30th Annual INCOSE international symposium

Virtual Event
July 20 - 22, 2020

Complexity, Systems Thinking and an Integrated Systems Engineering and Project Management Model

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Technical Leadership II
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Outline

- Introduction and Background
- PM-SE Integration Requirements
- Managing Complexity with an Integrated Model
- The Management Curves and Hypothesis
- A Decision Support System and SD Model
- Results
- Questions

Introduction and Background

- Only 16 percent of organizations fully integrated
- More than half of complex projects fail
- More than half of organizations express doubt in managing complexity
- Organizational and project dynamics not understood until it's too late

- PMI Report on PM's of the Future: collaborative leadership, digital age skills for data driven decisions
- INCOSE SE Vision 2025: SE as integrating role, need capable models and tools

- Disparate models and tools, unproductive PM-SE tension, lack of planning, conflicting practices, undefined roles, no common language or platform for decision-making
- Theoretical requirements but no practical approach; Paradigm Shift is required

Integrated PM-SE Model Central Themes – The 'Big Picture'

- Need for a structured Systems Thinking Approach with SE as a common view
- System Dynamics
- Decision Support System
- Cross-Functional processes, perspectives, practices, and coupling of models
- Central Themes from: literature review, interviews and surveys

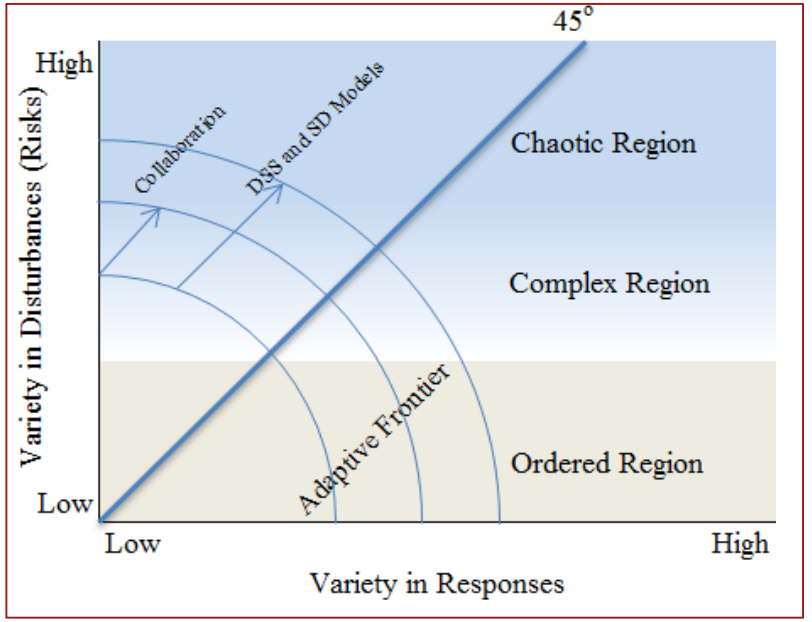
PM-SE Integration Requirements

Principles of a Learning Organization (Senge)	Key Practices for an Integrated Management System (Lee)	Integrated Product and Process Development Features (Laverghetta)	Dimensions of PM-SE Integration (Rebentisch)
Systems Thinking	Infrastructure to Support Vision	Team **Collaboration**	Processes, Practices and Tools
Personal Mastery	Cultivate **Knowledge**	**Early Knowledge**	Environment: Leadership, **Knowledge** and Culture
Team **Learning**	**Learning and Social Networking**	**Optimization of Decisions**	**People Competencies: Learning and Communication**
Mental Models	Integration of Useful **Information**	**Simulation of Information**	Contextual Factors: Program, **Organization and Team Characteristics**
Shared Vision	Continuous Improvement	**Early Design Analysis**	**Program Performance**

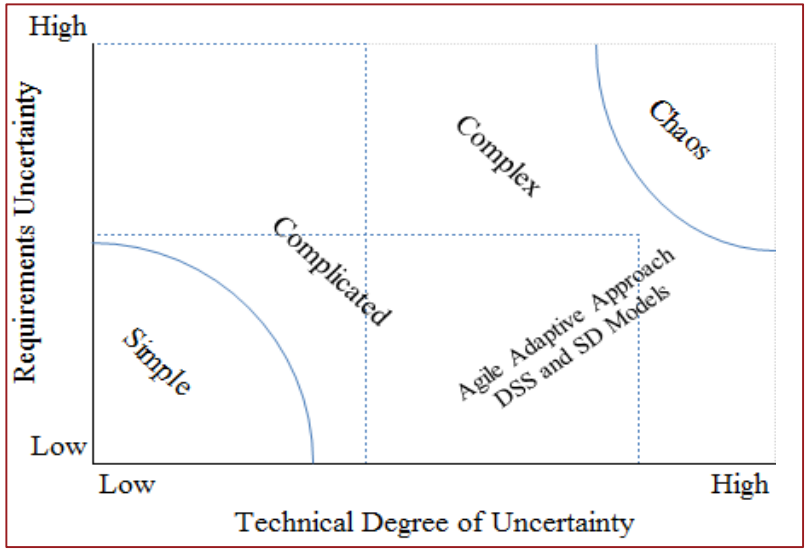
Managing Complexity

- Cynefin Spaces
  - Simple, Complicated, Complex and Chaotic
- Ashby Space
- Stacey Complexity Model

- PM-SE Model and Navigating Complexity
  - Adapt with
    - Increased collaboration
    - Early Knowledge
    - Ease-of-Change
      - Changes
      - new technology
      - margins
    - Design Change Management
    - Decision Support System
  - Allow time for Critical Thinking



