

Mission Engineering Competencies

Sponsor: DASD(SE)

Presented By

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Research Team

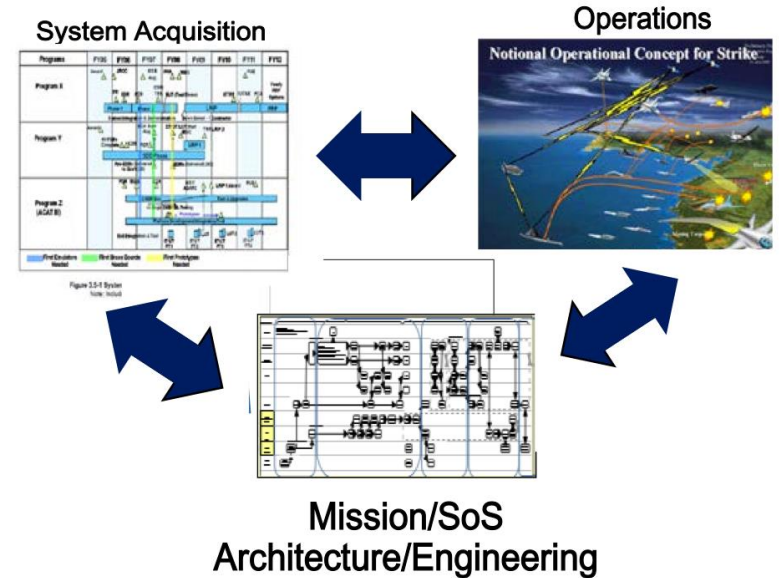
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- Mission engineering is the application of systems of systems (SoS) engineering in an operational context.
- Research tasking and objectives to identify the critical skills required to successfully accomplish and shepherd mission engineering.
- Competency model builds on grounded theory leverages 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.
- The key competency areas are: discipline and domain foundations, mission concept, systems engineering skills, systems mindset, interpersonal skills, and technical leadership.

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.

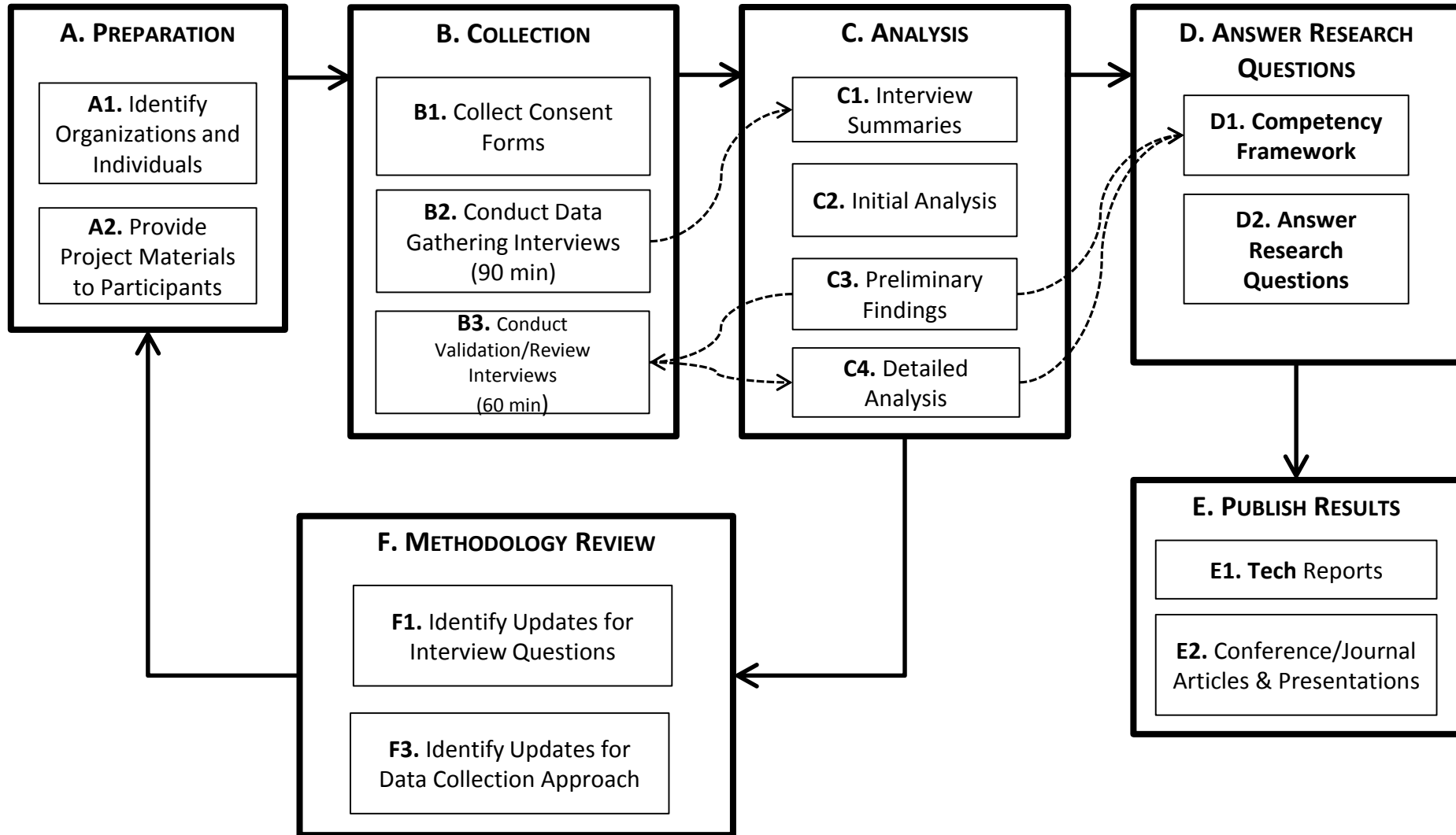
- Mission engineering differs from mission analysis in that the latter only addresses current operational and system capabilities and not the engineering to assure the mission.
- Mission engineering within the Department of Defense (DoD) **applies an operational mission context to the complex systems of systems (SoS).**
- The SoS approach has arisen in response to the DoDs 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.

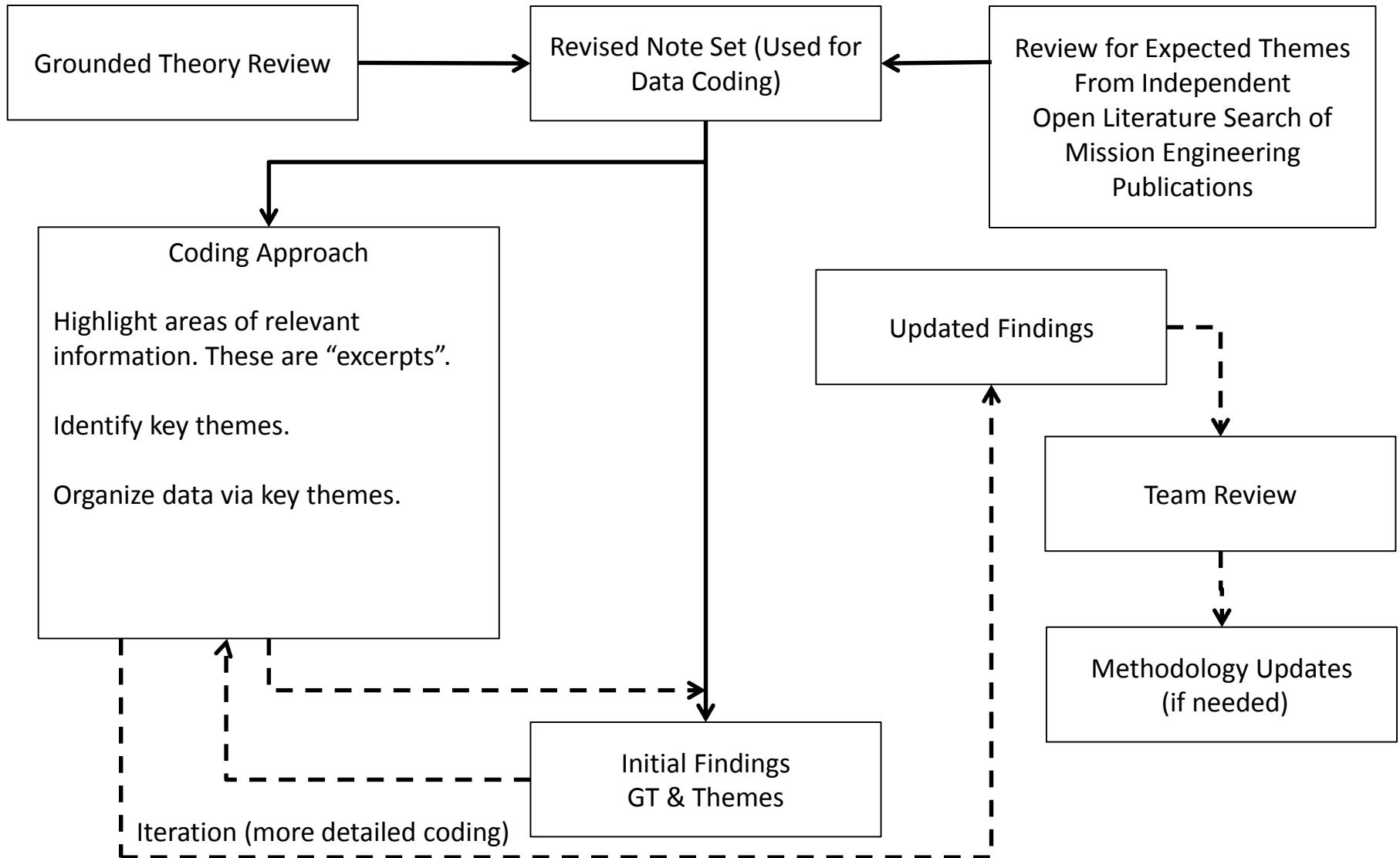
The Office of the Deputy Assistant Secretary of Defense for Systems Engineering ODASD(SE) has tasked the Systems Engineering Research Center (SERC) to identify the critical skills required to successfully accomplish and shepherd Mission Engineering.

