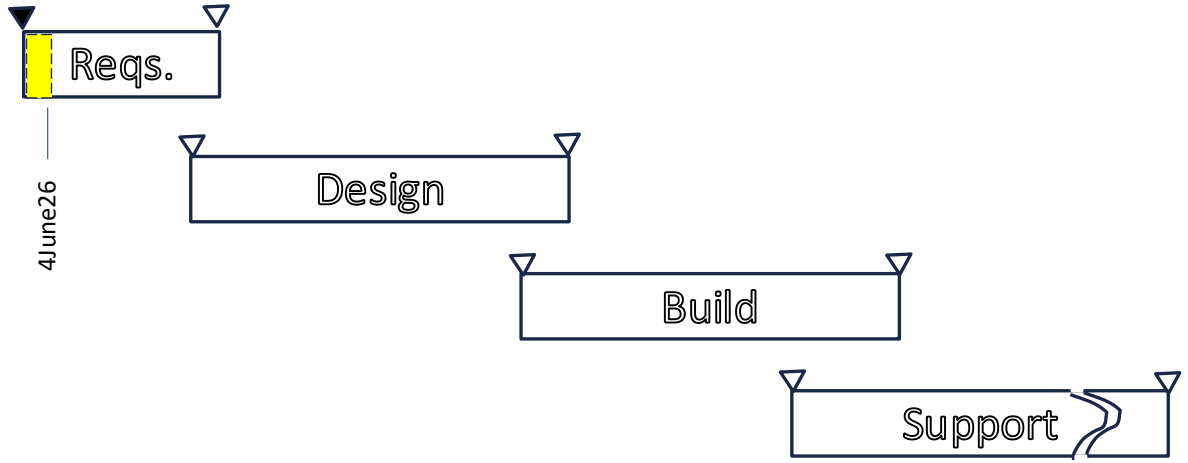


SAIL Lab Development Status – 17June26

A small fleet of 'Work' surface / submarine ships, and spaceships, with strategically located Port Stations

Objectives

Create a mobile environment where business professionals can experience all facets of the integration of product, process and people architectures in complex systems, to realize improved business metrics (technical, cost, schedule, cycles)



Accomplishments

- INCOSE IS 2026 acceptance of MDM presentation
- SAIL Workshop proposal to Montreal PMI
- Formation of Enhanced PM-SE Integration Steering Group
- Plan for DSM input to SEBoK
- Developing SAIL proposal for New England INCOSE
- Developed SAIL@Work Webinar Flyer & Intro
- Initiated discussions with 12 – country startup group

Help Needed

- Promotion of SAIL initiative to INCOSE
- Promotion of SAIL initiative to PMI
- **Industry case for national SAIL@Work webinars**
- Promotion of SAIL to 12-country startup group

….the Webinar

System Architectures Integration Lab (SAIL)
http://tbd/

PMI SE Working Group

Draft

SAIL@Work!

'PM-SE Integration' Regional Webinars
2026, Fridays @ 11am

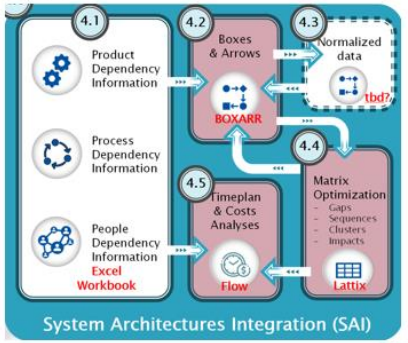
Draft

Are you in business and wondering about increasing complexity?

Participate in a 60 mins webinar on technology and experiences for you to consider adding to your existing management toolkit.



#11:00am - Introduction : Matt P.
#11:05am - Situation : Tina S.
#11:10am - Vision : Tika R.
#11:15am - SAI Process : Matt P.
#11:20am - SAI Demo in Sandbox : Mike S. / Ian P. / Frank W. / Paul W.
#11:35am - Risks and Benefits : Don H.
#11:40am - Resources : Mike S.
#11:45am - Q&A : Matt P.
#Noon - Close : Matt P.



