RT-171: Mission Engineering Competencies

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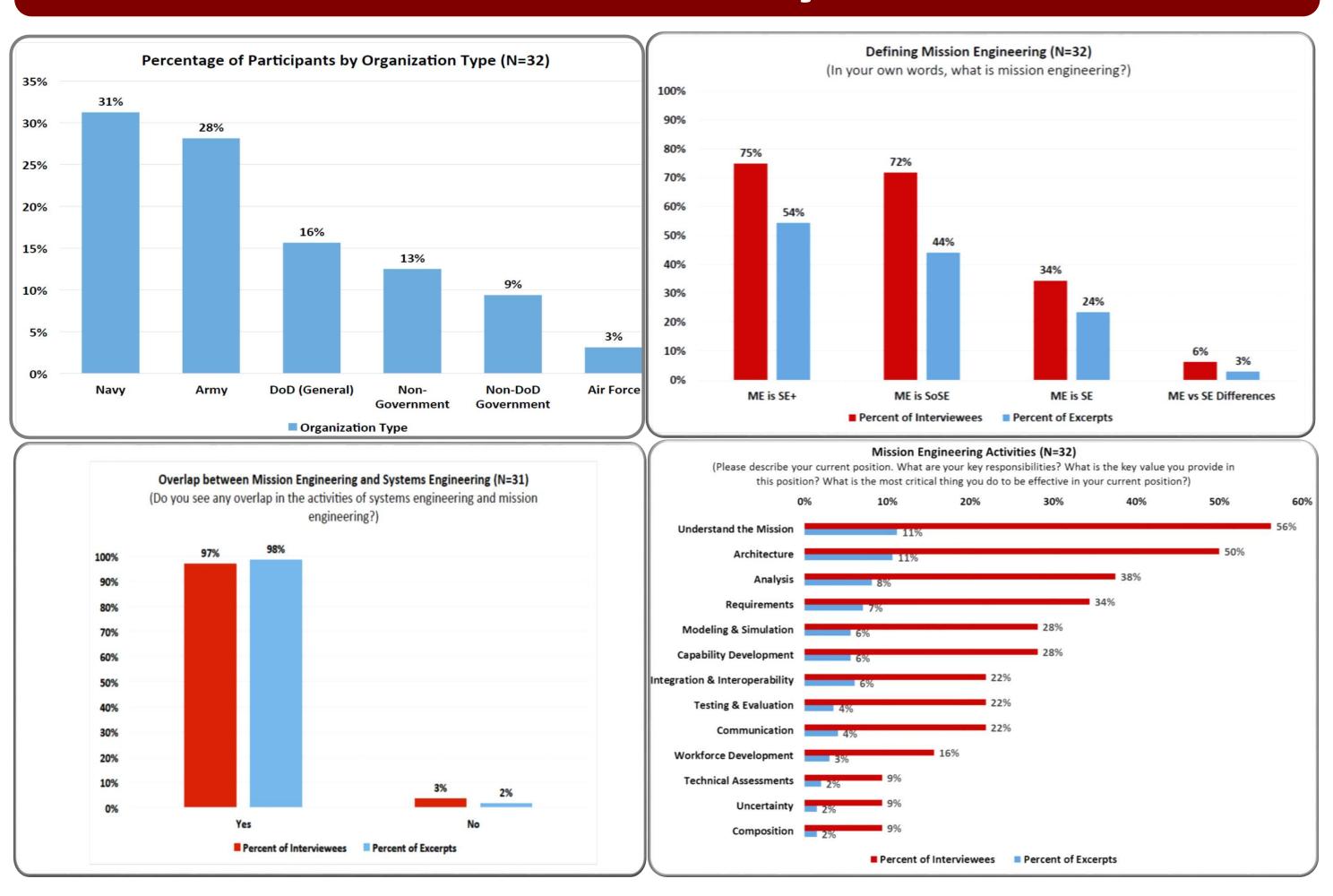Dr. Hoong Yan See Tao, Dr. Jon Wade, Mr. William Miller, Mr. Sergio Luna

SYSTEMS ENGINEERING RESEARCH CENTER

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Research Task / Overview

- Mission engineering is the application of systems of systems (SoS) engineering in an operational context.
- Research tasking and objectives to identify the critical skills required to successfully accomplish and shepherd mission engineering.
- Mission engineering overlaps systems engineering competencies with important differentiation in 1) governance, 2) foundational math/science/general engineering skills, 3) operational concepts, 4) interpersonal skills, and 5) leadership skills.
- Based on the research findings, the team recommends a broader view:

Mission engineering combines the structure of systems engineering and the tactical insights of operational planning to a system of systems to deliver a specific capability.

