

# SoSECIE Webinar

Welcome to the  
2019 System of Systems Engineering Collaborators  
Information Exchange (SoSECIE)



*We will start at 11AM Eastern Time*

*Skype Meeting +1 (703) 983-2020, 46013573#*

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# NDIA System of Systems SE Committee

- **Mission**

- To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
- To identify successful strategies for applying systems engineering principles to systems engineering of SoS

- **Operating Practices**

- Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August
- SoS Track at NDIA 22nd Annual Systems Engineering Conference, Grand Hilton Tampa Downtown, Tampa, FL, October 21-24, 2019
  - Conference Info:  
<http://www.ndia.org/events/2019/10/21/22nd-annual-systems-and-mission-engineering-conference>

NDIA SE Division SoS Committee Industry Chairs:

Mr. Rick Poel, Boeing

Ms. Jennie Horne, Raytheon

OSD Liaison:

Dr. Judith Dahmann, MITRE

# Simple Rules of Engagement

- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at [sosecie@mitre.org](mailto:sosecie@mitre.org).
- Download the presentation so you can follow along on your own
- We will hold all questions until the end:
  - I will start with questions submitted online via the CHAT window in Skype.
  - I will then take questions via telephone; State your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

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# 2019 System of Systems Engineering Collaborators Information Exchange Webinars *Sponsored by MITRE and NDIA SE Division*

***March 12, 2019***

***Mission Engineering Competency Model***

*Dr. Gregg Vesonder and Nicole A. Hutchison, Stevens Institute of Technology*

***March 26, 2019***

***Practical Modeling Concepts for Engineering Emergence in Systems of Systems***

*Dr. Judith Dahmann, The MITRE Corporation*

*Ms. Philomena Zimmerman, OUSD(R&E)*

***April 16, 2019***

***Mission Analysis and Operational Architectures***

*Mr. Mark Simons, Vitech Corporation*

***April 30, 2019***

***Digital Engineering Transformation***

*Mr. Thomas McDermott, Georgie Tech Research Institute, SERC*

# 2019 System of Systems Engineering Collaborators Information Exchange Webinars *Sponsored by MITRE and NDIA SE Division*

***May 14, 2019***

***Toward Scaling Model-based Engineering for Systems of Systems***

*Dr. Ryan B. Jacobs, The MITRE Corporation*

***May 28, 2019***

***Mission Engineering and Prototype Warfare***

*Mr. Matthew Horning, US ARMY FUTURES COMMAND*

***June 11, 2019***

***TBD***

*TBD*

***June 25, 2019***

***A Tool for Architecting Socio-Technical Problems: SoS Explorer***

*Dr. Cihan Dagli*

***July 16, 2019***

***Modular Online Open SoS Education (MOOSE)***

*Mr. Kyle Hastings, The MITRE Corporation*



# Mission Engineering Competency Model

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***Stevens Institute of Technology***

**SoSECIE Webinar**

**12 March 2019**



# Systems Engineering Research Center

- Systems Engineering Research Center – the University Affiliated Research Center (UARC) for Systems Engineering Research
- Collaborative network of universities
- The national resource for systems engineering research

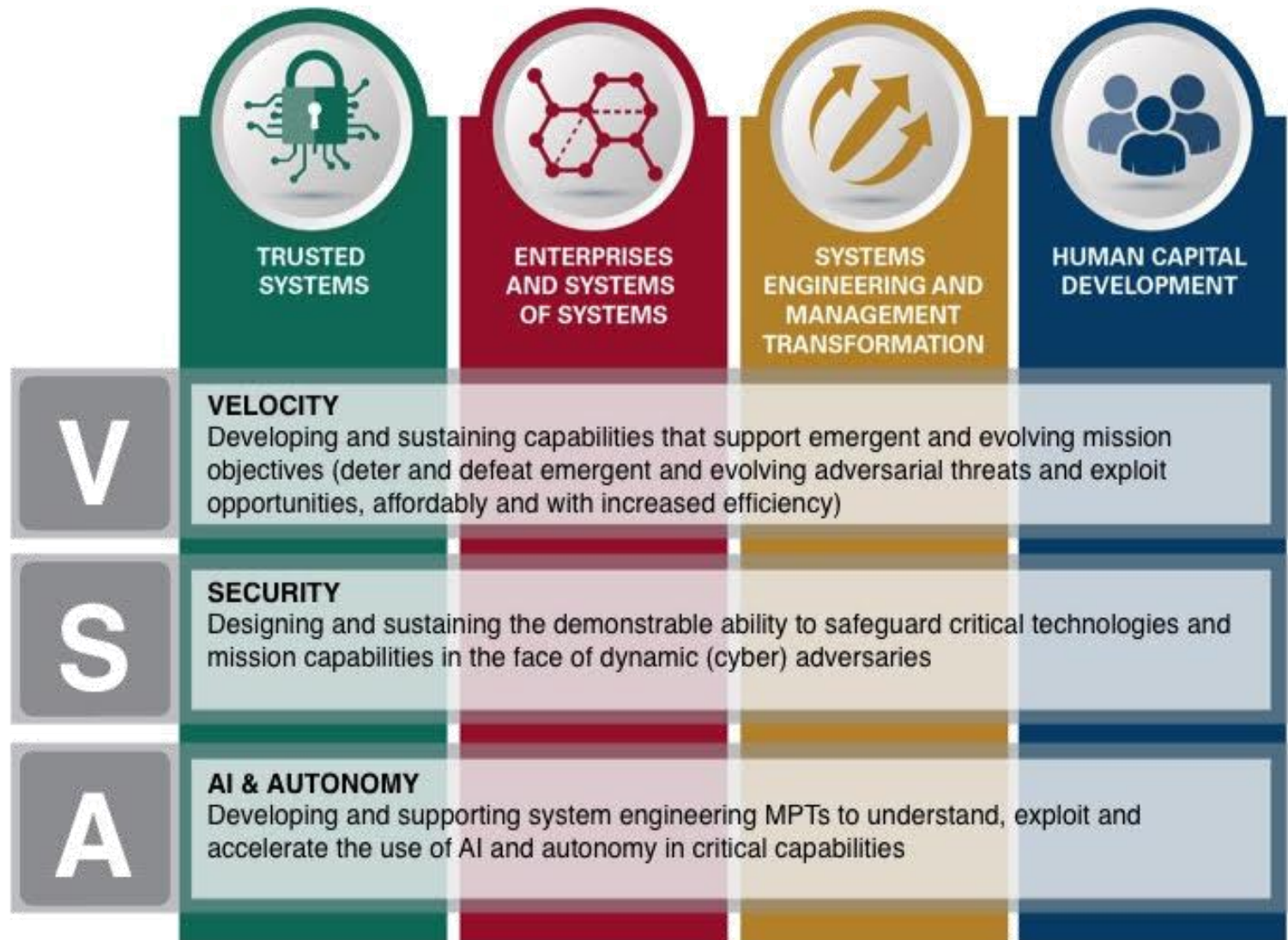


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**USC** University of  
Southern California





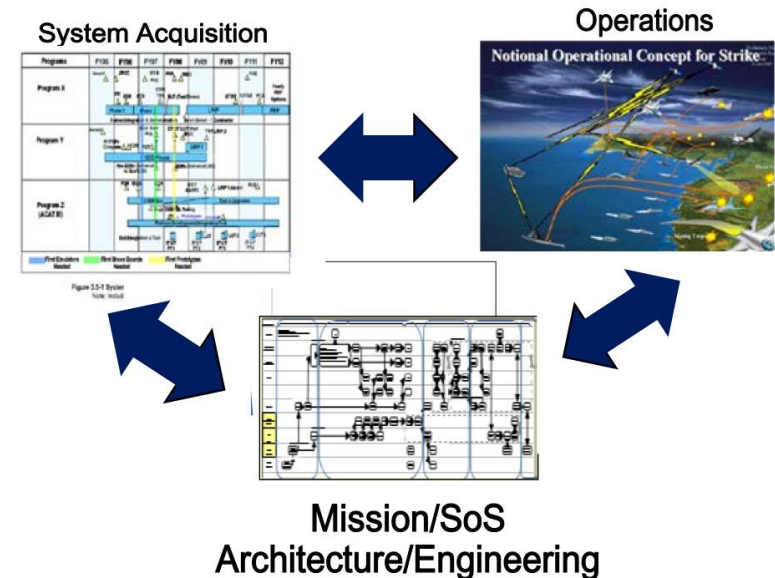


- Definition (going in): Mission engineering is the **application of systems of systems (SoS) engineering** in an **operational context**.
- Research tasking and objectives to **identify the critical skills** required to successfully accomplish and shepherd mission engineering.
  - Competency model built on grounded theory and leveraged the Helix methodology on developing effective system engineers using a combination of mission engineer interviews as informed by searching the open source literature.
  - Interviews and open source literature covers 1) mission engineering definition and organizational support, 2) identification of competencies and gaps, and 3) future vision.
- The key competency areas are: discipline and domain foundations, mission concept, systems engineering skills, systems mindset, interpersonal skills, and technical leadership.