This webinar is a precursor to formal on-site workshops.

Register for Webinar

Rev. 4 June, 2026

Mike & @ Matt dsmpsi.com

System Architectures Integration Lab (SAIL)
http://tbd/

PMI SE Working Group

Draft

SAI sandbox process

Draft

INTEGRATOR (Excel, BOXARR, Lattix):

IG1. Collect architecture information (product, process, people).
IG2. Perform initial assemblies
IG3. Review assemblies with stakeholders
IG4. Update assemblies
IG5. Analyze assemblies (Sequence, Cluster, Gap, Impact)
IG6. Review and update as required
IG7. Export to CONDUCTOR toolkit
- Dependency Structures
- Quantitative Properties (durations, costs, cycles, etc.)

CONDUCTOR (Flow and other management tools):

CN1. Assign quantitative properties to assembly
CN2. Analyze for management metrics
CN3. Review and baseline plan
CN4. Manage execution of plan
CN5. Facilitate closure of plan

Rev. 4 June, 2026

Mike & @ Matt dsmpsi.com

WORK SHIPS - SUBMERSIBLE CATAMARAN

Nuclear Fusion Powered

8 Ships in Fleet

Week-long excursions

6 Craft Stations

4 Sports Areas

4 Sports Areas

Conference Rooms



SPACE SHIPS - ORBITING VESSEL

Nuclear Fusion Powered

Flying between 8 Stations

Social Areas

Complex System Challenges





FUTURE FLEET FOR SYSTEM CHALLENGES & SKILL BUILDING

PM-SE IWG: Harmonizing Systems Integration and Program Management

PM I SE Working Group

- **Use case:** United States Department of Defense (DoD) Integrated Baseline Review (IRB)
- Few recurring reasons why the IRB crumbles during the 90-day review
  - Outdated Work Breakdown Structures (WBS)
  - Unrealistic Integrated Master Schedules (IMS)
  - Immature Planning
  - Mismatch between Integrated Master Plan (IMP) and IMS
  - Disconnect Between Veto and Approval

PM-SE IWG: Harmonizing Systems Integration and Program Management

PM I SE Working Group

- **The SAI capabilities**
  - Assist you in planning engineering design that considers the interdisciplinary and iterative nature of the process
  - Reduce the risk to equip you with a compromised design process containing inevitable cycles of rework
  - Minimize the associated time and cost penalties in both design and production
  - Risk identification
  - Identifies co-ordination requirements and changes to design practices in achieving co-ordination
- **The CONDUCTOR**
  - Program Manager's role
  - System Engineer's role
  - Formalizing the Integration of PM-SE roles

CONDUCTOR (Flow and other management tools):

CN1. Assign quantitative properties to assembly
CN2. Analyze for management metrics
CN3. Review and baseline plan
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Mark Your Calendar

28th International DSM Conference: September 29 - October 1, Milan, Italy

- Enhanced PM-SE IWG session

PMIWDC Conference: October 2-3, Washington DC, US

- Enhanced PM-SE IWG panel discussion

PMI Global Summit: October 21-24, Michigan, US

IPMA-USA PM Forward Conference: C



Mark Your Calendar



[28th International DSM Conference]
- Enhanced PM-SE IWG session



[PMIWDC Conference]: October 2-3, Washington DC, US
- Enhanced PM-SE IWG panel discussion



[PMI Global Summit]



[IPMA-USA PM Forward Conference]: October 15, Virtual, US
- Systems Thinking in Project and Program Management

Q&A



Presenters:
Frank Waldman: frank.waldman@lattix.com
Tikajit Rai, PhD: tikajit.rai@incose.net

Appendix A: PM-SE IWG Timeline

PMI SE Working Group

2011

- **A strategic alliance formed between INCOSE and PMI**
- A joint white paper* published