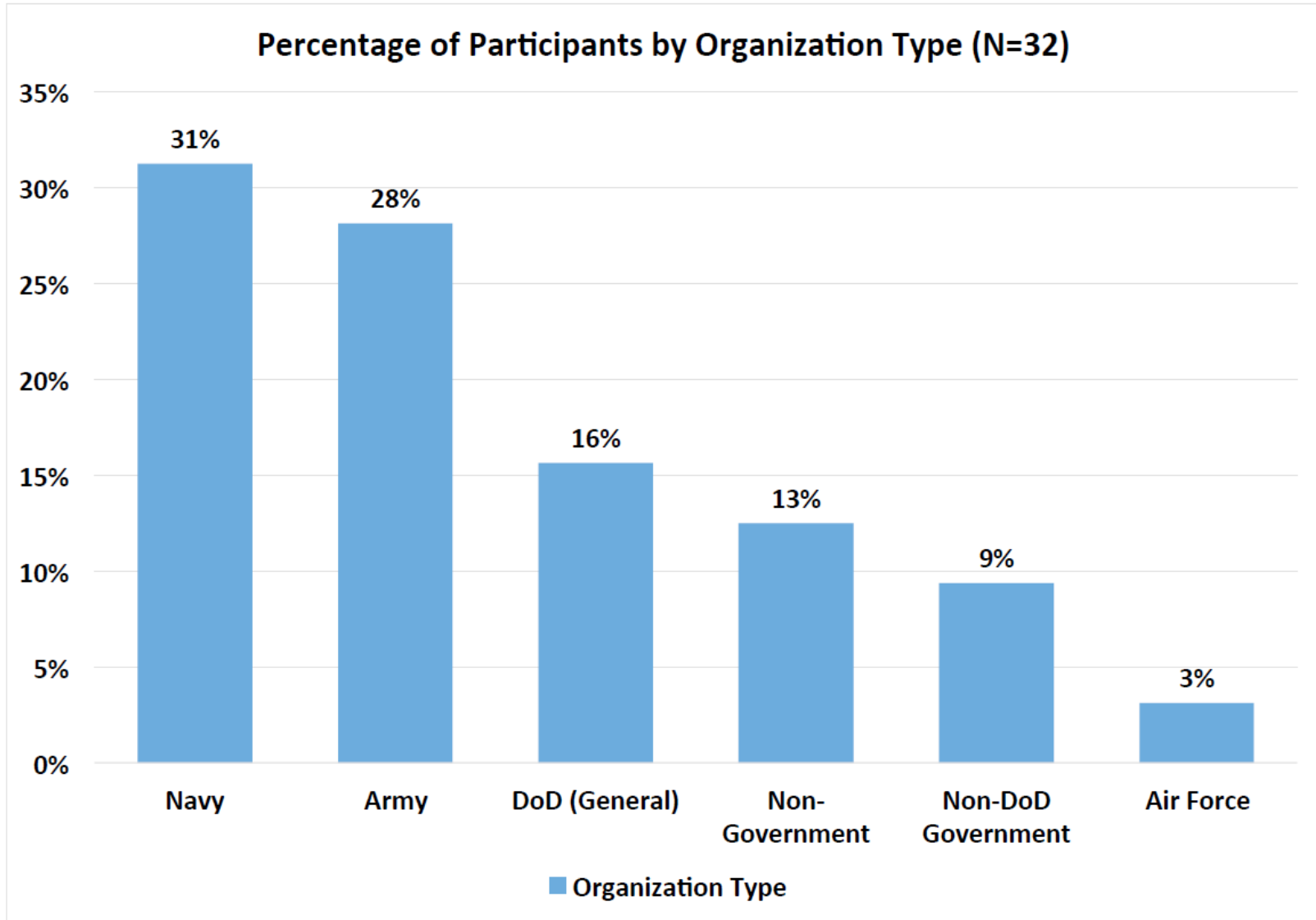
- Identify competencies for mission engineering that are truly unique, showing where there is separation from the generally demanded acquisition competencies or systems engineering competencies.
- Identify critical overlaps between mission engineering and systems engineering competencies.
- Identify 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 (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.