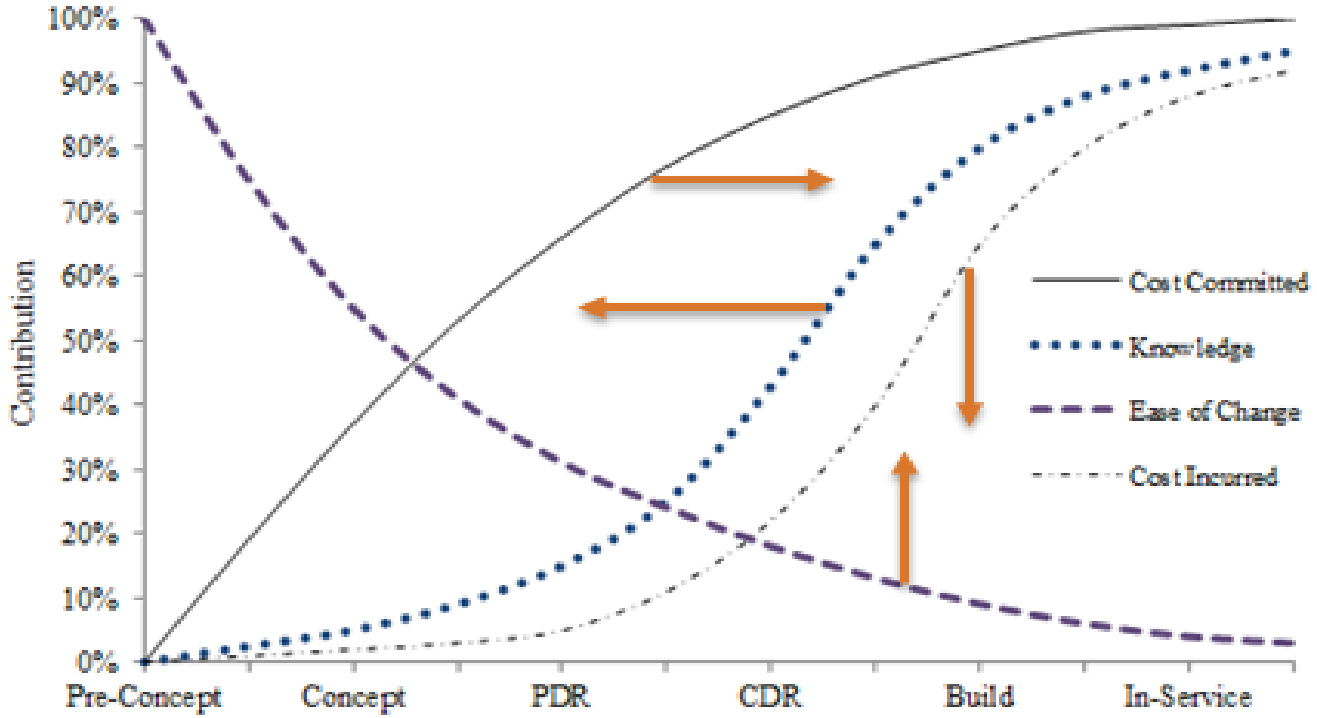
Ashby



Stacey

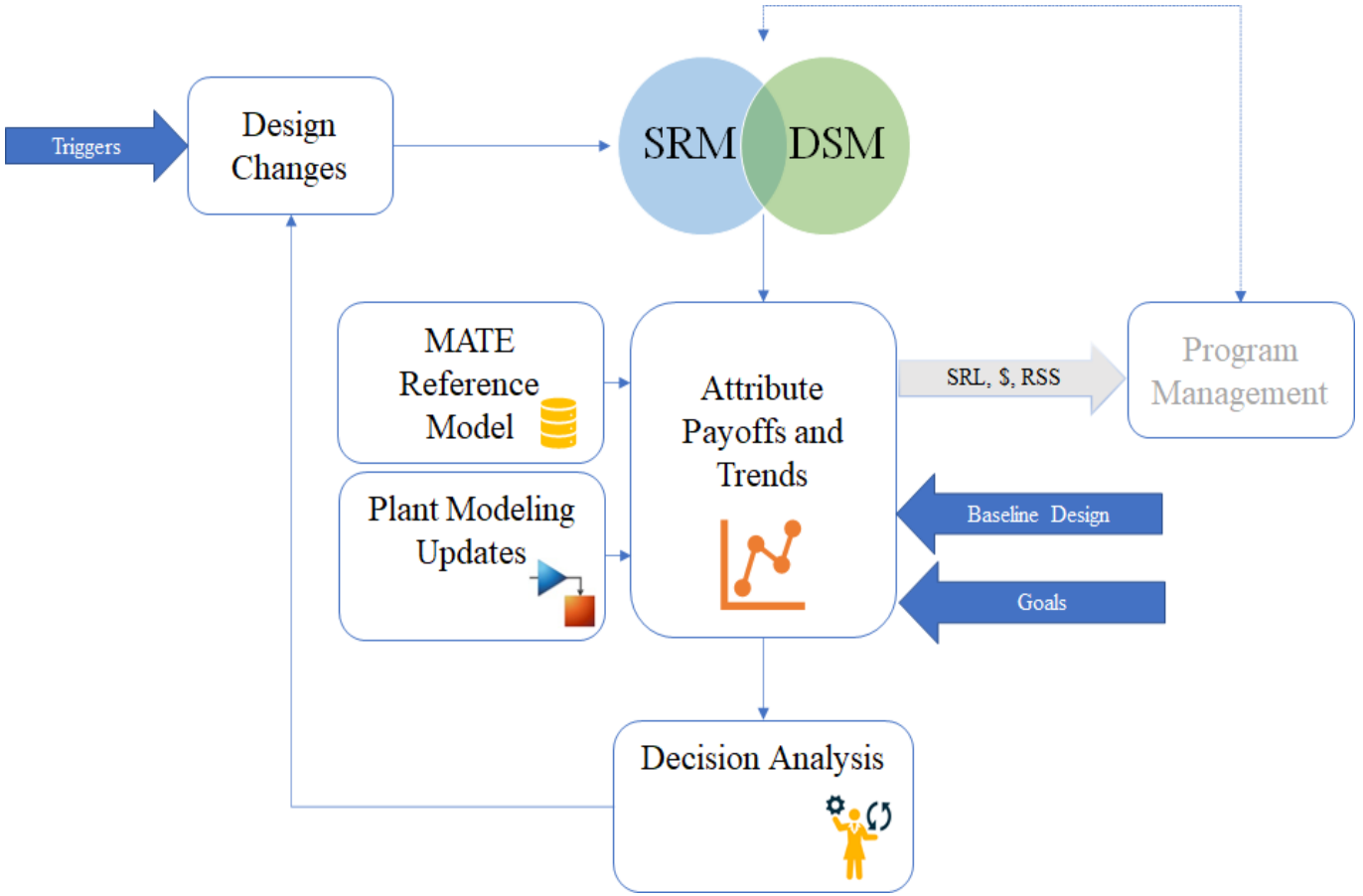
The Management Curves

- Lack of Early Knowledge
- Lack of Design Flexibility
- 85 percent Commitments made prior to Detailed Design