# Mission Engineering Definition

Mission engineering is the deliberate planning, analyzing, organizing, and integrating of current and emerging operational and systems capabilities to achieve desired warfighting mission effects – Gold 2016



Or, more simply put . . .  
The mission is the system.



# Mission Engineering Context

- Mission engineering differs from mission analysis in that the latter only addresses current operational and system capabilities and not the engineering to assure the mission.
- Mission engineering within the Department of Defense (DoD) applies an **operational mission context** to the **complex systems of systems (SoS)**.
- The SoS approach has arisen in response to the DoD's needs for capabilities requiring multiple linked systems that are greater than the sum of the capabilities of the constituent parts.
- Mission engineering differs from traditional systems engineering because from the **mission engineering perspective**, the **individual systems that comprise the military capability are inherently flexible, functionally overlapping, multi-mission platforms** supported by a complex backbone of **information communication networks**.
- Several other allied nations use the term “capabilities engineering” rather than mission engineering.



# Research Tasking and Objectives

The Office of the Deputy Assistant Secretary of Defense for Systems Engineering ODASD(SE) tasked the SERC to identify critical skills required to successfully accomplish and shepherd Mission Engineering.

- 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.
- Identify aspects of mission engineering that are general enough to be considered critical by the broader acquisition workforce, yet specific enough to support building interdisciplinary mission engineering knowledge and abilities.
- 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, as well as modifying the applicable acquisition career fields' curricula to build interdisciplinary mission engineering knowledge and abilities.



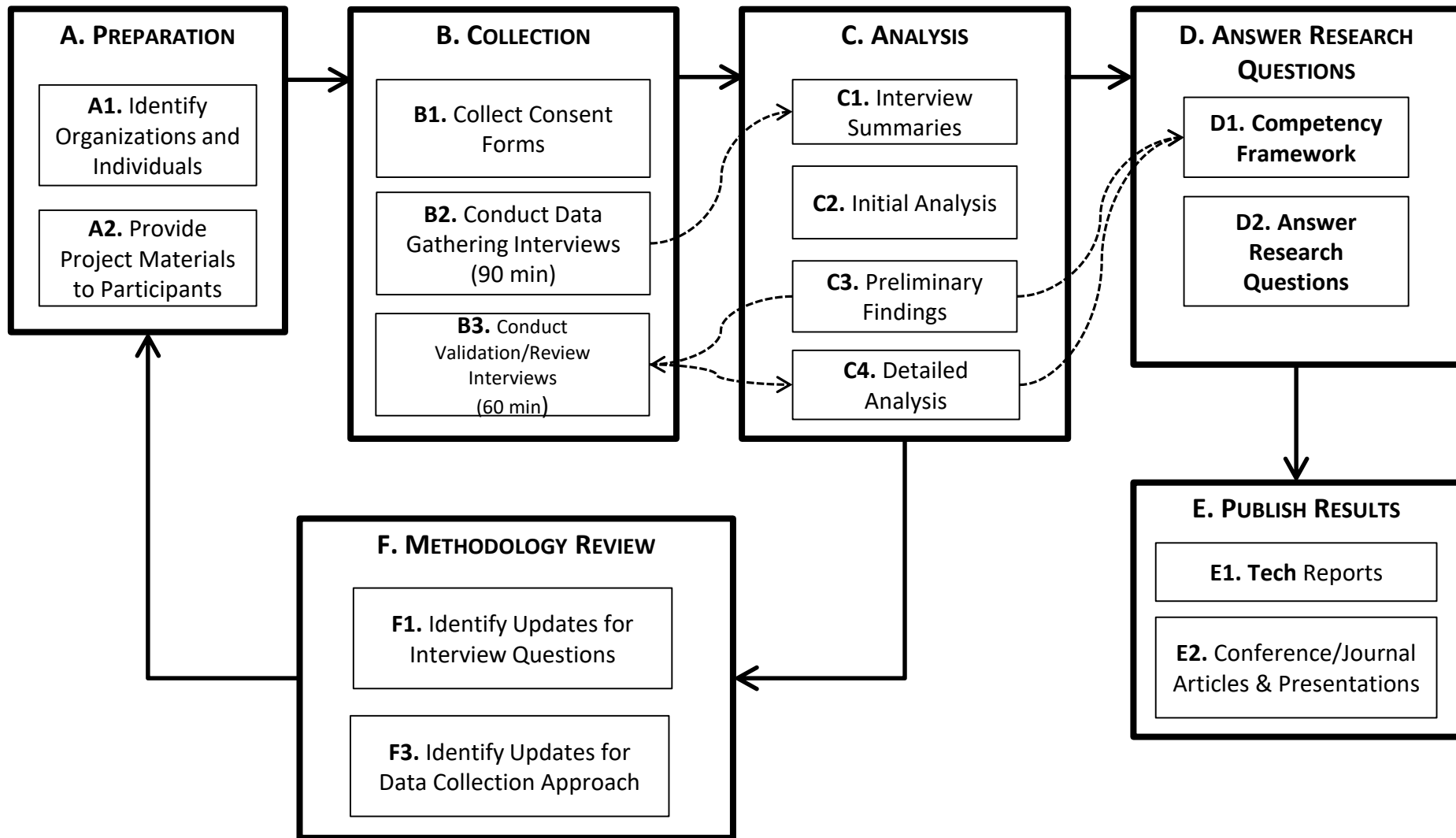
# Mission Engineering Competency Study

- Mission engineering (ME) competency model lays out the skills, abilities and behaviors that are critical to ME and whether they are unique or overlap with systems engineering.
- The research draws heavily from the Helix methodology on developing effective system engineers.
- Reflects industry approaches and best practices.