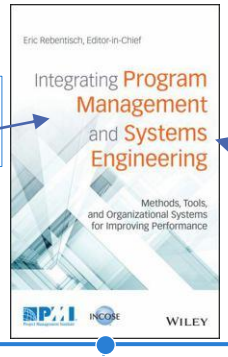


2012-2013

- 2012: PM, INCOSE, MIT joint survey
- 2012: Shingo prize-winning guide
- 2013: First phase study released

2014-2015

- 2014: 2nd & 3rd phase study released
- 2015: PM, INCOSE, joint book initiated



2016

- **PM-SE IWG launched during INCOSE SI**

2017

- PM, INCOSE, joint book** published
- Webinar series kicks off

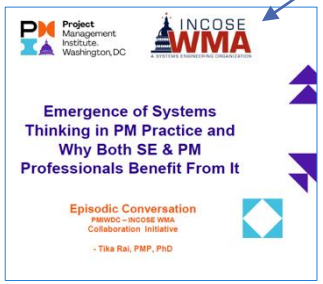
2022

- PM-SE tensions & opportunities presented at PMI Global Summit***
- **PMIWDC and INCOSE WMA charter signed to collaborate at chapter level**
- PM-SE IWG presented during INCOSE chapter meeting by PMIWDC



2025-till now

- 2025: INCOSE IS hosts 'Empowering SEs and PMs: Unlocking the Potential of DSMs" webinar
- **2025: DSM joins the collaboration, PMIWDC kicks off CoPs****
- **2025: The charter is renewed**
- **2025: The chapter level PM-SE collaboration Steering Committee is formed and gains momentum to throttle the effort forward**
- **2026: INCOSE WMA kicks off SE Excellence Awards with PM as qualifying and judging criteria**



PMI: Project Management Institute
WDC: Washington DC
WMA: Washington Metro Area

*Toward a New Mindset: Bridging the Gap between Program Management and Systems Engineering
**Integrating Program Management and Systems Engineering

***Same content was presented during INCOSE LA meeting in 2024
****First CoP: Systems Thinking in PM. Second CoP, PM-SE Collaboration. Former merged with the latter due to overlaps.

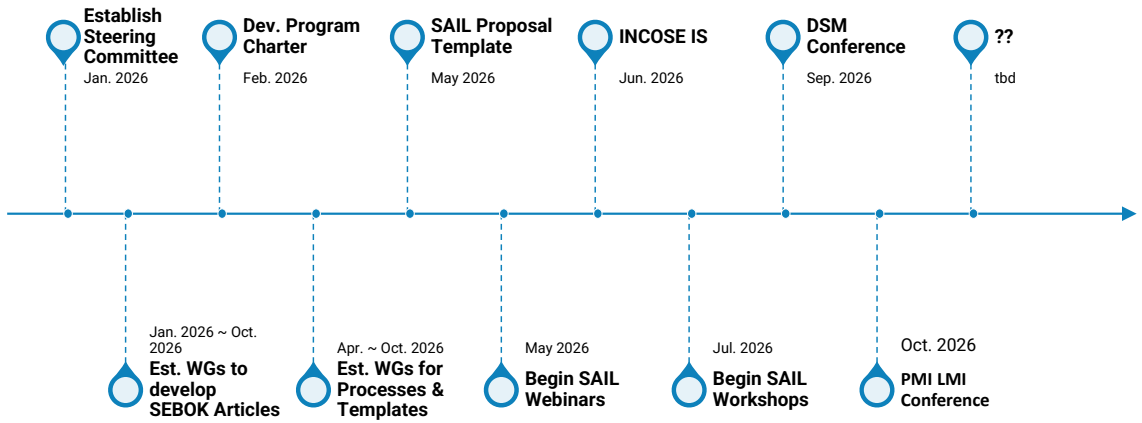
Appendix B: PM- SE Integration - 2026

Vision

Promote PM-SE integration to support successful project and program implementation

Mission

Enrich program/project management practice by establishing common language, roles, processes, and tools to support integration of program/project management and systems engineering throughout the lifecycle of project, program, product, and services.