- Late Changes and Increased Costs
- Techno-socio-economic and cultural factors and underlying interrelationships
- Interactive Levers to influence the Curves



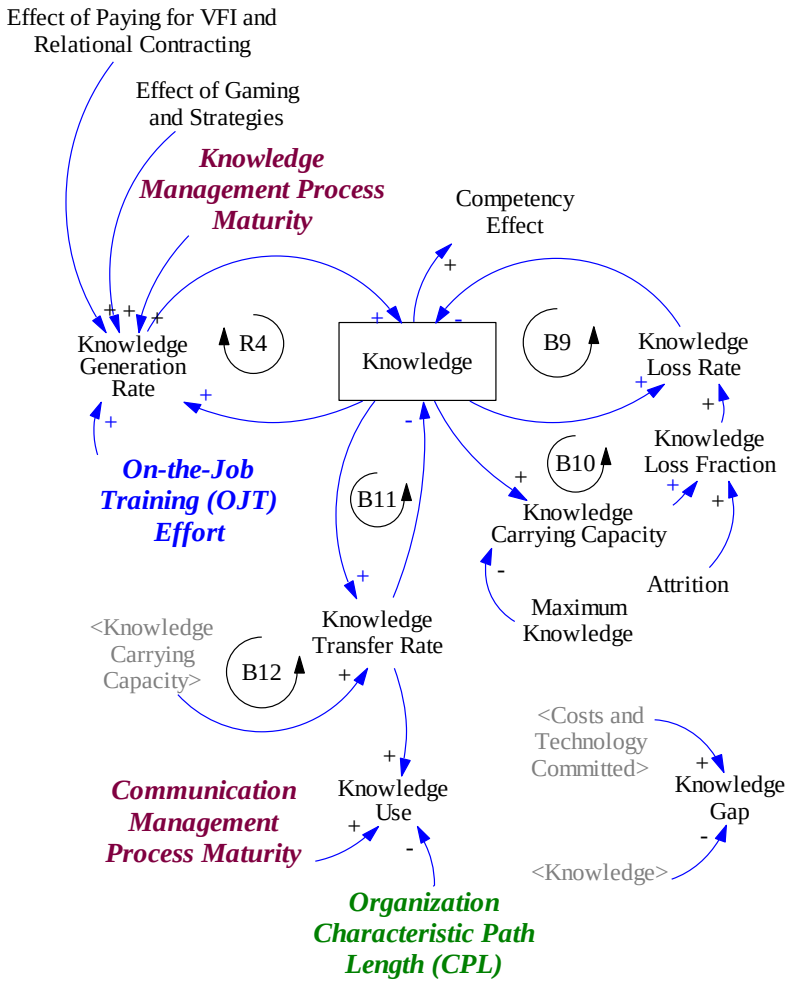
Systems Thinking and a Decision Support System