Data & Analysis

Percentage of Participants by Organization Type (N=32)

Defining Mission Engineering (N=32) — (In your own words, what is mission engineering?)

Overlap between Mission Engineering and Systems Engineering (N=31) — (Do you see any overlap in the activities of systems engineering and mission engineering?)

Mission Engineering Activities (N=32) — (Please describe your current position. What are your key responsibilities? What is the key value you provide in this position? What is the most critical thing you do to be effective in your current position?)

Mission Engineering Competency Framework

6. Technical Leadership
- Guiding Diverse Stakeholders
- Team Building
- Political Savvy
- Decision Making
- Workforce Development

1. Discipline & Domain Foundations
- Principle and Relevant Disciplines
- Relevant Domains
- System Characteristics
- Relevant Systems
- Relevant Technologies
- Acquisition Context

5. Interpersonal Skills
- Communication
- Translation
- Enterprise Context
- Building & Utilizing a SME Network
- Coordination
- Influence, Persuasion, & Negotiation

2. Mission Concept
- Operational Context
- Mission Concept of Operation
- Mission Scenarios/Threads
- DOTMLPF Space

4. Systems Mindset
- 'Big Picture' Thinking
- Adaptability
- Paradoxical Mindset
- Multi-Scale Abstraction
- Critical Thinking

3. Systems Engineering Skills
- System of Systems Engineering
- Analysis
- Architecture
- Modeling and Simulation
- Requirements
- Integration
- Gap Analysis
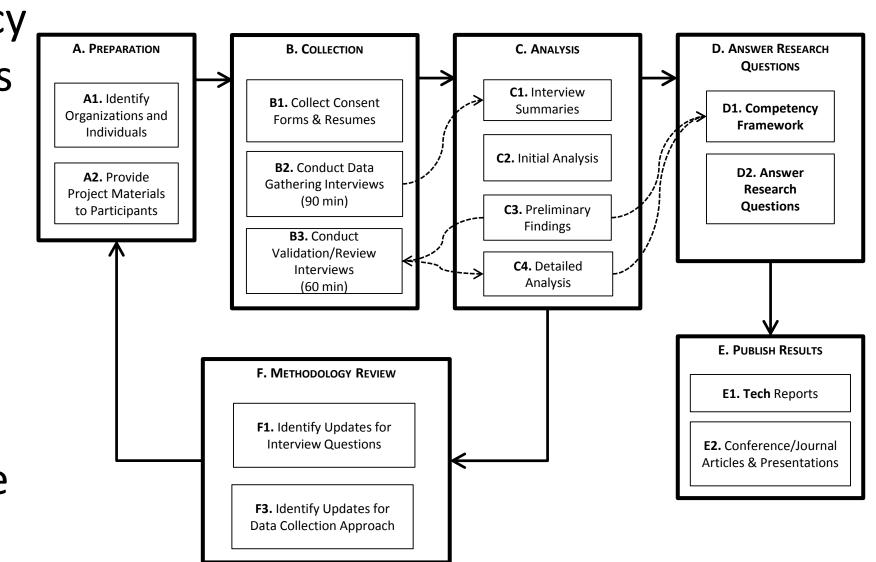
Initial Findings: Comparison with SE Competency Models

- Technical Leadership/Leadership
- Team Dynamics/Team Dynamics and Management/Leading High Performance Teams
- Stakeholder Expectation and Definition/Stakeholder Requirements Definition/Managing Stakeholders
- Facilitation
- Decision Analysis
- Coaching and Mentoring/Mentoring and Coaching/Coaching and Mentoring
- Communication/Communication/Communication
- NASA Interior and Exterior Environment
- Negotiation/Negotiations
- Organization

- Software Engineering
- Acquisition Strategies and Procurement/Acquisition

- INCOSE Competency Framework
- NASA Systems Engineering Competencies
- NAVY SE Competency Model

- Capability Engineering
- Mission Needs Statement
- System Environments/External Relationships
- Mission Level Assessment
- Mission and Results Focus

- Analysis/Logical Decomposition
- Architecture/System Architecture/Architecture Design
- Modeling
- Requirements/Technical Requirements Definition/Requirements Management/Stakeholder Requirements Definition/Requirements Analysis/Requirements Management
- Product Integration/Integration/Interface Management/Interface Management
- Trade Studies