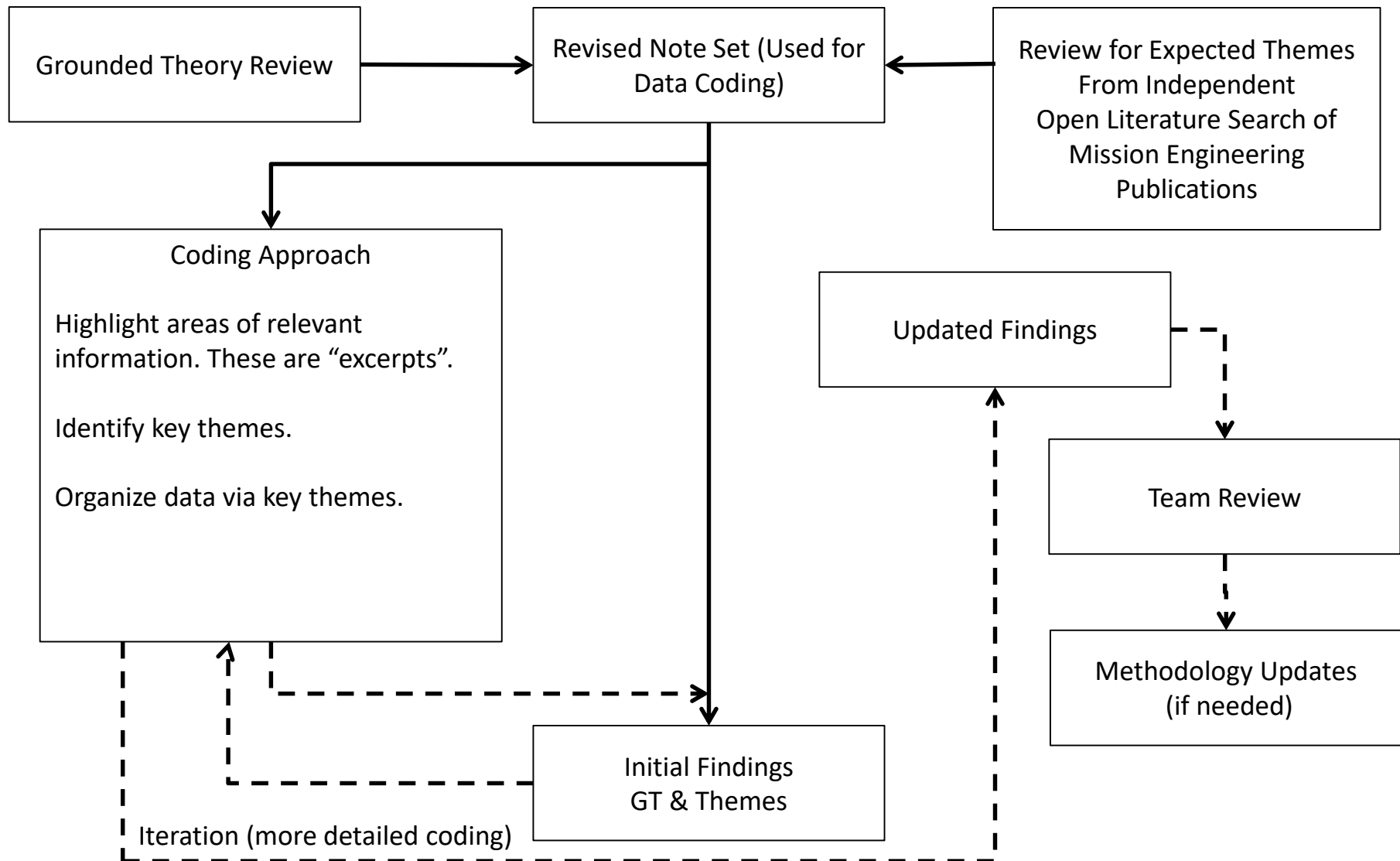


# Interview Methodology

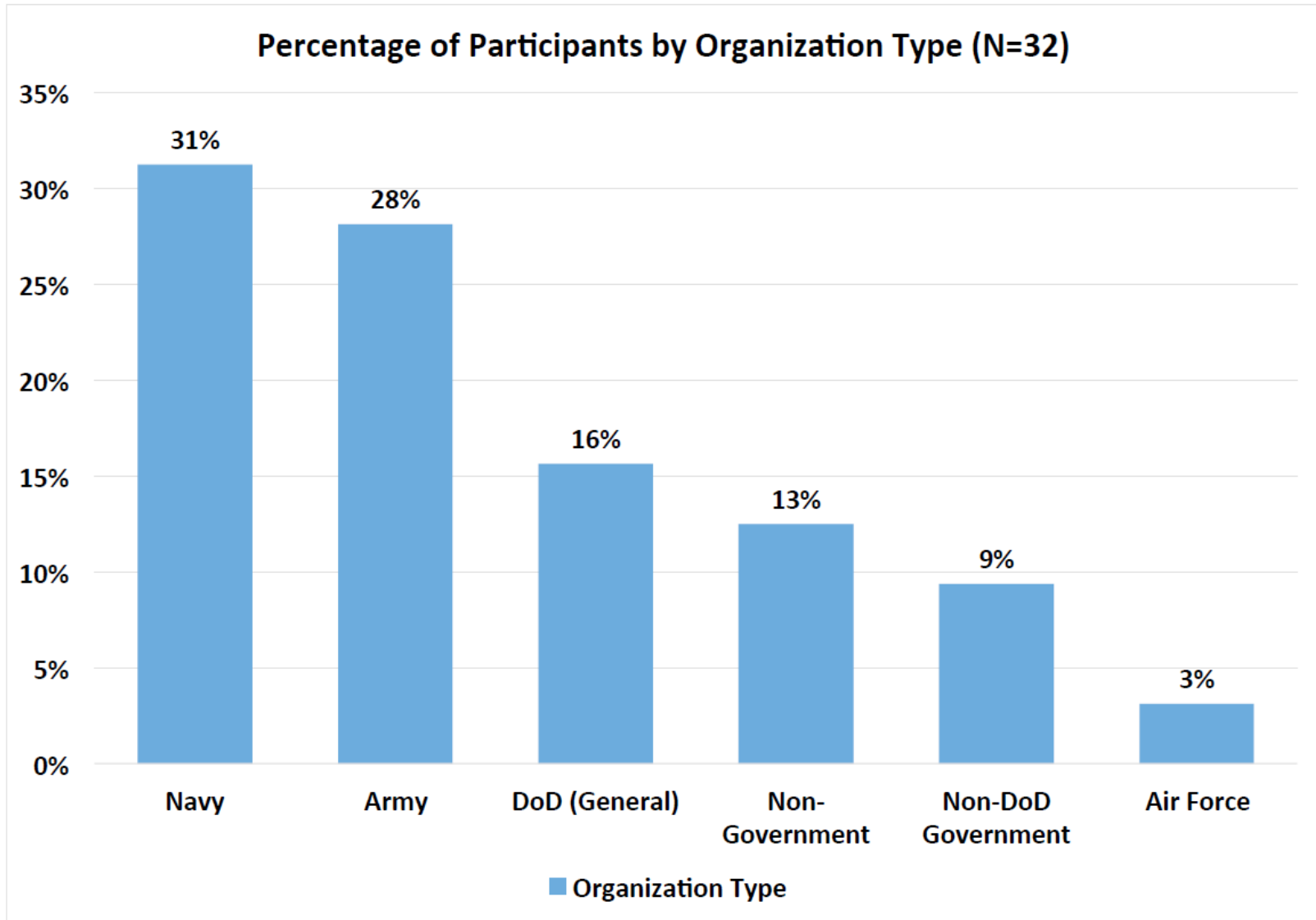