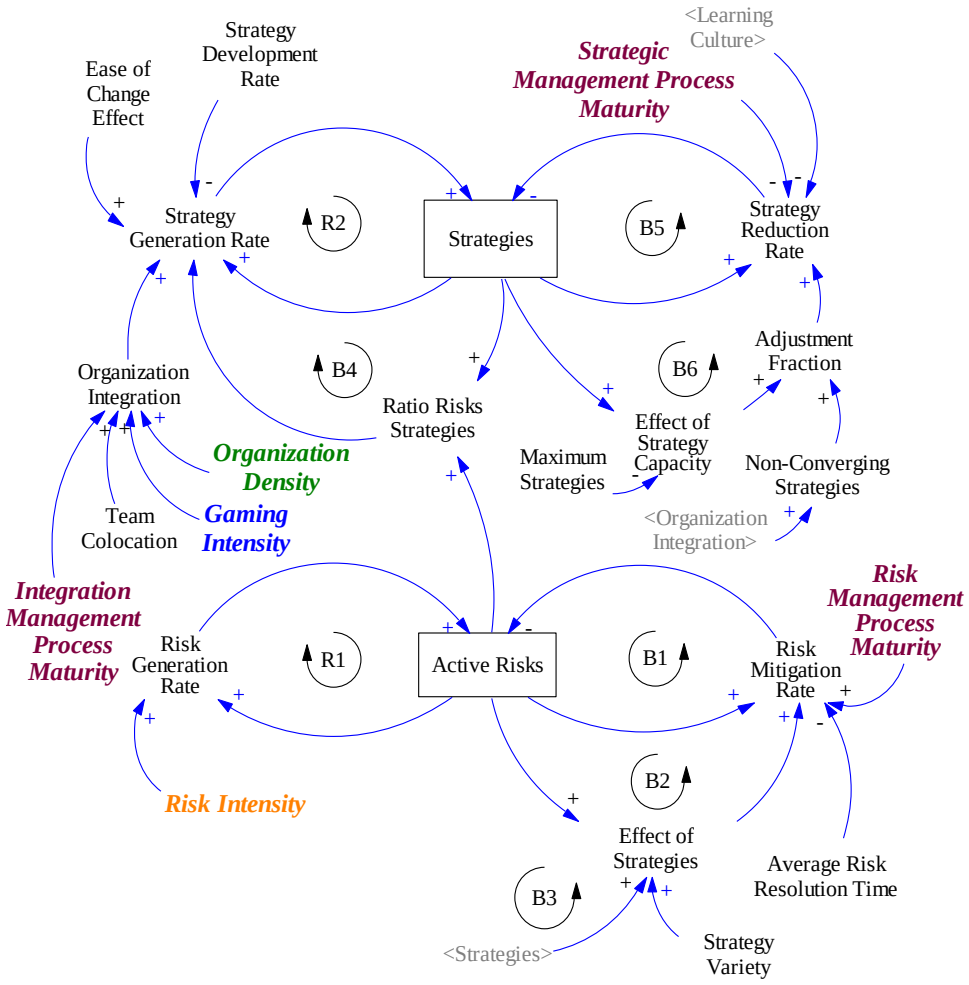
- Part 1 of the Integrated Model
- Early Planning
  - Gaming of Design Changes and Sharing Perspectives
  - Proactive Risk Management (Feed Forward)
  - Agile Management
  - Early Knowledge
  - Robust Design and Ease-of-Change (Set-Based)
- Bringing SE-PM performance models together
- Complimentary Integrated Model to Existing PM and SE practices
- Interactive Levers to influence the design