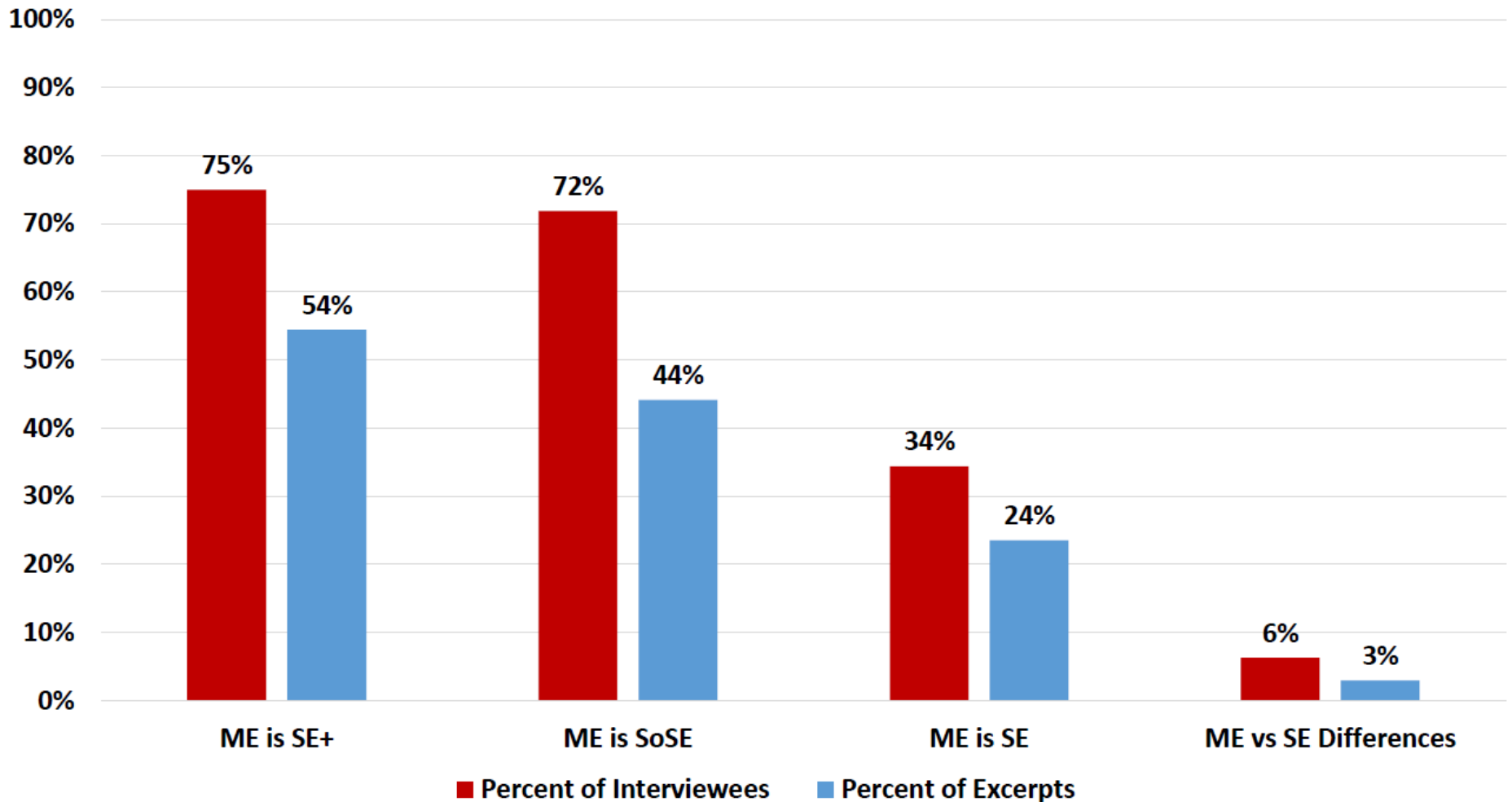


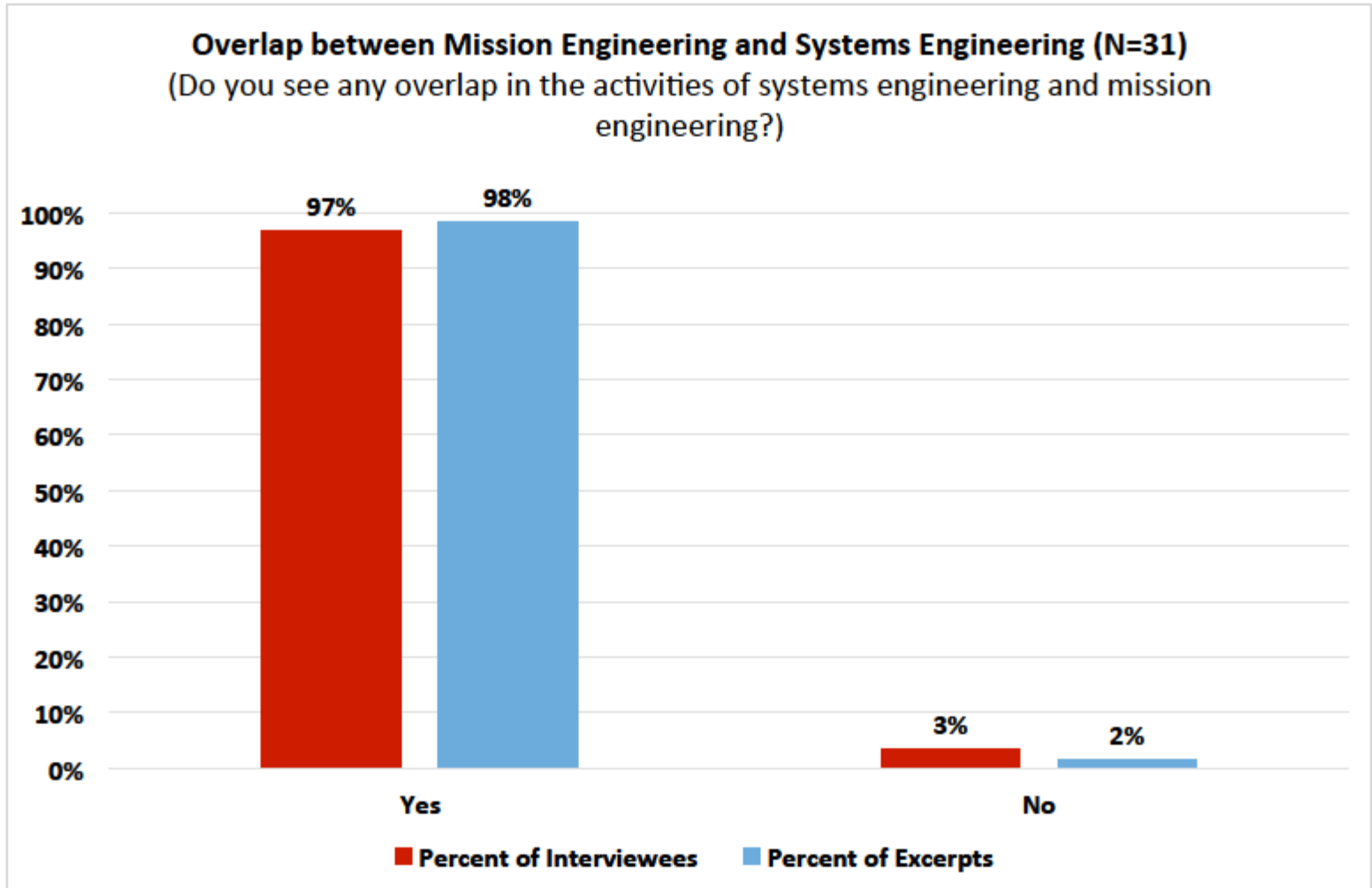




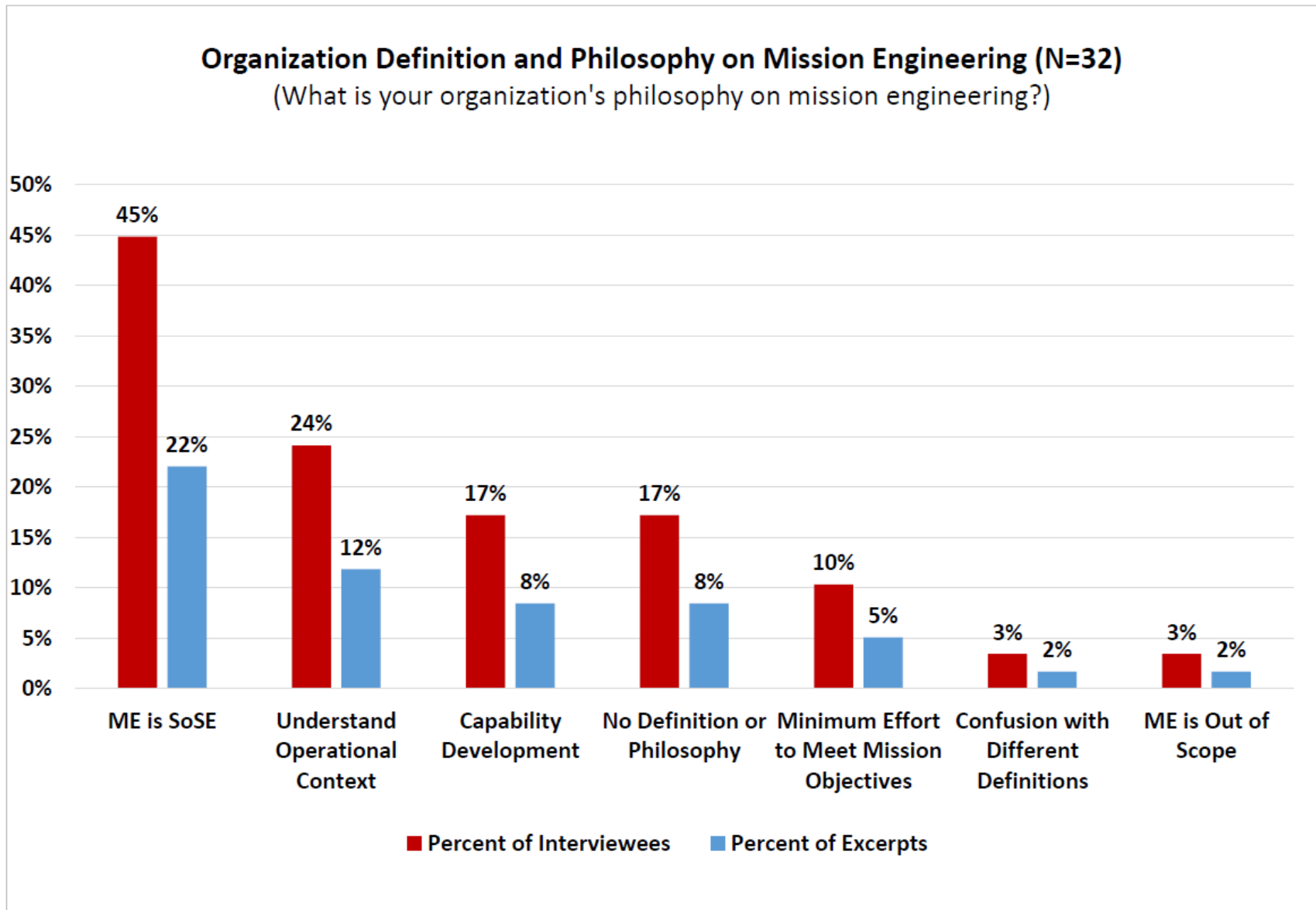
Q: What is mission engineering?