# Interview Data Analysis



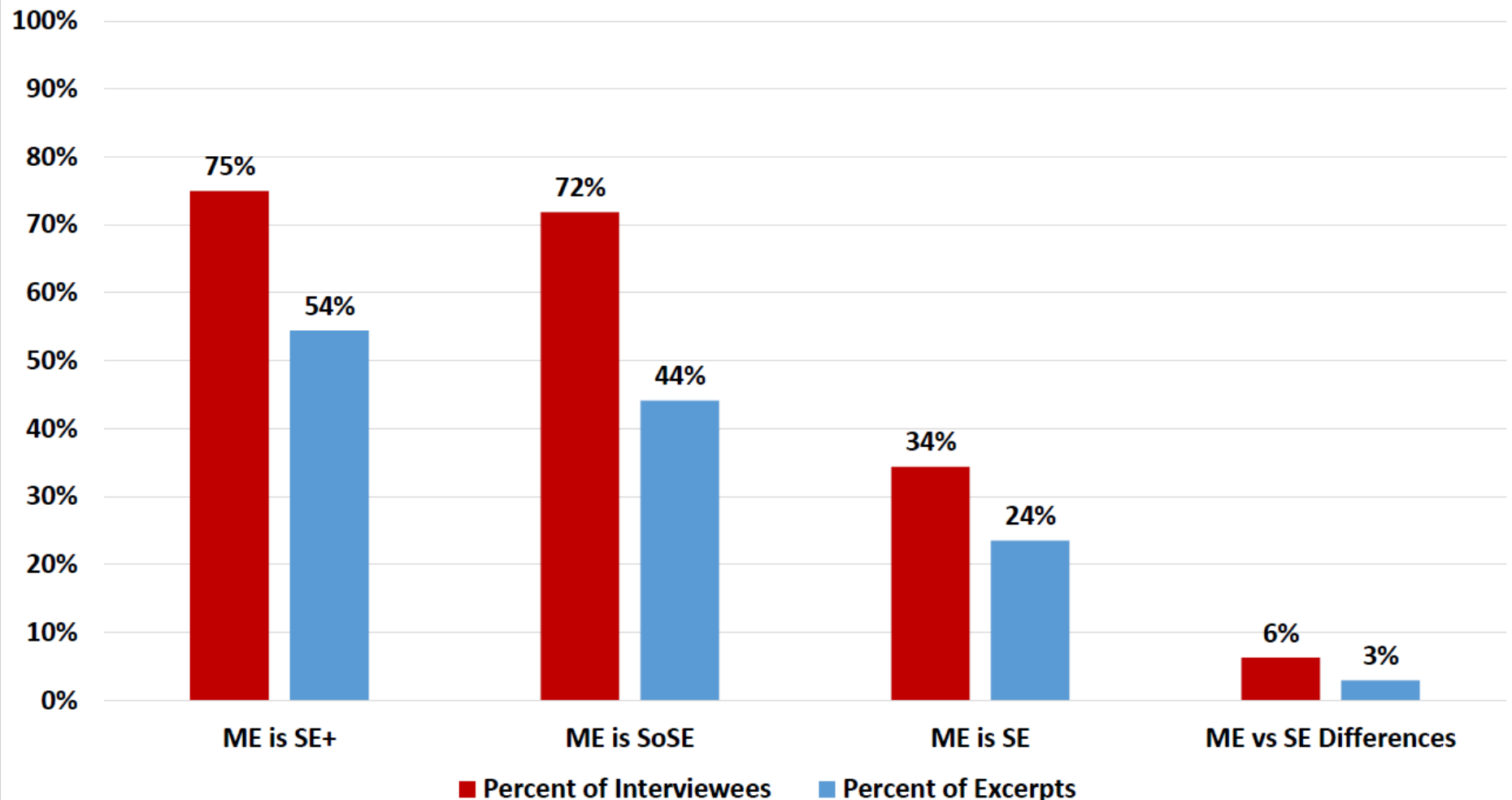






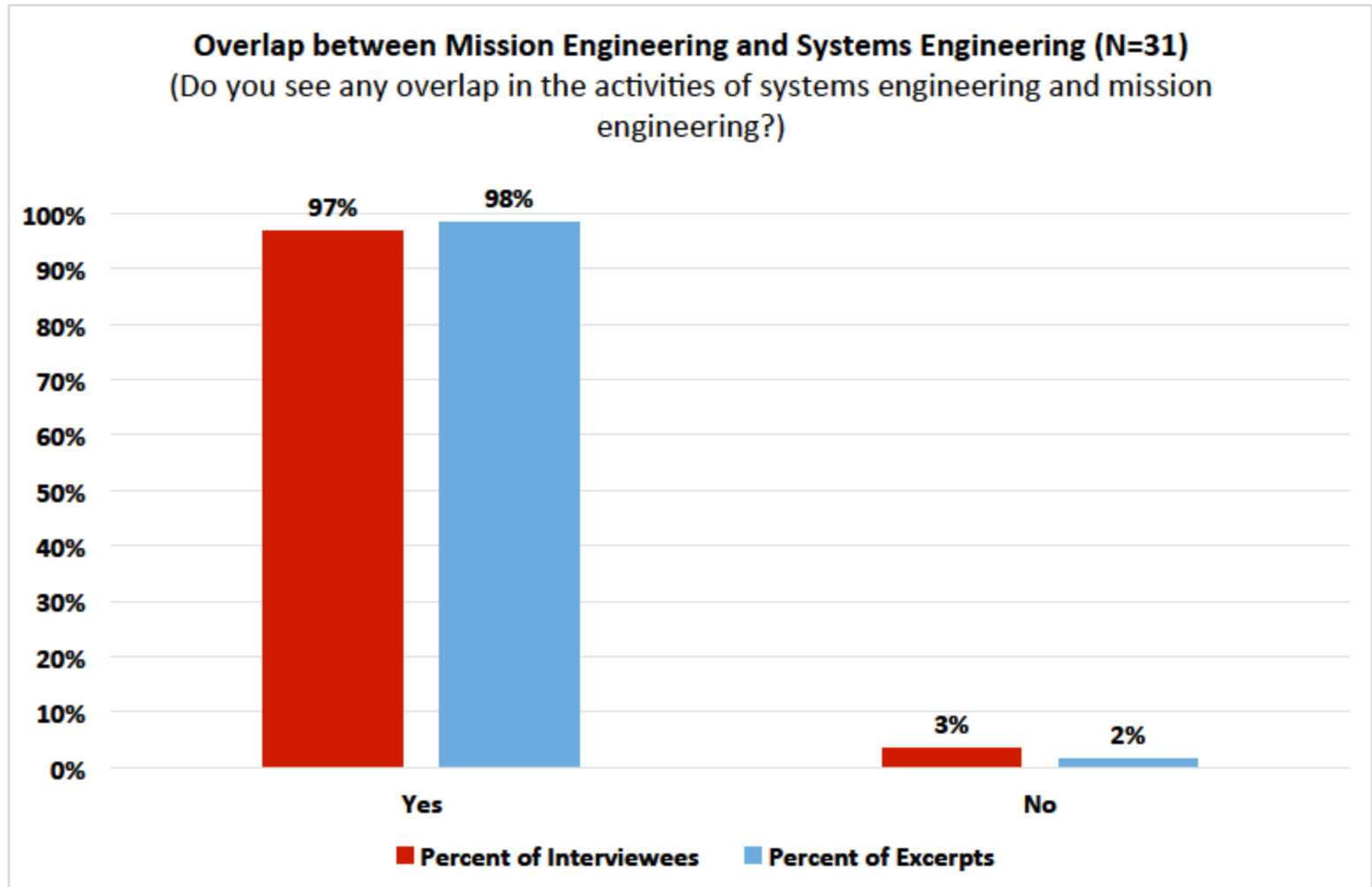
# Q: What is mission engineering?