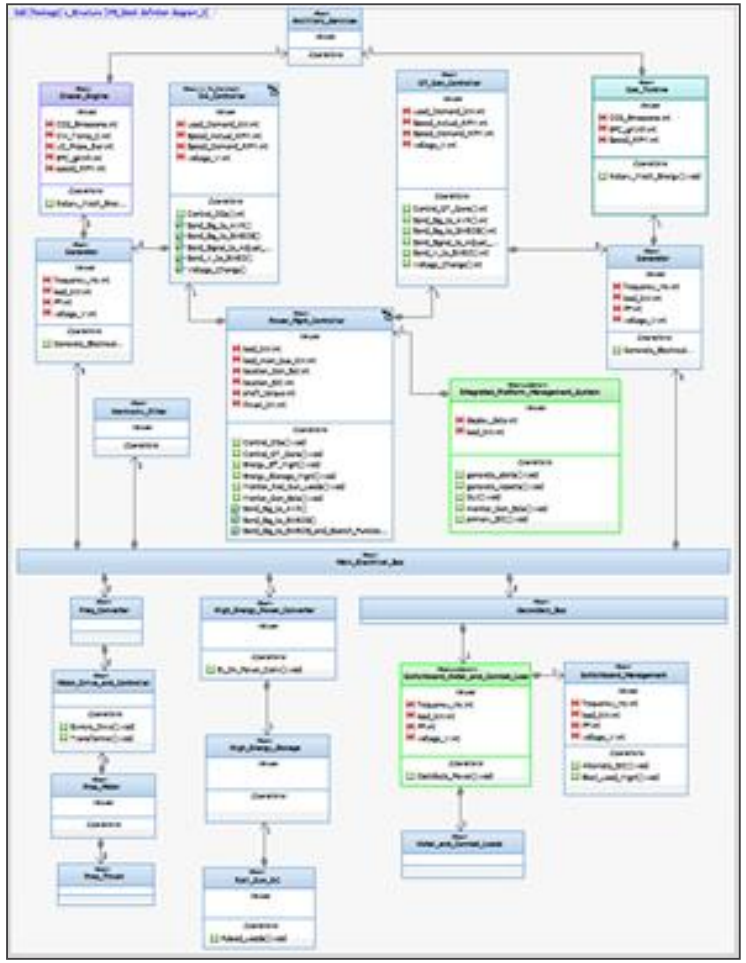
Systems Thinking and System Dynamics

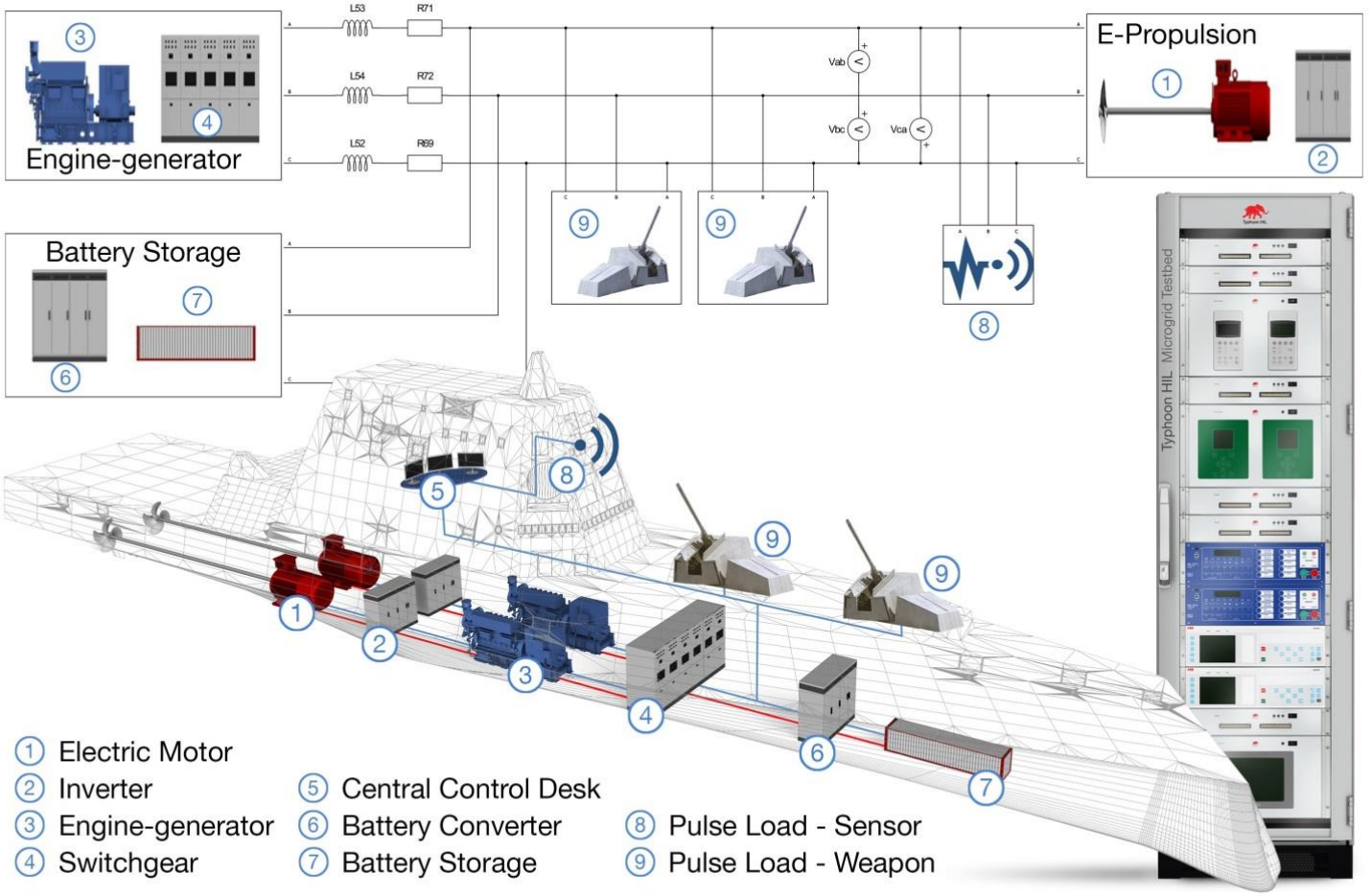
- Part 2 of the Integrated Model
- Understanding organizational and project dynamics
  - Causal Loop Diagrams
  - SD model in Vensim®
- Built-In Harmony and Resiliency
  - Feedback loops
  - Levers