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

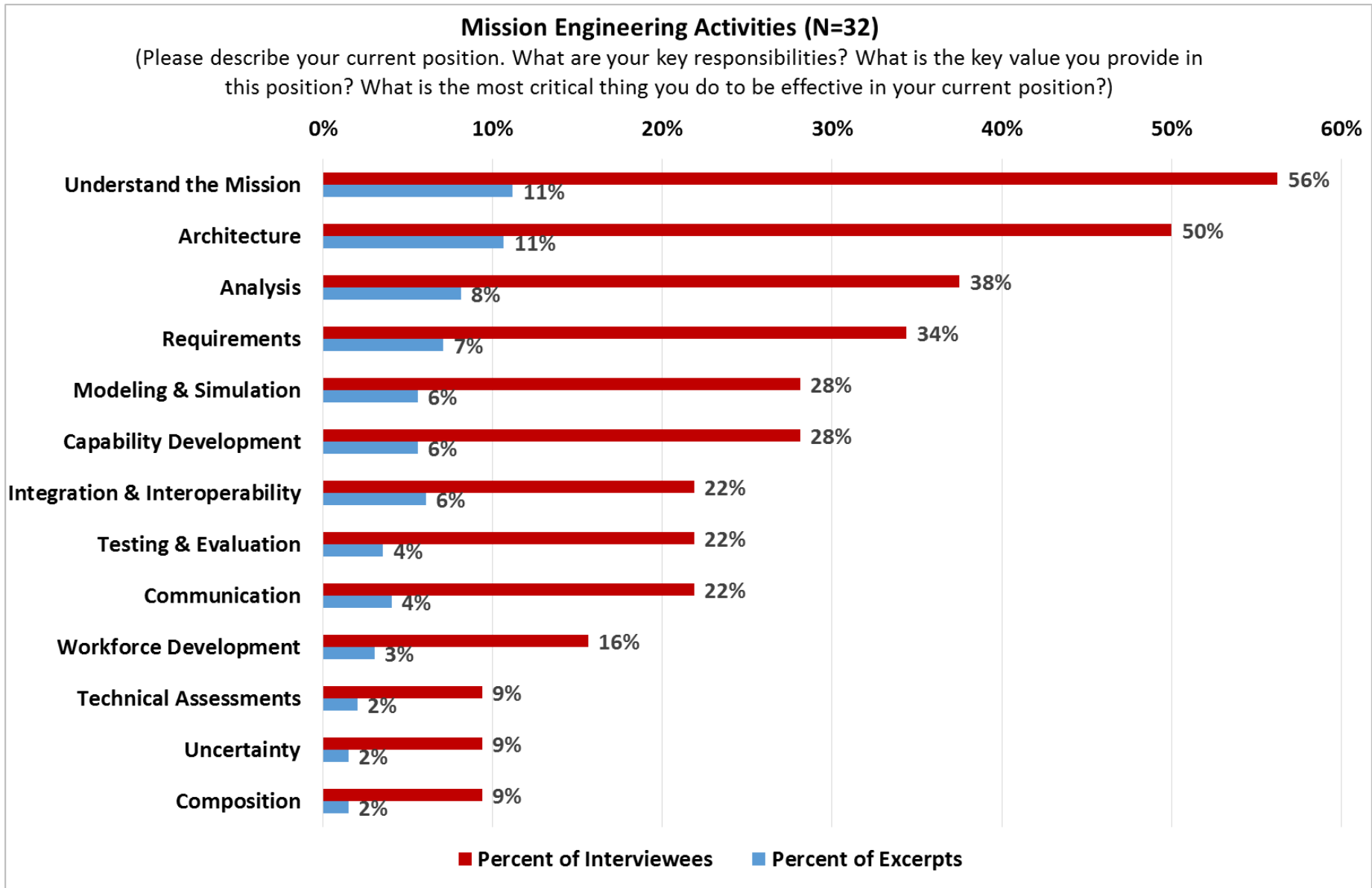


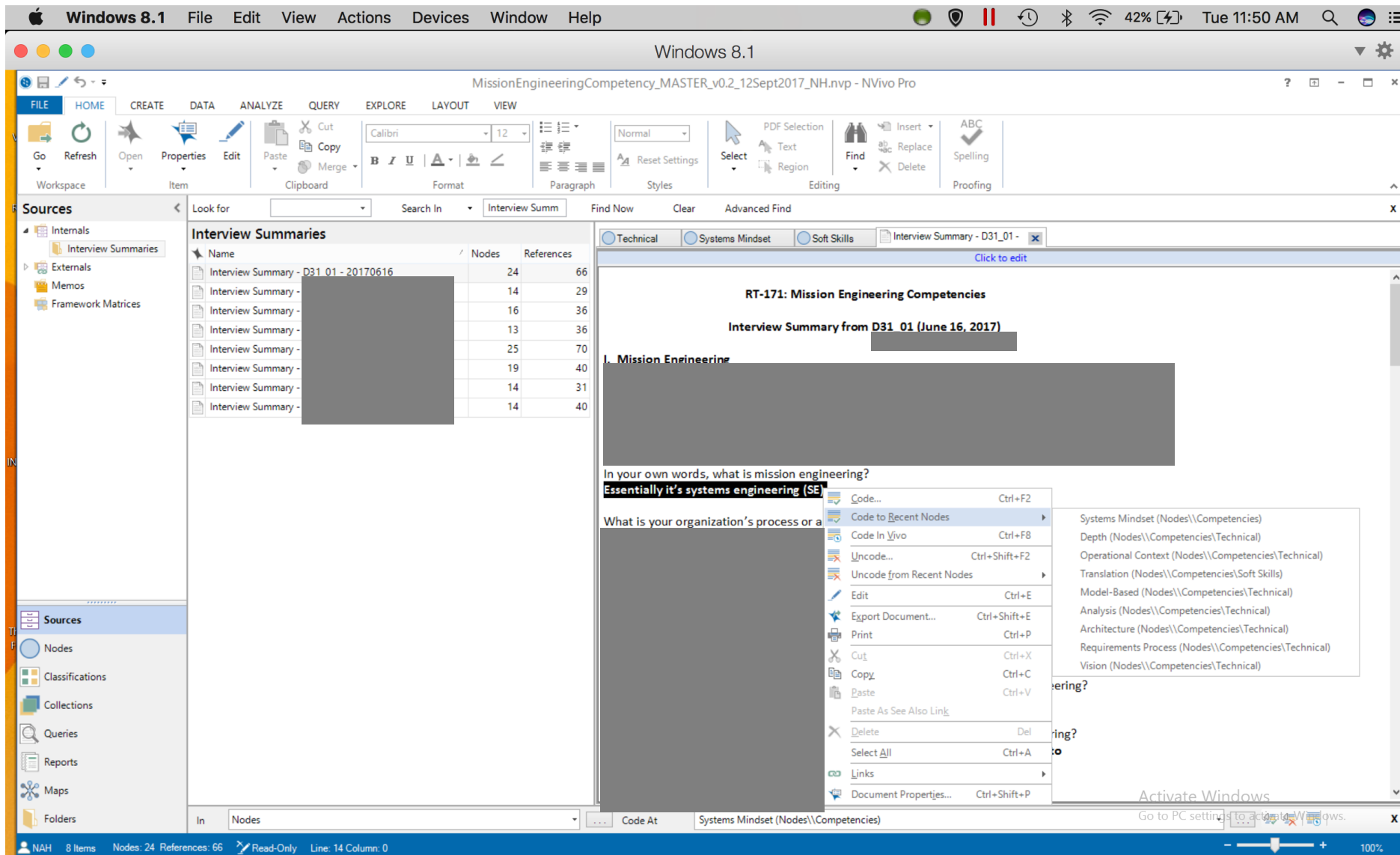


Q: What is the Philosophical Approach to Mission Engineering?



Q: What are Mission Engineering Activities?