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



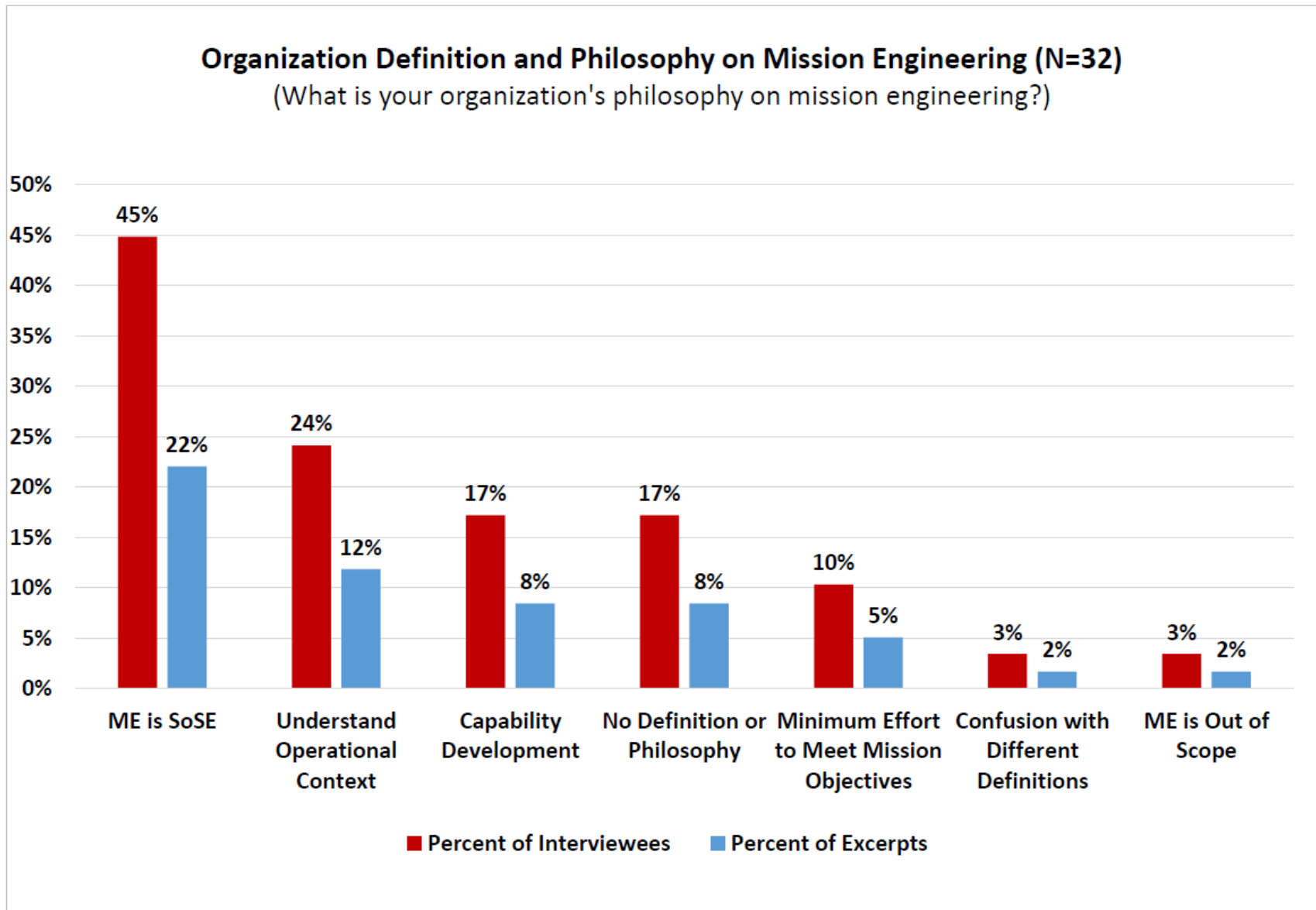


# Q: Mission engineering and systems engineering



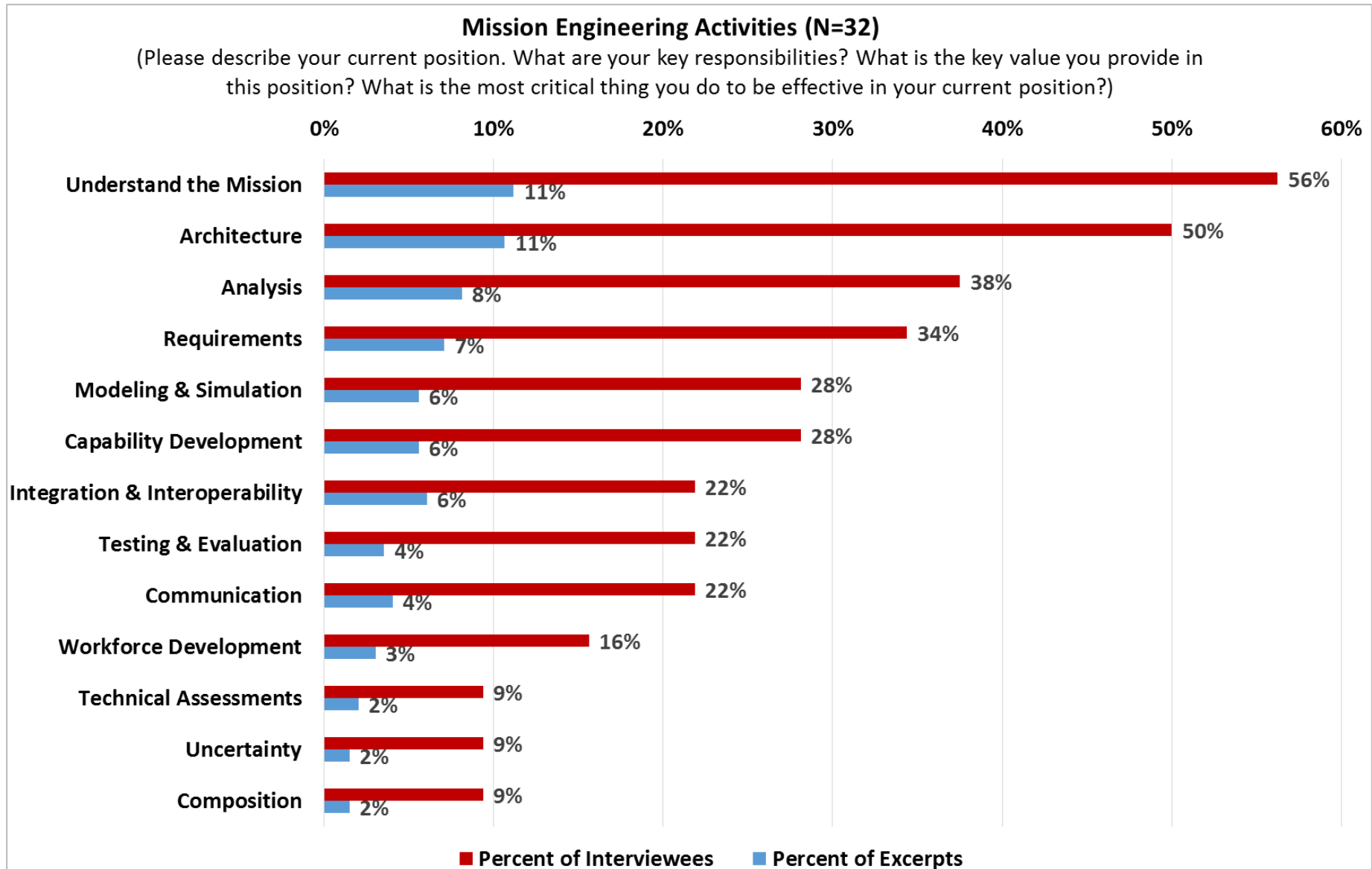


# Q: What is the Philosophical Approach to Mission Engineering?





# Q: What are Mission Engineering Activities?



# Competency Analysis Approach: Initial Coding

Windows 8.1 File Edit View Actions Devices Window Help

MissionEngineeringCompetency\_MASTER\_v0.2\_12Sept2017\_NH.nvp - NVivo Pro

FILE HOME CREATE DATA ANALYZE QUERY EXPLORE LAYOUT VIEW

Go Refresh Open Properties Edit Paste Cut Copy Merge

Workspace Item Clipboard Format Paragraph Styles Editing Proofing

Sources

Look for Search In Interview Summ Find Now Clear Advanced Find

Interview Summaries

Name	Nodes	References
Interview Summary - D31_01 - 20170616	24	66
Interview Summary - [REDACTED]	14	29
Interview Summary - [REDACTED]	16	36
Interview Summary - [REDACTED]	13	36
Interview Summary - [REDACTED]	25	70
Interview Summary - [REDACTED]	19	40
Interview Summary - [REDACTED]	14	31
Interview Summary - [REDACTED]	14	40

Technical Systems Mindset Soft Skills Interview Summary - D31\_01 - [REDACTED]

Click to edit

**RT-171: Mission Engineering Competencies**

**Interview Summary from D31\_01 (June 16, 2017)**

**I. Mission Engineering**

[REDACTED]

In your own words, what is mission engineering?  
Essentially it's systems engineering (SE)

What is your organization's process or a

[REDACTED]

Code... Ctrl+F2

Code to Recent Nodes Ctrl+F8

Code In Vivo Ctrl+Shift+F2

Unicode... Ctrl+Shift+F2

Unicode from Recent Nodes

Edit Ctrl+E

Export Document... Ctrl+Shift+E

Print Ctrl+P

Cut Ctrl+X

Copy Ctrl+C

Paste Ctrl+V

Paste As See Also Link

Delete Del

Select All Ctrl+A

Links

Document Properties... Ctrl+Shift+P

Systems Mindset (Nodes\Competencies)

Depth (Nodes\Competencies\Technical)

Operational Context (Nodes\Competencies\Technical)

Translation (Nodes\Competencies\Soft Skills)

Model-Based (Nodes\Competencies\Technical)

Analysis (Nodes\Competencies\Technical)

Architecture (Nodes\Competencies\Technical)

Requirements Process (Nodes\Competencies\Technical)

Vision (Nodes\Competencies\Technical)

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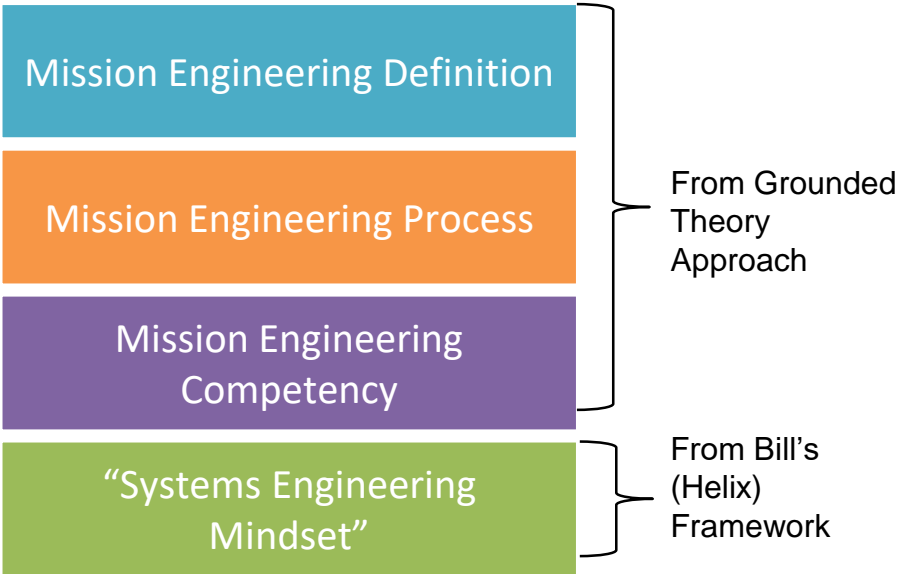
Go to PC settings to activate Windows.