Stakeholders

- PM-SE Initiative:
  - Accountable and Responsible:
    - WDC-WMA Joint Working group
      - PMI-WDC: Don Hong, Houng Soo
      - INCOSE-WMA: Tika Rai (PM), Houng Soo
      - PM: Tika Rai
    - INCOSE PM-SE Integration Working Group
      - Tina Srivastava (PM), Steve Dam, Tammy Tober, Mark Kaufman
    - DSM: Mike Stowe
  - Consult:
    - PMI-WDC Professional Development (PD) Group: Vishal Khokha, Houng Soo
  - Inform:
    - INCOSE WMA: In monthly chapter meeting
    - INCOSE: In monthly Americas Sector chapter meeting
    - PMIWDC: In monthly meeting
    - PMI: In quarterly meeting by PMIWDC
- External Stakeholders:
  - Multiple companies in the DSM SAIL environment
  - University students
  - Aerospace production group

END

Project Management Institute. Washington, DC

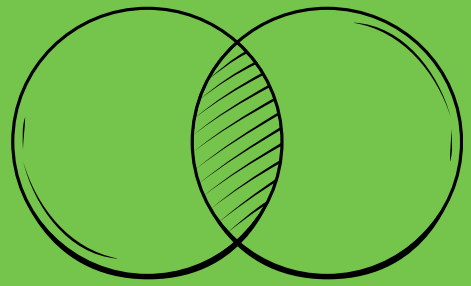
Program/Project Management and Systems Engineering (PM-SE) Collaboration

Community of Practice (CoP) Update

Don Houng
Tika Rai, PhD
PM-SE Collaboration CoP
Professional Development

08/20/2027

"Who Has the Responsibility?"



Life Cycle Planning

External Supplier Relations

Program/Project Risk

Responsibilities:

- Managing the project budget



Project Manager

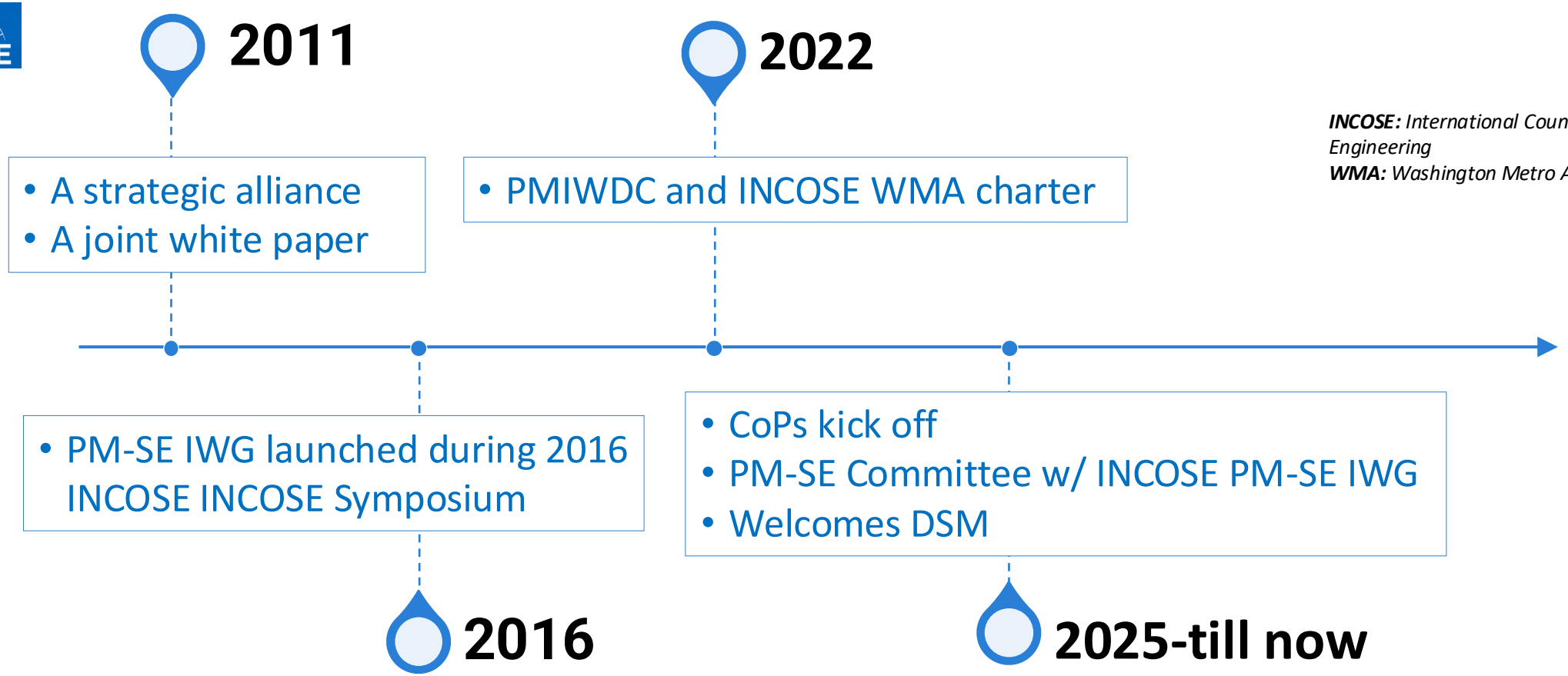


Responsibilities:

- Technical Requirements

Systems Engineer

PM-SE Integration Working Group (IWG) Timeline



INCOSE: *International Council for Systems Engineering*
WMA: *Washington Metro Area*

Next Steps and Call to Actions

- Come and join us to represent the PM perspective
- Reach out to us with questions

Don Hong, Don.Hong@pmiwdc.org
Tika Rai, tikajit.rai@pmiwdc.org

Appendix

PM-SE Integration Working Group (IWG) Timeline

Project Management Institute. Washington, DC

Project Management Institute.

INCOSE

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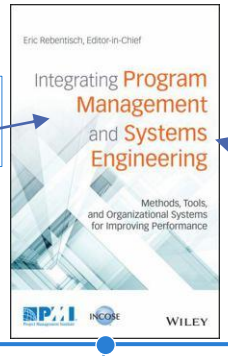
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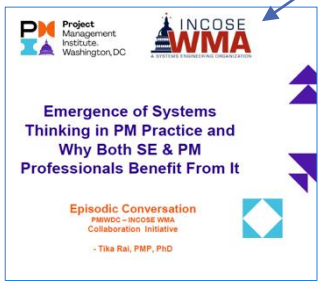
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***Same content was presented during INCOSE LA meeting in 2024
****First CoP: Systems Thinking in PM. Second CoP, PM-SE Collaboration. Former merged with the latter due to overlaps.

MoU Between the Chapters, the CoP, Milestones

- **PM-SE Working Group MOU between PMIWDC and INCOSE WMA chapters**
  - Enhance the PMI and the Chapter's strategic capabilities
  - Provide value to Chapter members through building, exchanging, and archiving knowledge and developing capabilities critical to your professional success
- **PMIWDC CoPs**
  - Systems Thinking in PM
  - PM-SE Collaboration
- **Key Milestones**
  - The two CoPs merged after 10/8/25 Systems Thinking in PM CoP
  - Dependency Structures Matrix (DSM) joined the working group: PM-SE Enhanced WG
  - A Steering Committee formed, mission/vision finalized, meets monthly, logo designed
  - *Separate meeting series hosted by INCOSE for broader PM/SE audiences, promoted by PMIWDC*