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

Workspace Item Clipboard Format Paragraph Styles Editing Proofing

Sources

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 -

Click to edit

RT-171: Mission Engineering Competencies

Interview Summary from D31 01 (June 16, 2017)

Mission Engineering

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

What is your organization's process or a

- Code... Ctrl+F2
- Code to Recent Nodes
- Code In Vivo Ctrl+F8
- 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

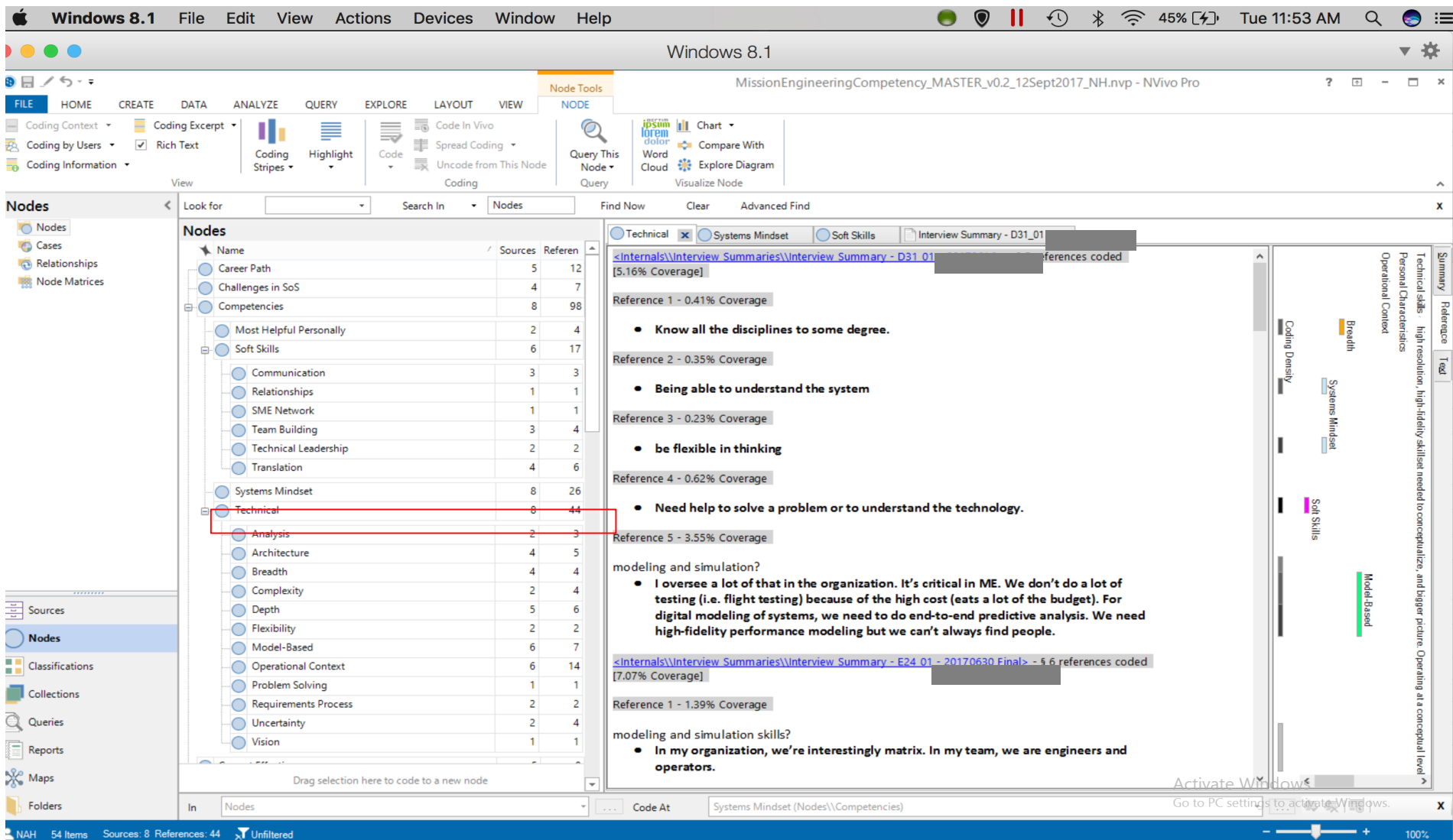
Systems Mindset (Nodes\Competencies)

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

Activate Windows

Go to PC settings to activate Windows.

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



The screenshot displays the NVivo Pro interface on a Windows 8.1 system. The main window shows a node hierarchy on the left and a text excerpt on the right. The node hierarchy includes:

- Nodes
 - Career Path (Sources: 5, References: 12)
 - Challenges in SoS (Sources: 4, References: 7)
 - Competencies (Sources: 8, References: 98)
 - Most Helpful Personally (Sources: 2, References: 4)
 - Soft Skills (Sources: 6, References: 17)
 - Communication (Sources: 3, References: 3)
 - Relationships (Sources: 1, References: 1)
 - SME Network (Sources: 1, References: 1)
 - Team Building (Sources: 3, References: 4)
 - Technical Leadership (Sources: 2, References: 2)
 - Translation (Sources: 4, References: 6)
 - Systems Mindset (Sources: 8, References: 26)
 - Technical (Sources: 8, References: 44)**
 - Analysis (Sources: 2, References: 3)
 - Architecture (Sources: 4, References: 5)
 - Breadth (Sources: 4, References: 4)
 - Complexity (Sources: 2, References: 4)
 - Depth (Sources: 5, References: 6)
 - Flexibility (Sources: 2, References: 2)
 - Model-Based (Sources: 6, References: 7)
 - Operational Context (Sources: 6, References: 14)
 - Problem Solving (Sources: 1, References: 1)
 - Requirements Process (Sources: 2, References: 2)
 - Uncertainty (Sources: 2, References: 4)
 - Vision (Sources: 1, References: 1)

The text excerpt on the right shows a list of references with their coverage percentages and associated coding. A red box highlights the 'Technical' node in the hierarchy, which is linked to the text excerpt. The text excerpt includes:

- Reference 1 - 0.41% Coverage: **Know all the disciplines to some degree.**
- Reference 2 - 0.35% Coverage: **Being able to understand the system**
- Reference 3 - 0.23% Coverage: **be flexible in thinking**
- Reference 4 - 0.62% Coverage: **Need help to solve a problem or to understand the technology.**
- Reference 5 - 3.55% Coverage: modeling and simulation?
 - I oversee a lot of that in the organization. It's critical in ME. We don't do a lot of testing (i.e. flight testing) because of the high cost (eats a lot of the budget). For digital modeling of systems, we need to do end-to-end predictive analysis. We need high-fidelity performance modeling but we can't always find people.**
- Reference 1 - 1.39% Coverage: modeling and simulation skills?
 - In my organization, we're interestingly matrix. In my team, we are engineers and operators.**

The interface also shows a 'Nodes' table with columns for Name, Sources, and References. The 'Technical' node is highlighted with a red box. The text excerpt is displayed in a window titled 'Interview Summary - D31_01'.

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



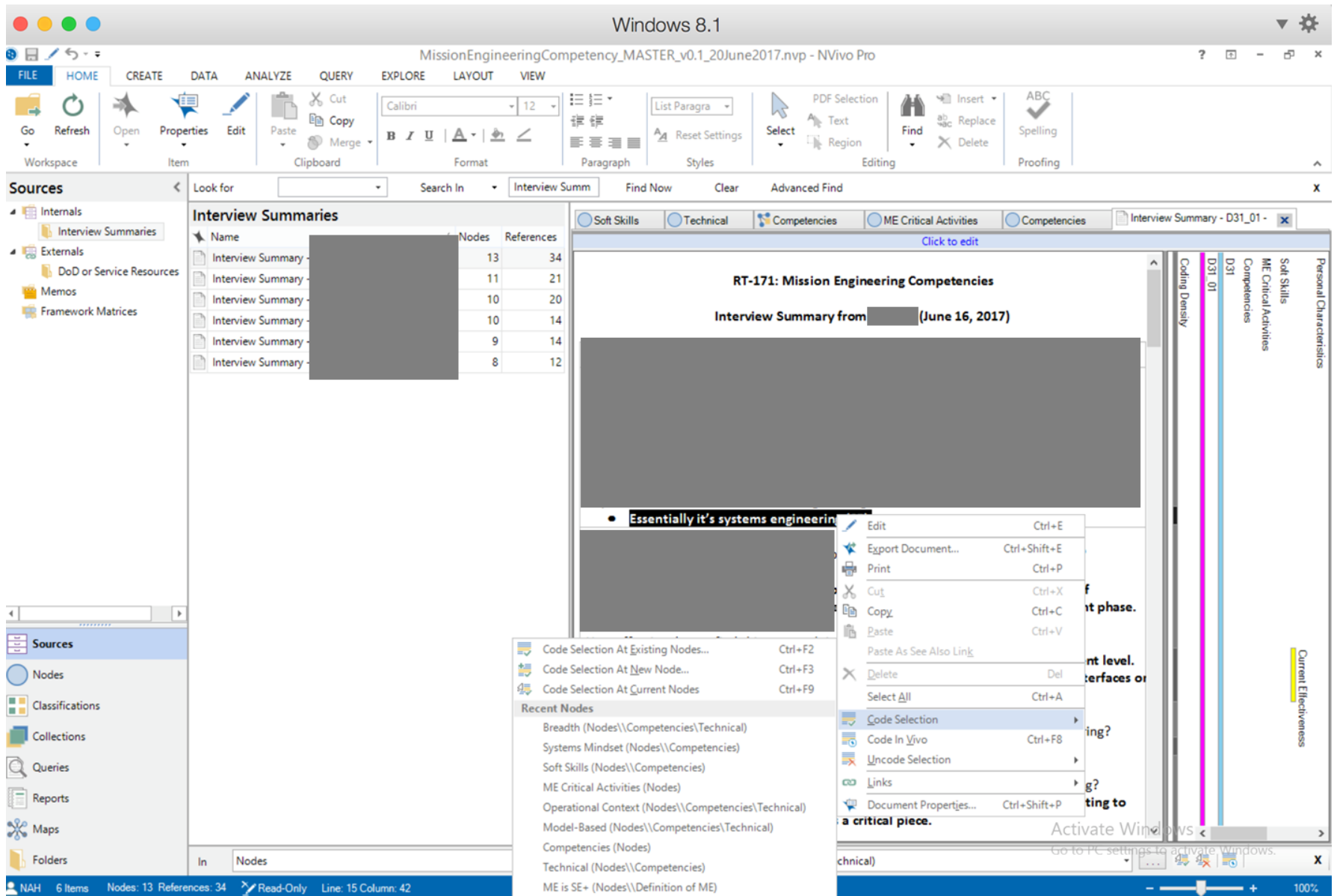
- Competencies
 - Soft Skills
 - Systems Mindset
 - Technical
 - Most Helpful Personally