NAH 8 Items Nodes: 24 References: 66 Read-Only Line: 14 Column: 0



# Analysis Approach: Review Excerpts and Update Coding Structure Based on Details

## Coding Example



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



# Coding: An Iterative Analysis

- Career path
- Challenges in Systems of Systems
- Competencies
- Definition of Mission Engineering
- Definition of System of Systems
- Personal Characteristics



- Competencies
  - Soft Skills
  - Systems Mindset
  - Technical
  - Most Helpful Personally



- Competencies
  - Soft Skills
    - Communication
    - Translation
    - Relationships
    - SME Network
    - Team Building

- Grounded Theory
  - “Bottom up” approach reflecting the patterns seen in the data
  - Paired with a “top down” approach from reviewing the literature (separate)
- Multi-iteration effort
  - “Chunking” into main categories
  - Development of sub-categories
  - Additional refinement





# Initial Mission Engineering Competency Framework

## 6. Technical Leadership

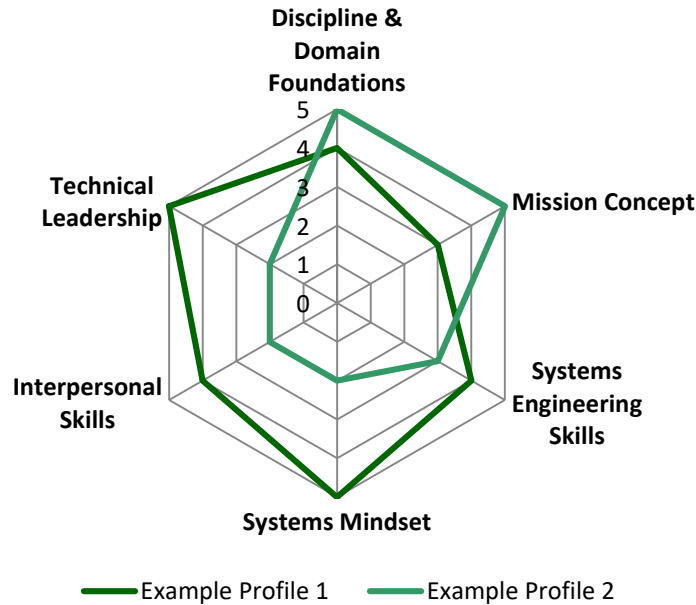
Guiding Diverse Stakeholders
Team Building
Political Savvy
Decision Making
Workforce Development

## 5. Interpersonal Skills

Communication
Translation
Enterprise Context
Building & Utilizing a SME Network
Coordination
Influence, Persuasion, & Negotiation

## 4. Systems Mindset

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



## 3. Systems Engineering Skills

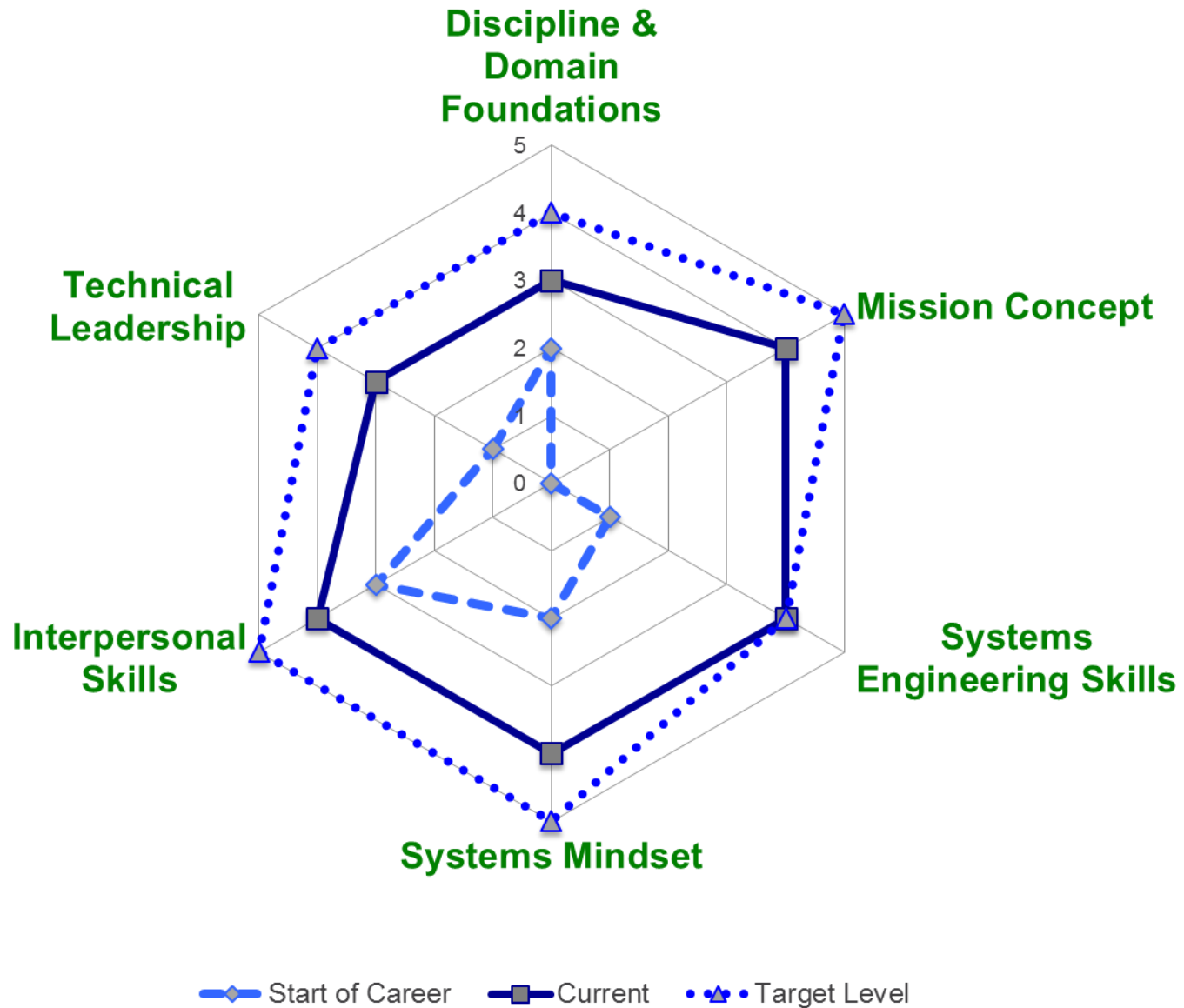
System of Systems Engineering
Analysis
Architecture
Modeling and Simulation
Requirements
Integration
Gap Analysis