- Critical Thinking
- Systems Thinking
- Strategic Thinking
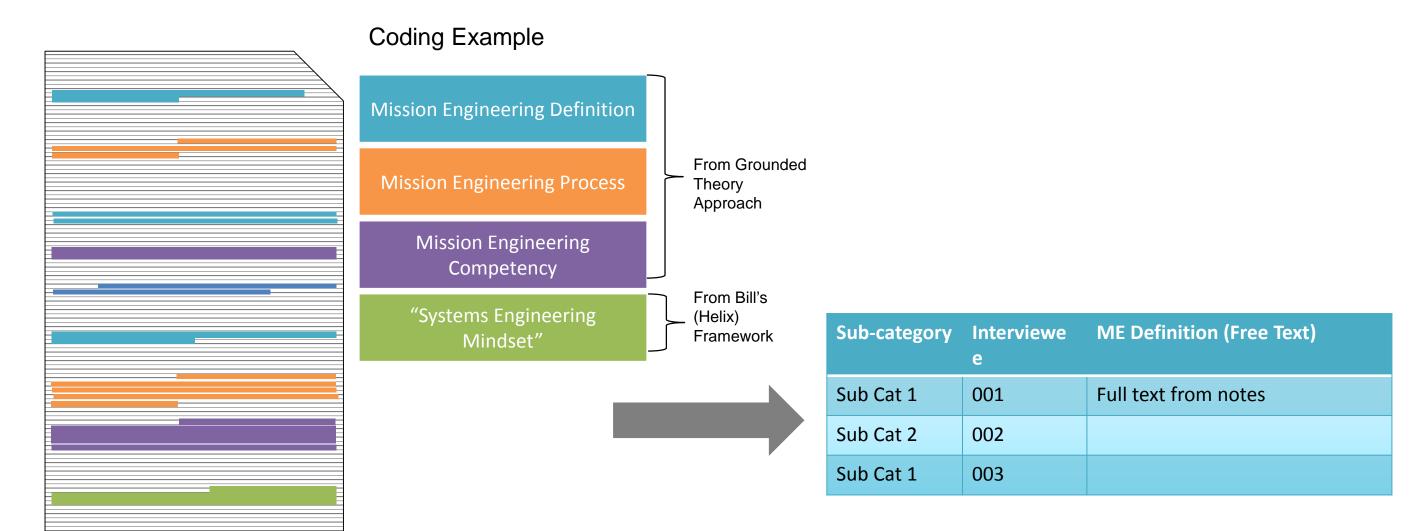- Problem Solving

Goals & Objectives

- Identify competencies for mission engineering that are truly unique, showing where there is separation from the generally demanded acquisition competencies or systems engineering competencies.
- Identify critical overlaps between mission engineering and systems engineering competencies.
- Develop a mission engineering competency model that supports the DoD engineering community but also provides input to each acquisition career field (e.g. program management, test & evaluation, etc.) unique to their responsibilities to support and manage mission engineering.
- Conduct a gap analysis comparing Defense Acquisition University's (DAU) current curricula against the competency requirements.
- Provide recommendations on creating a mission engineering curriculum.

Methodology

- To develop the competency model, this research draws heavily from the Helix methodology, which is based on a grounded theory approach using a combination of interviews with 32 mission engineers and an extensive literature review that covers 1) mission engineering definition and organizational support, 2) identification of competencies and gaps, and 3) future vision.

A. Preparation
- A1. Identify Organizations and Individuals
- A2. Provide Project Materials to Participants

B. Collection
- B1. Collect Consent Forms & Resumes
- B2. Conduct Data Gathering Interviews (90 min)
- B3. Conduct Validation/Review Interviews (60 min)

C. Analysis
- C1. Interview Summaries
- C2. Initial Analysis
- C3. Preliminary Findings
- C4. Detailed Analysis

D. Answer Research Questions
- D1. Competency Framework
- D2. Answer Research Questions

E. Publish Results
- E1. Tech Reports
- E2. Conference/Journal Articles & Presentations

F. Methodology Review
- F1. Identify Updates for Interview Questions
- F3. Identify Updates for Data Collection Approach

Coding Example
- Mission Engineering Definition
- Mission Engineering Process — From Grounded Theory Approach
- Mission Engineering Competency
- "Systems Engineering Mindset" — From Bill's (Helix) Framework

Sub-category	Interviewee	ME Definition (Free Text)
Sub Cat 1	001	Full text from notes
Sub Cat 2	002	
Sub Cat 1	003	

Future Research

- Future research opportunities include:
  - Finding the "right" people and the "right" team
    - Competition with private industry creates a shortage of the needed skills and competencies in the government workforce
- Need to fix a dysfunctional acquisition process
  - A coalition of the willing to work together to ensure all the services are participating with a truly joint solution
  - Funding a mission test capability is a real challenge; no one program has the resources to assess the end-to-end effects to accomplish the mission
- Educating DoD personnel in both the acquisition and operational contexts on what mission engineering is, but in order to do that, the appropriate courses and materials need to be developed
- Exploring the processes of mission engineering and the skills and talents necessary for the process
  - Observing mission engineering in practice with an emphasis on operational domain knowledge

Contacts/References

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