3x webinars followed by kicking of the CoP:
- 04/23/2025: Fundamentals and Application of **Systems Thinking** in **Project Management**
- 07/09/2025: Tackling complex problems through **Systems Thinking**
- 07/30/2025: Navigating uncertainty through **Systems Thinking**
- 10/08/2025: PM and Systems Thinking for Systems Engineering Projects

- 05/25/2025: PM-SE Collaboration Kick-off
- 09/10/2025: Facing Tensions between PM and SE
- 11/17/2025: PM-SE Integration Working Group, joined by INCOSE

PMISE Working Group

PM-SE Enhanced IWG Update & Call for Participation

Project Management Institute. Washington, DC

- **Updating 10x SE BoK Wiki articles**
  - Two published in May 2026
  - 7 more being updated
  - Publish date: Nov 2026
  - Contributors to provide inputs by end of August 2026
  - SE BoK Articles:
    - Project Planning
    - Assessment and Control
    - Technical Management Processes
    - Procurement and Acquisition
    - The Influence of Project Structure and Governance on Systems Engineering and Project Management Relationships (Replaces old article)
    - The Nature of Project Management
    - Relationships between Systems Engineering and Project Management

Interested to contribute?
Don Hong, Don.Hong@pmiwdc.org

PM-SE Enhanced IWG Update & Call for Participation

Project Management Institute. Washington, DC

- **Common language, process, and templates**
  - Publish date: November 2026
  - Contributors to provide Inputs by: October 2026
  - Templates:
    - PM PgM Planning Guide
    - Stakeholder Engagement Guide
    - Requirement Gathering Guide
    - Risk Management Guide
    - PMO Joint Process Guide
- **Lifecycle Modeling Language (LML) V2.0 Update**
  - PM PgM language being added
  - Publish date: November 2026

Interested to contribute?
Don Hong, Don.Hong@pmiwdc.org

PM-SE Enhanced IWG Update & Call for Participation

Project Management Institute. Washington, DC

The Systems Architecture Integration Lab (SAIL) Template



- BOXARR designs the complex system architecture (the "What")
- Lattix validates the code structure (the "How"),
- ADePT FLOW takes the outputs of both and builds the optimized execution schedule (the "When" and "Who").

Australia - Mining industry
Brazil - Oil and Gas industry
Canada - Medical Equipment industry
Finland - Escalator / Elevator industry
France - Food and Wine industry
Germany - Industrial Equipment industry
Italy - Ship and Boat Building industry
Japan - Automotive industry
Netherlands - Nuclear Fusion industry
Sweden - Healthcare industry
UK - Infrastructure Development industry
US - Aerospace industry

- **INTEGRATOR (IG):**
  - **BOXARR** for modeling complex interdependencies with Boxes (things), Arrows (relationship), and Groups (contexts) representing physical components, tasks, and legal requirements.
  - **Lattix** for software architecture interdependencies and system-to-software requirements allocation.
- **CONDUCTOR (CN):**
  - **FLOW** for defining and streamlining (optimization is part of it) the process. The different views are like a map. Blockages, hindrances, barriers can be identified during project delivery.

Global Collaboration

Project Management Institute. Washington, DC

PM-SE Integration Working Group | **INCOSE - PMI** → **2016**

INCOSE WMA - PMI WDC Chapters level MoU → **2021**

DSM joins the IWG | Steering Committee Formed → **2025**

New name: PM-SE Enhanced Integration Working Group

- Slides/Videos
- SEBoK Wiki
- PM-SE Templates
- SAIL Template

Inform & share to national chapters

apm INCOSE UK

Joint Working Group

INCOSE and APM: UK (2013)

AISE INCOSE Chapter Italia ITALY IPMA international project management association

3 PMI Chapters

INCOSE and PMI or IPMA: Italy

Other national INCOSE and PM related chapters

Systems Engineering and Project Management Integration: V-model (Explanatory Note)

Guide to SE and P3M Processes

Guide To SEPM Roles and Responsibilities

Artifacts

Artifacts