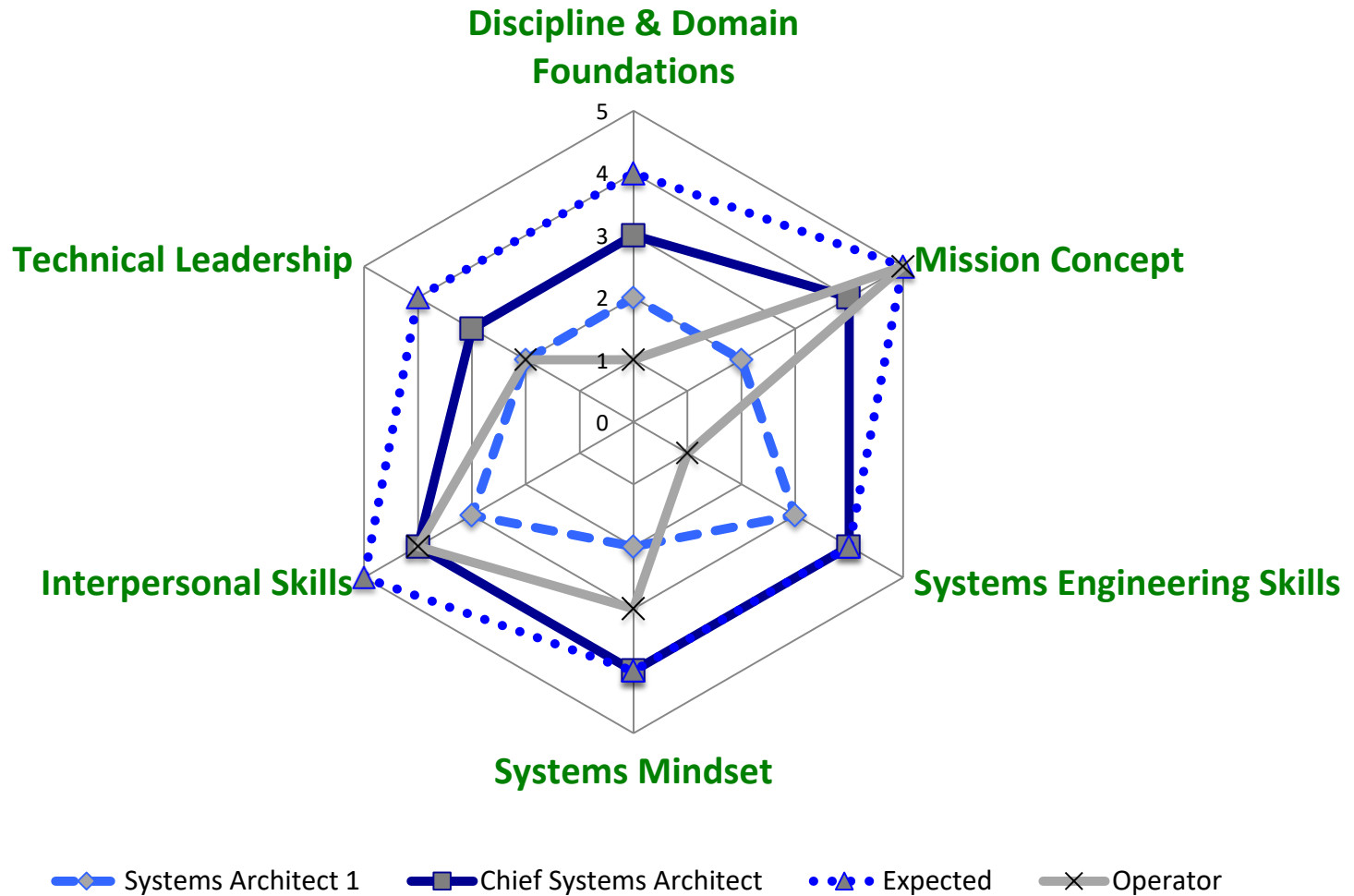
## 1. Discipline & Domain Foundations

Principle and Relevant Disciplines
Relevant Domains
System Characteristics
Relevant Systems
Relevant Technologies
Acquisition Context

## 2. Mission Concept

Operational Context
Mission Concept of Operation
Mission Scenarios/Threads
DOTMLPF Space







# Initial Findings – Mission Engineering Definitions

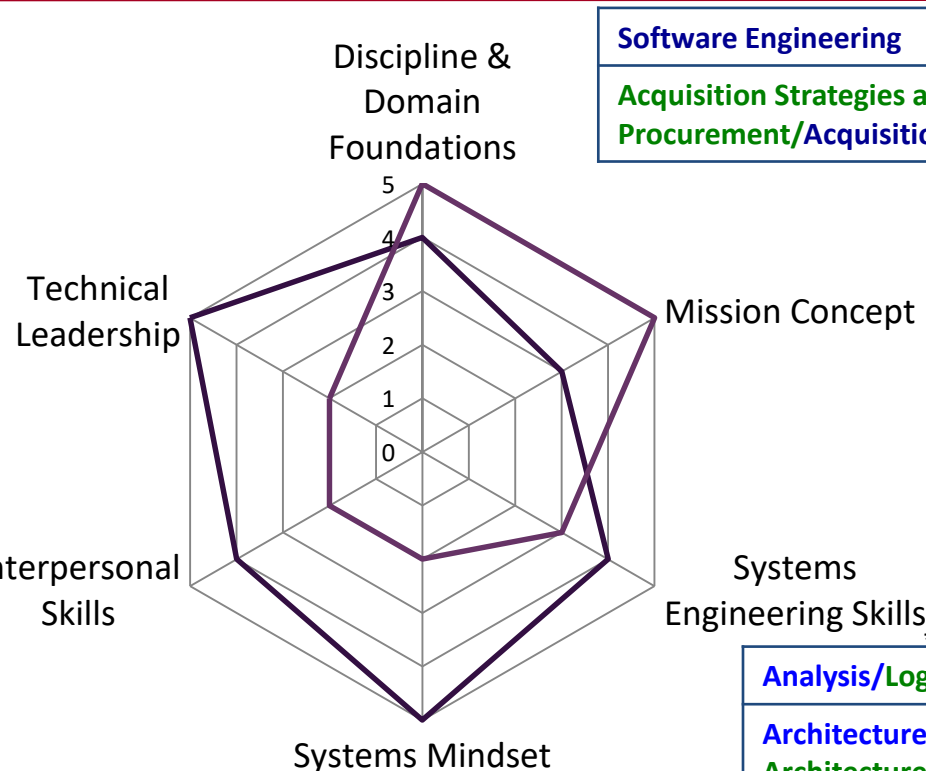
Technical Leadership/Leadership
Team Dynamics/Team Dynamics and Management/Leading High Performance Teams
Stakeholder Expectation and Definition/Stakeholder Requirements Definition/Managing Stakeholders
Facilitation
Decision Analysis
Coaching and Mentoring/Mentoring and Coaching/Coaching and Mentoring

Communication/Communication/Communication
NASA Interior and Exterior Environment
Negotiation/Negotiations
Organization

INCOSE Competency Framework

NASA Systems Engineering Competencies

NAVY SE Competency Model



— Example Profile 1 — Example Profile 2

Critical Thinking
Systems Thinking
Strategic Thinking
Problem Solving

Software Engineering
Acquisition Strategies and Procurement/Acquisition

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



# Initial Findings – Mission Engineering Futures

- Responses to Inquiries of Future Vision for Mission Engineering
- 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 know future requirements to do Mission Engineering and to turn these requirements into capabilities to achieved the desired effects
- 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
- Mission Engineering is established and embedded in all Systems Engineering organizations
  - Every engineer is a mission engineer in terms of working the mission



- 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.***

- Research tasking and objectives identify the critical skills required to successfully accomplish and shepherd mission engineering.
- Competency model builds on grounded theory leveraging the Helix methodology on developing effective system engineers, using a combination of mission engineer interviews as informed by searching the open source literature.
- Interviews and open source literature covers 1) mission engineering definition and organizational support, 2) identification of competencies and gaps, and 3) future vision.
- 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, 5) and leadership skills.