Integrated Model Case Study - IPS

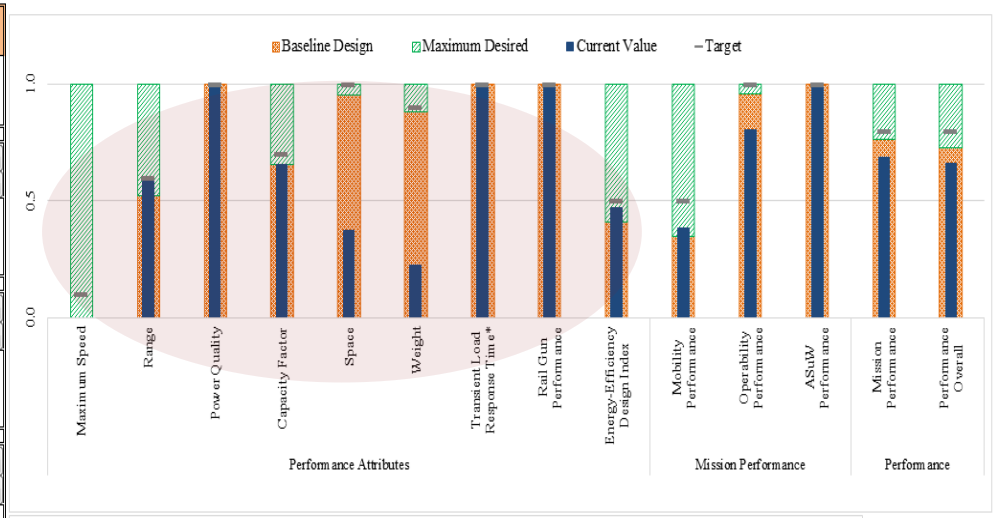


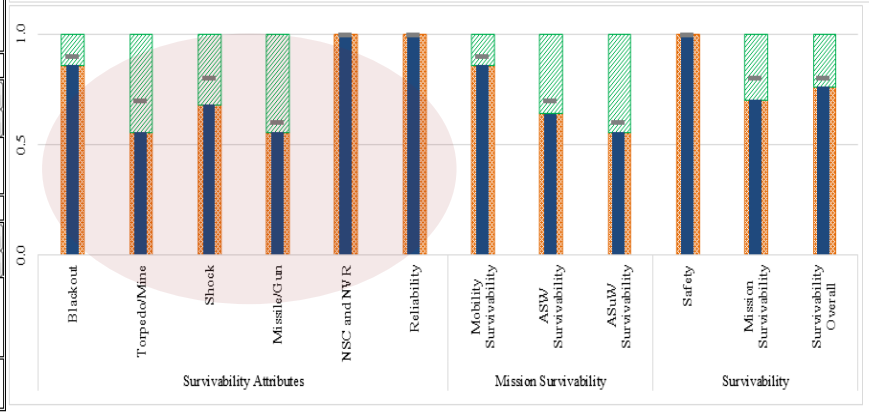


DSS Model – Part 1

Design Change Scenarios and Predicted System State

Performance Design - Model Updates		
GT Power Baseline Design #32	GT Power Update	
MW	MW	Input
30	30	
DG Power Baseline Design #32	DG Power Update	
MW	MW	Input
6	6	
HESS Power Baseline Design #32	HESS Power Update	
MJ	MJ	Input
320	320	
Raft Weight Baseline Design #32	Raft and/or Isolator Weight Update	
kg	kg	Input
5000	5000	
THD Baseline Design #32	THD Update	
%	%	Input
2	2	
Transient Response Baseline Design #32	Transient Response Update	Values
Slow-Med-Fast	Slow-Med-Fast	TBD
Fast	Fast	Input



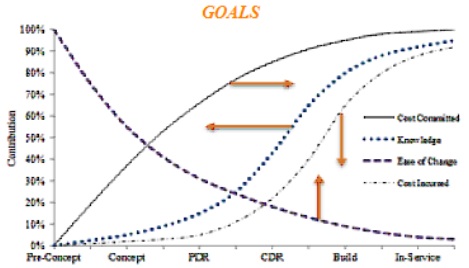


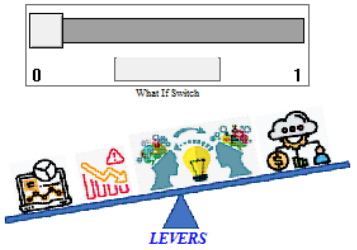
Component Change	
	Drop-Down
DG Type	WHR
GT Type	Conv
Controller Type	MPC
Compartmentilization	ZED
Shock Hardening	Raft
HESS Type	Ultra-Cap

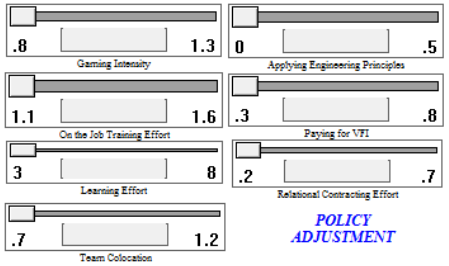
Capability	IPS Attribute/Month	Variability Within Tolerance	Capability Within Tolerance	Trend
Performance Attributes	Maximum Speed	Yes	No	
	Range	Yes	Yes	
	Power Quality	Yes	Yes	
	Capacity Factor	Yes	Yes	
	Space	No	No	
	Weight	No	No	
	Transient Load Response Time*	Yes	Yes	
	Rail Gun Performance	Yes	Yes	
	Energy-Efficiency Design Index	Yes	Yes	
Mission Performance	Mobility Performance	Yes	Yes	
	Operability Performance	Yes	Yes	
	ASuW Performance	Yes	Yes	
Performance	Mission Performance	Yes	Yes	
	Performance Overall	Yes	Yes	
Survivability Attributes	Blackout	Yes	No	
	Torpedo/Mine	Yes	Yes	
	Shock	No	No	
	Missile/Gun	Yes	Yes	
	NSC and NVR	Yes	Yes	
	Reliability	Yes	No	
Mission Survivability	Mobility Survivability	Yes	No	
	ASW Survivability	Yes	No	
	ASuW Survivability	Yes	Yes	
Survivability	Safety	Yes	No	
	Mission Survivability	Yes	Yes	
	Survivability Overall	Yes	Yes	
Program	TRL Index	Yes	Yes	
	SRL Index	Yes	Yes	
	Costs ($M)	Yes	No	
	Schedule Slippage	No	No	