- 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

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

RT-171: Mission Engineering Competencies

Interview Summary from [redacted] (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)

Coding Density

Soft Skills
ME Critical Activities
Competencies

Personal Characteristics
Current Effectiveness

NAH 6 Items Nodes: 13 References: 34 Read-Only Line: 15 Column: 42

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 Videos Pictures Memos From Other Sources Import

Classification Sheets Attribute Values Report Extract Items List Project Classification Sheets To Other Destinations Export Purchase Transcript Check Status Transcription

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

Sources Nodes Classifications Collections Queries Reports Maps

Competencies

<Internals\Interview Summaries\Interview Summary - [redacted] > - § 10 references coded [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.

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

Nodes			
Name	Sources	References	
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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.)

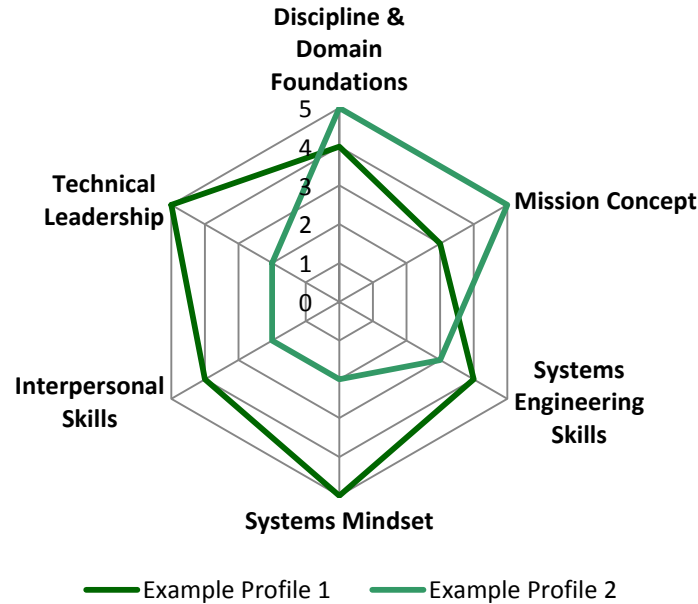
Preliminary findings:

- 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 general align with the three types of competencies outlined in Helix:
 - Soft Skills
 - Systems Mindset
 - Technical Skills

Initial Mission Engineering Competency Framework

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

6. Technical Leadership

Guiding Diverse Stakeholders
Team Building
Political Savvy
Decision Making
Workforce Development

3. Systems Engineering Skills

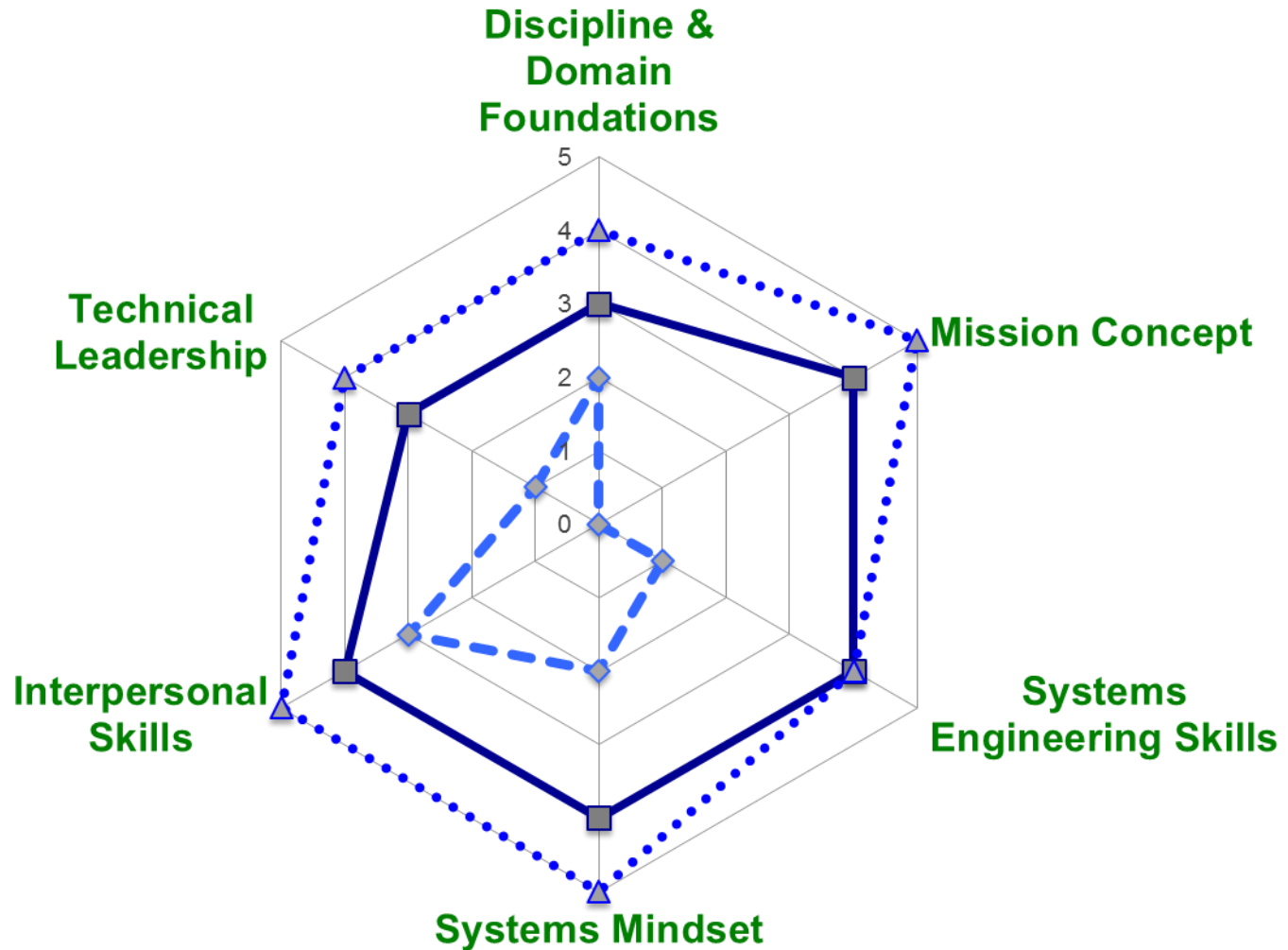
System of Systems Engineering
Analysis
Architecture
Modeling and Simulation
Requirements
Integration
Gap Analysis