# Questions?



# Analysis Approach: Initial Coding

Windows 8.1

MissionEngineeringCompetency\_MASTER\_v0.1\_20June2017.nvp - NVivo Pro

FILE HOME CREATE DATA ANALYZE QUERY EXPLORE LAYOUT VIEW

Go Refresh Open Properties Edit Paste Copy Cut Merge

Workspace Item Clipboard

Calibri 12

List Paragraph

Reset Settings

Select PDF Selection Text Region Find Replace Delete Spelling

Sources

Look for Search In Interview Summ Find Now Clear Advanced Find

Internals

Interview Summaries

Externals

DoD or Service Resources

Memos

Framework Matrices

Interview Summaries

Name	Nodes	References
Interview Summary	13	34
Interview Summary	11	21
Interview Summary	10	20
Interview Summary	10	14
Interview Summary	9	14
Interview Summary	8	12

Soft Skills Technical Competencies ME Critical Activities Competencies

Click to edit

RT-171: Mission Engineering Competencies

Interview Summary from (June 16, 2017)

Essentially it's systems engineering

Code Selection At Existing Nodes... Ctrl+F2

Code Selection At New Node... Ctrl+F3

Code Selection At Current Nodes Ctrl+F9

Recent Nodes

- Breadth (Nodes\\Competencies\\Technical)
- Systems Mindset (Nodes\\Competencies)
- Soft Skills (Nodes\\Competencies)
- ME Critical Activities (Nodes)
- Operational Context (Nodes\\Competencies\\Technical)
- Model-Based (Nodes\\Competencies\\Technical)
- Competencies (Nodes)
- Technical (Nodes\\Competencies)
- ME is SE+ (Nodes\\Definition of ME)

Activate Windows

Go to PC settings to activate Windows.





# Analysis Approach: Review Excerpts and Update Coding Structure Based on Details

FILE

HOME

CREATE

DATA

ANALYZE

QUERY

EXPLORE

LAYOUT

VIEW

Project

Documents

PDFs

Dataset

Audios

Pictures

Memos

From Other Sources

Classification Sheets

Attribute Values

Report

Extract

Items

List

Project

Classification Sheets

To Other Destinations

Export

Purchase Transcript

Check Status

Transcription

Import

Nodes

Nodes

Cases

Relationships

Node Matrices

Nodes

Name	Sources	References
Competencies	7	41
Soft Skills	4	11
Systems Mindset	7	11
Technical	6	15
Breadth	3	3
Model-Based	3	4
Operational Context	3	7
Current Effectiveness	5	8
Definition of ME	6	10
ME is a Different Discipline from SE	0	0
ME is SE	2	2
ME is SE+	4	5
ME is SOSE	2	2
ME vs SE Differences	2	2
ME Critical Activities	6	10
Personal Characteristics	3	7

Competencies

<Internals\Interview Summaries\Interview Summary - [6.64% Coverage]

Reference 1 - 0.41% Coverage

- Know all the disciplines to some degree.

Reference 2 - 1.34% Coverage

- Have excellent communication skills. We get SMEs in the area and we they need to communicate with them, both orally and in writing.

Reference 3 - 0.26% Coverage

- Soft skills are important.

Reference 4 - 0.82% Coverage

- Ability to be deliberate when we look at the challenges in projects that we have.

Reference 5 - 0.35% Coverage

- Being able to understand the system

References 6-7 - 0.24% Coverage

- be flexible in thinking.

Reference 8 - 1.12% Coverage

- There are a lot of issues in engineering systems and we have to bring the right help to deal with these things.

Reference 9 - 1.47% Coverage

- Go to outside experts. Have the attitude that we don't know it all and know when to go outside. Some think they know it all but they never will.

Reference 10 - 0.62% Coverage

- Need help to solve a problem or to understand the technology.

Sources

Nodes

Classifications

Collections

Queries

Reports

Maps



# Analysis Approach: Review Excerpts and Update Coding Structure Based on Details

Nodes			
	Name	Sources	References
[-]	Competencies	7	41
	Soft Skills	4	11
	Systems Mindset	7	11
[-]	Technical	6	15
	Breadth	3	3
	Model-Based	3	4
	Operational Context	3	7
	Current Effectiveness	5	8
[-]	Definition of ME	6	10
	ME is a Different Discipline from SE	0	0
	ME is SE	2	2
[-]	ME is SE+	4	5
	ME is SOSE	2	2
	ME vs SE Differences	2	2
	ME Critical Activities	6	10
	Personal Characteristics	3	7

Total number of times the theme was mentioned across all interviews

Total number of interviews in which the theme was mentioned. (Equates to number of interviewees who discussed this.)

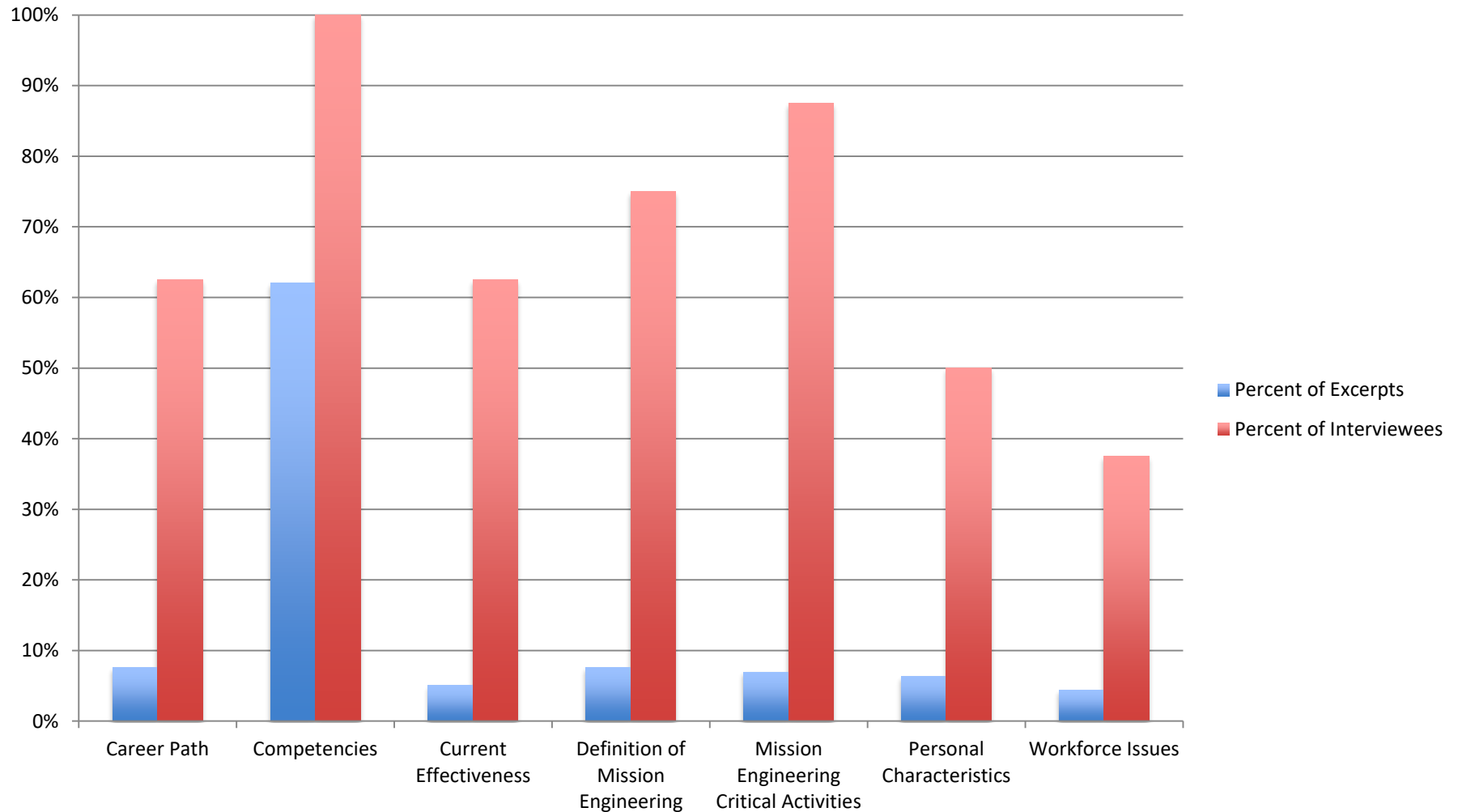
## Preliminary findings:

- All interviewees believe that ME is either equivalent to SE or is SE with a different perspective/additional skills
- A quarter have defined ME as SoS or “end-to-end” SE
- Competencies generally align with the three types of competencies outlined in Helix:
  - Soft Skills
  - Systems Mindset
  - Technical Skills



# Coverage of Coding Categories

Major Coding Categories





## Mission Engineering Competencies