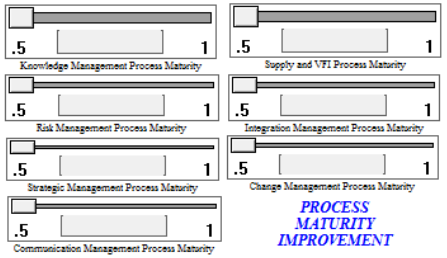
SD Model – Part 2

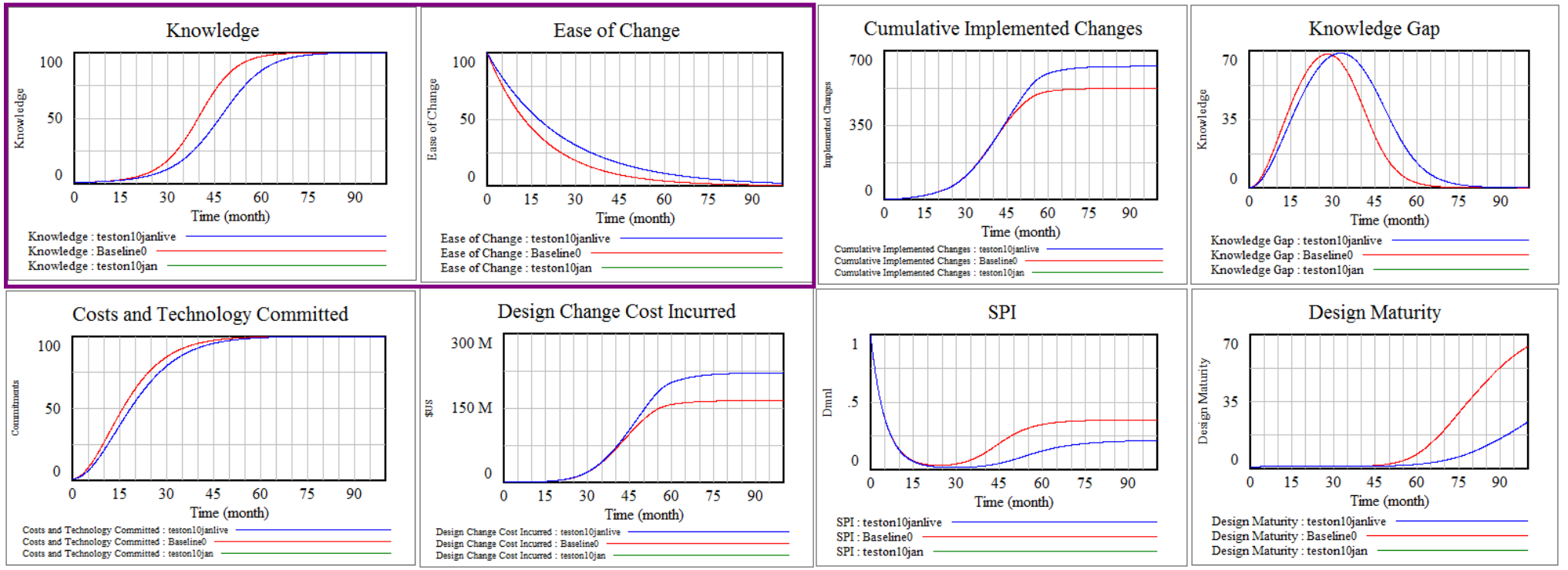
Predicted Management State and Levers of Influence