5. Interpersonal Skills

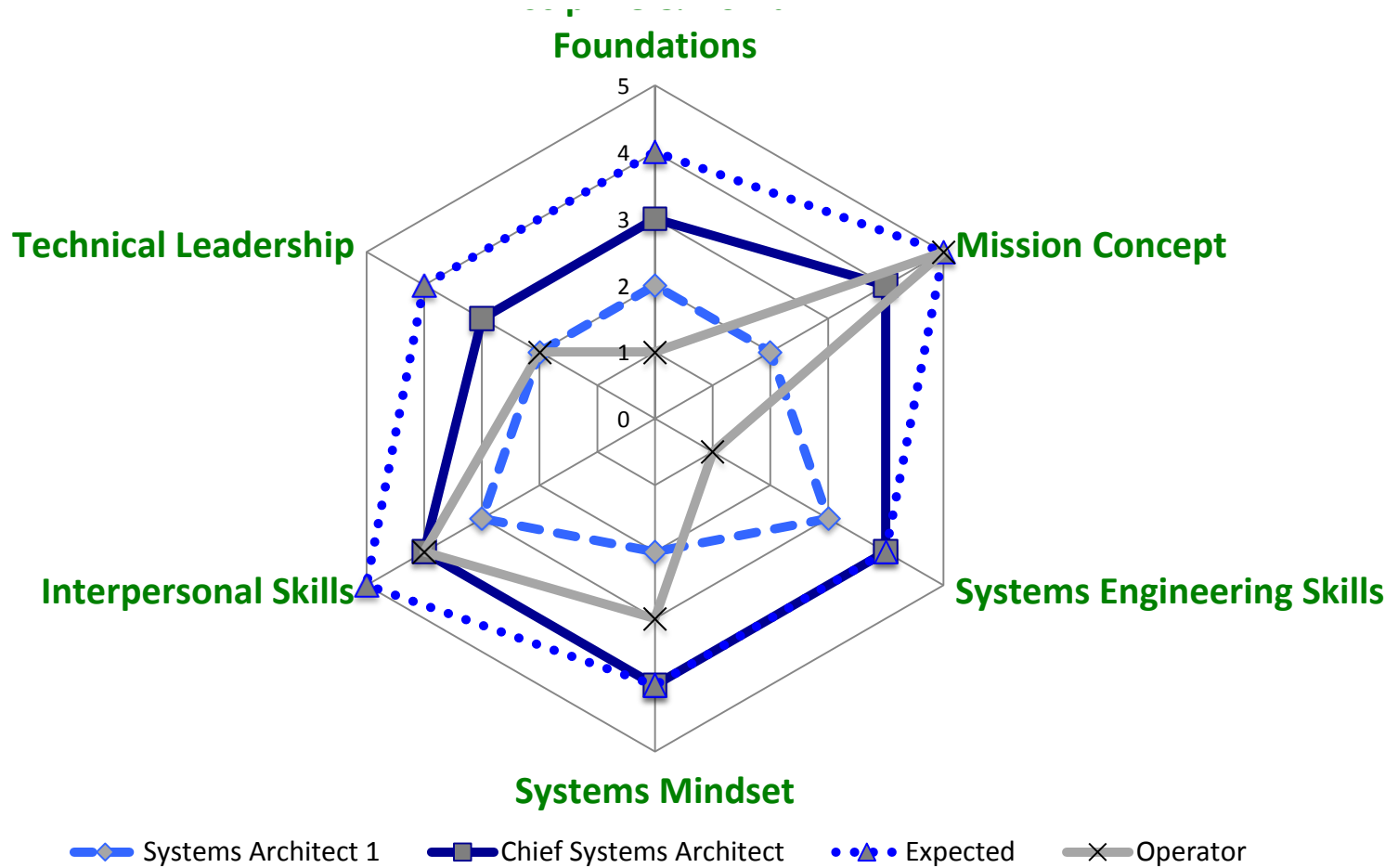
Communication
Translation
Enterprise Context
Building & Utilizing a SME Network
Coordination
Influence, Persuasion, & Negotiation

4. Systems Mindset

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



◆ Start of Career ■ Current ●▲ Target Level

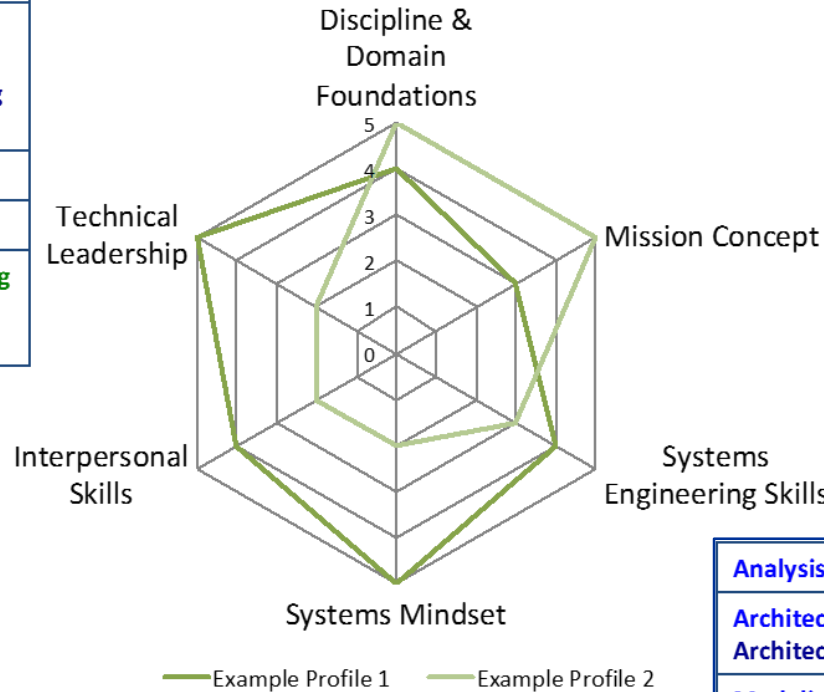


Initial Findings – Mission Engineering Definitions

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

Software Engineering
Acquisition Strategies and Procurement/Acquisition

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



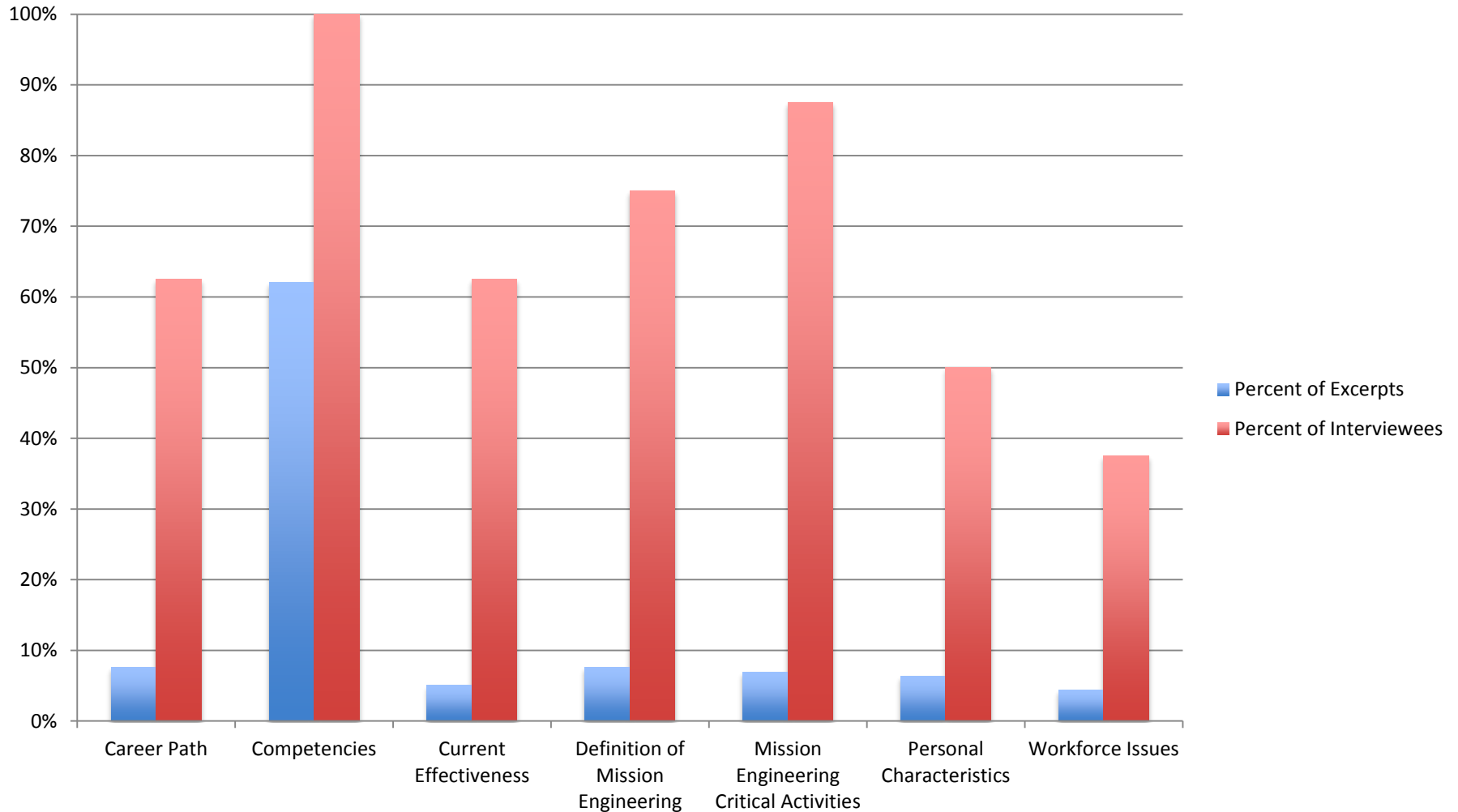
Communication/ Communication/ Communication
NASA Interior and Exterior Environment
Negotiation/Negotiations
Organization