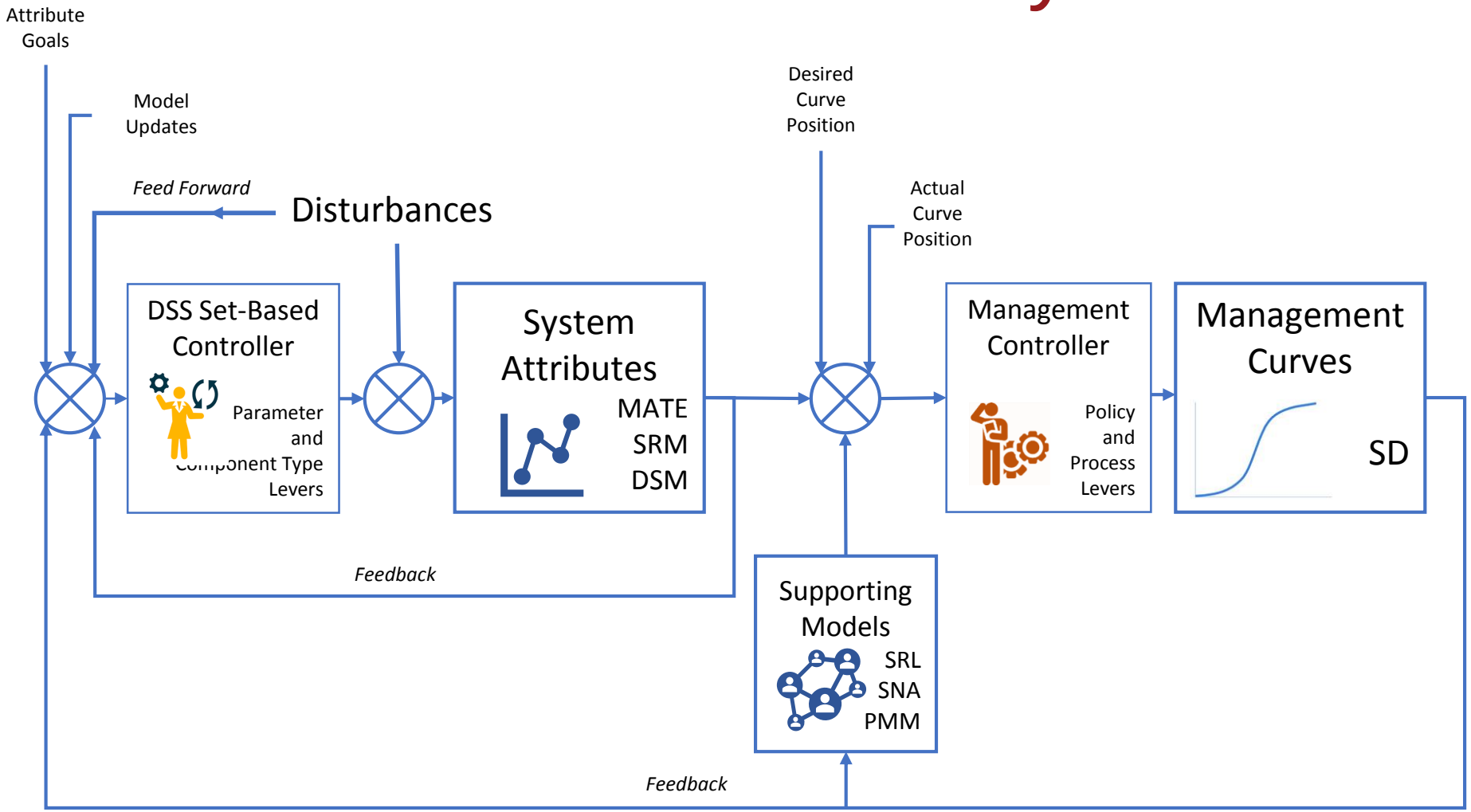






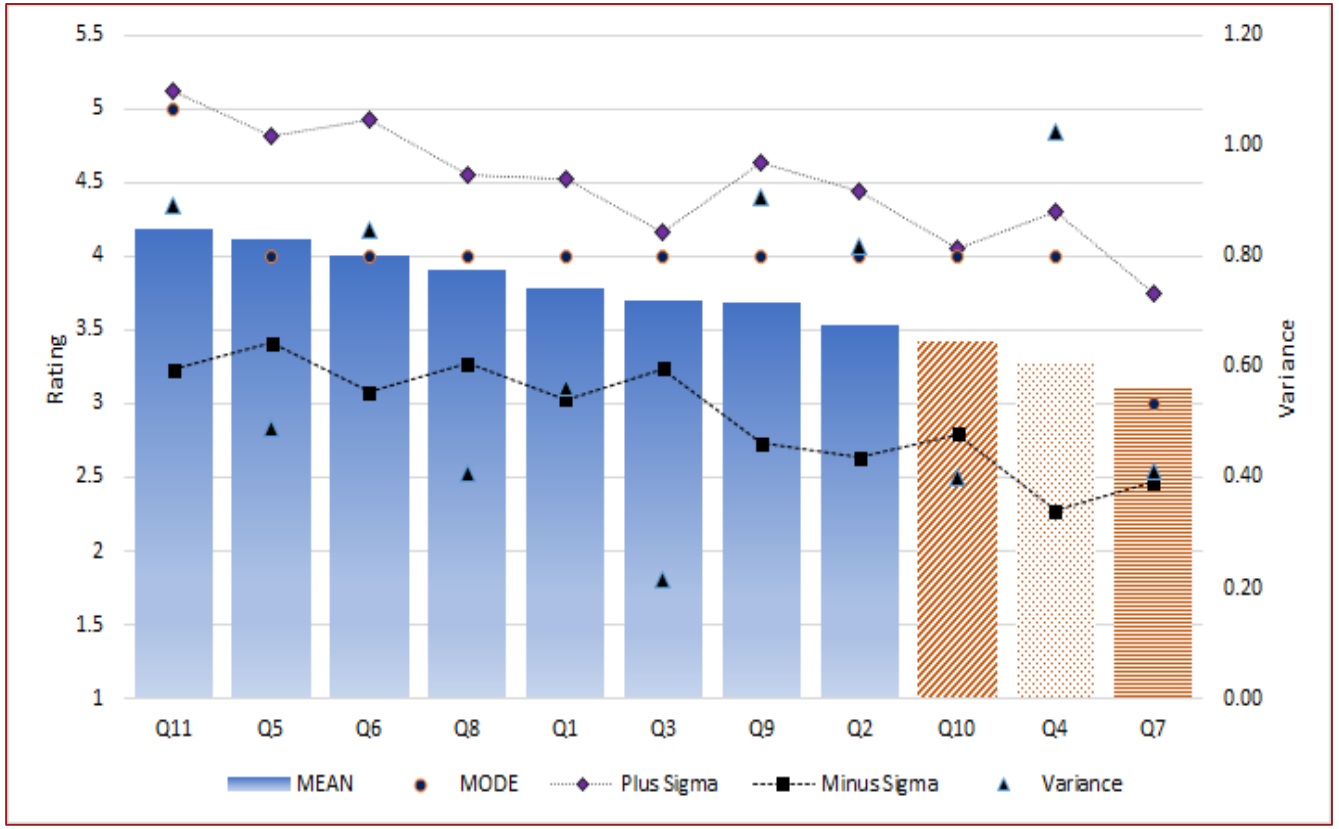


The Integrated PM-SE Model as a Feedback Control System



INCOSE IW2020 PM-SE Integration and MBSE

Q	How do you rate (Low 1 to Very High 5) the potential of the Management Flight Simulator to:
Q1	Improve Communication and Collaboration?
Q2	Increase early Knowledge, Learning and provide Mental Models?
Q3	**Proactively address risks and promote a Risk Management culture?**
Q4	Promote learning and application of Systems Engineering and its models?
Q5	**Provide different Perspectives for addressing Complexity?**
Q6	**Enhance Tradeoff Analysis and Optimize design change Decisions?**
Q7	Increase Product Quality?
Q8	Improve Project Performance and foster Continuous Improvement?
Q9	Address techno-socio-economic and cultural factors?
Q10	Represent real world systems, predict and analyze behavior?
Q11	**Advance the field of Systems Engineering and Project Management integration?**



IW2020 25-28 Jan 2020

Questions

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Thank You