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

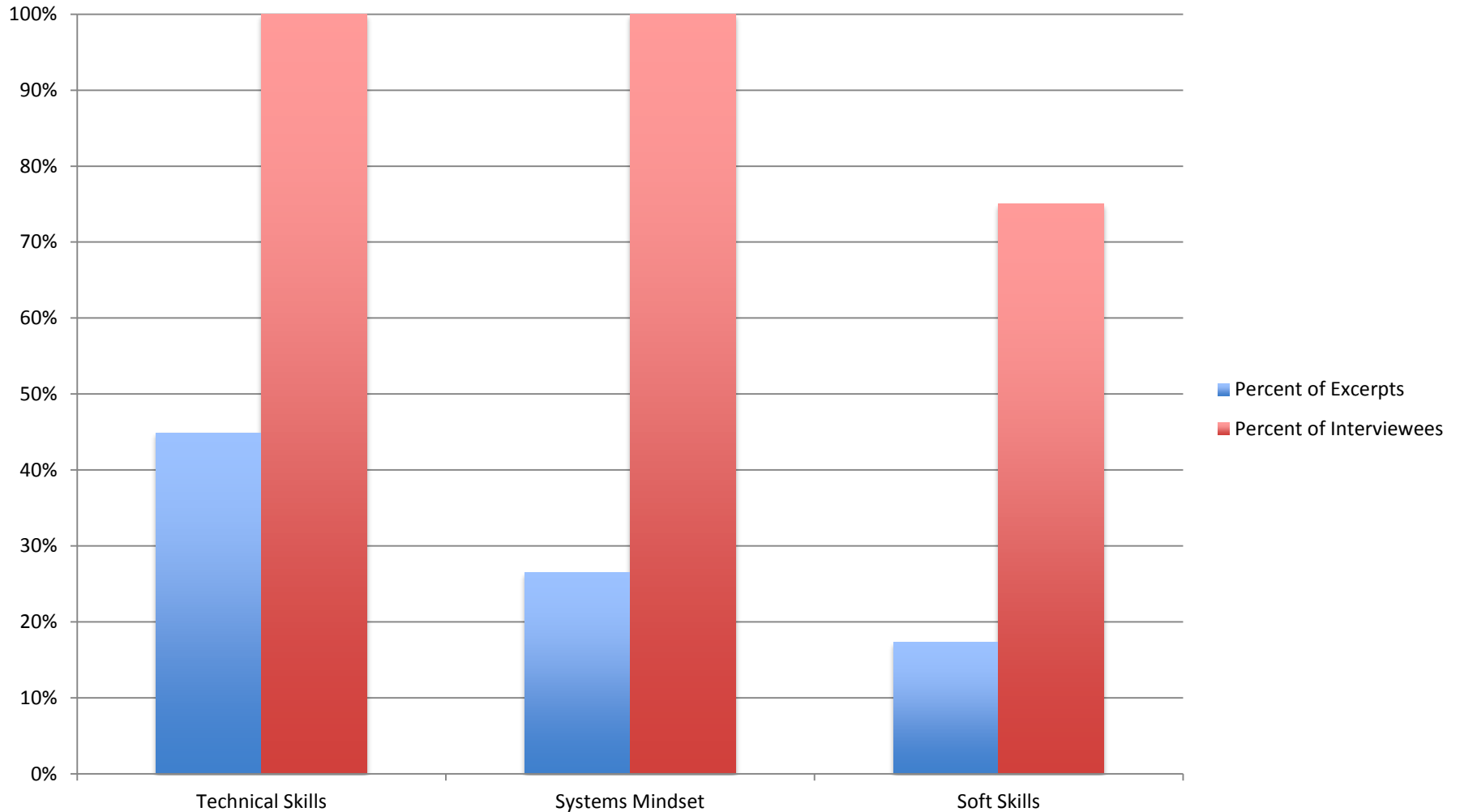
Critical Thinking
Systems Thinking
Strategic Thinking
Problem Solving

INCOSE Competency Framework
NASA Systems Engineering Competencies
NAVY SE Competency Model

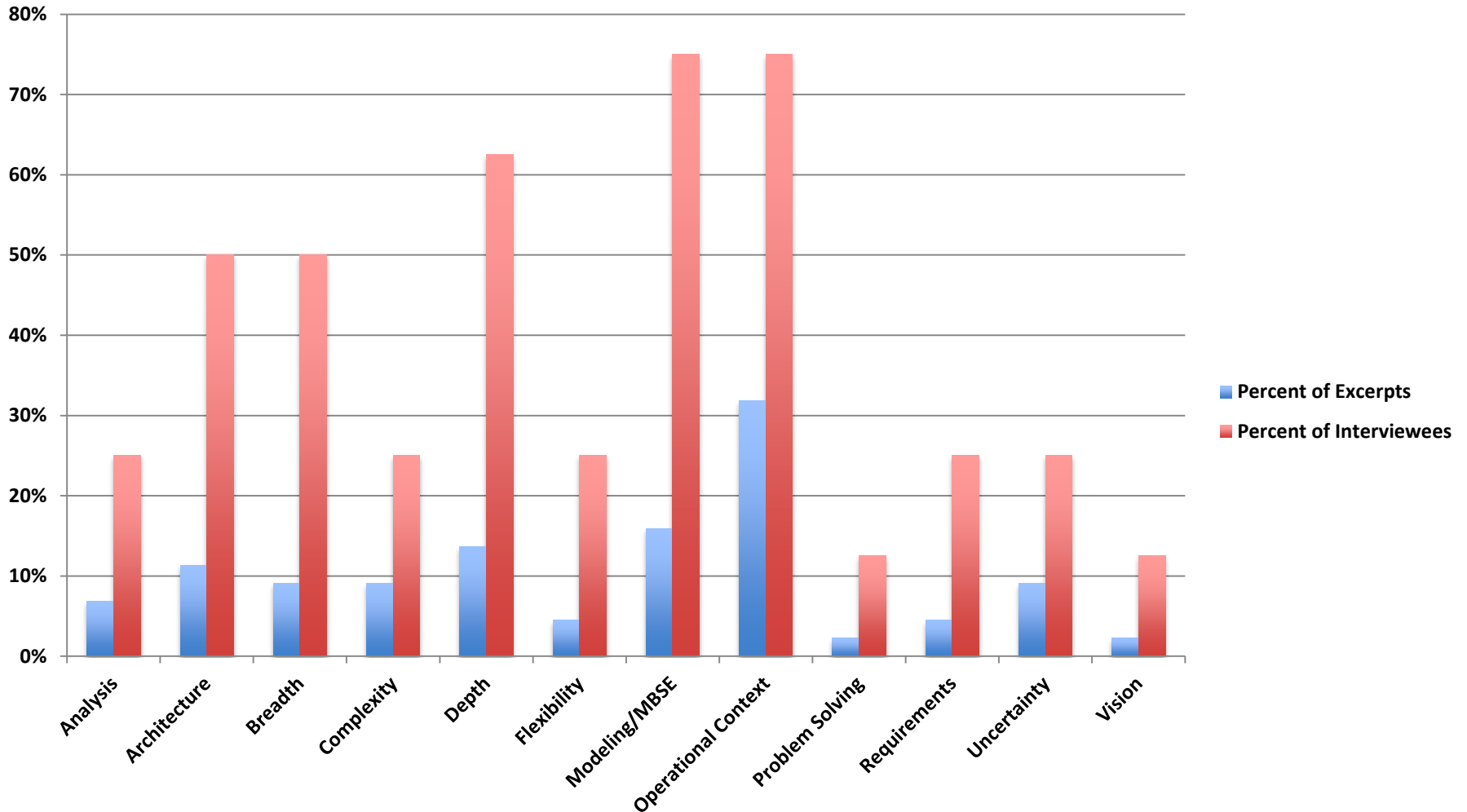
Major Coding Categories



Mission Engineering Competencies



Technical Skills



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.
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Questions?