



RT-171 Mission Engineering Competencies

Sponsor: DASD(SE)

By

Dr. Gregg Vesonder, Dr. Dinesh Verma, Dr. Nicole Hutchinson

Mr. William Miller, Dr Hoong Yan See Tao

9th Annual SERC Sponsor Research Review

November 8, 2017

FHI 360 CONFERENCE CENTER

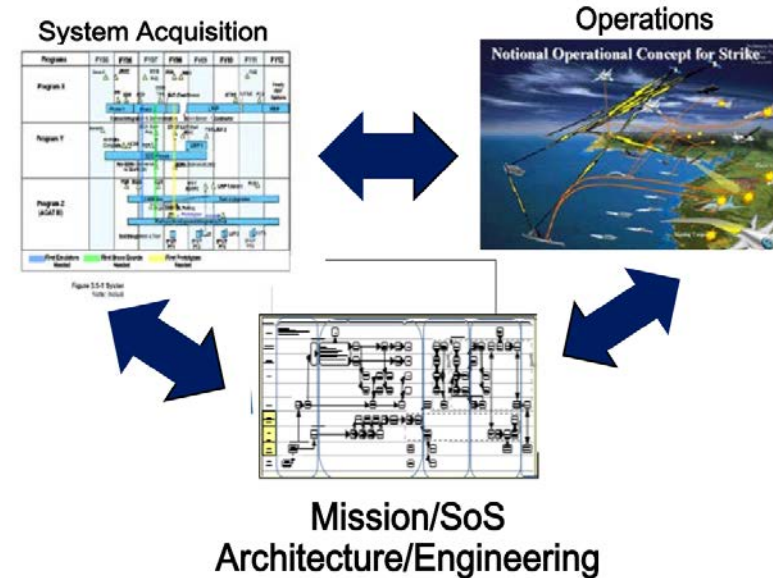
1825 Connecticut Avenue NW, 8th Floor

Washington, DC 20009

www.sercuarc.org

- Mission engineering as the application of systems of systems (SoS) engineering in a 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.

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



-
-

- 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.

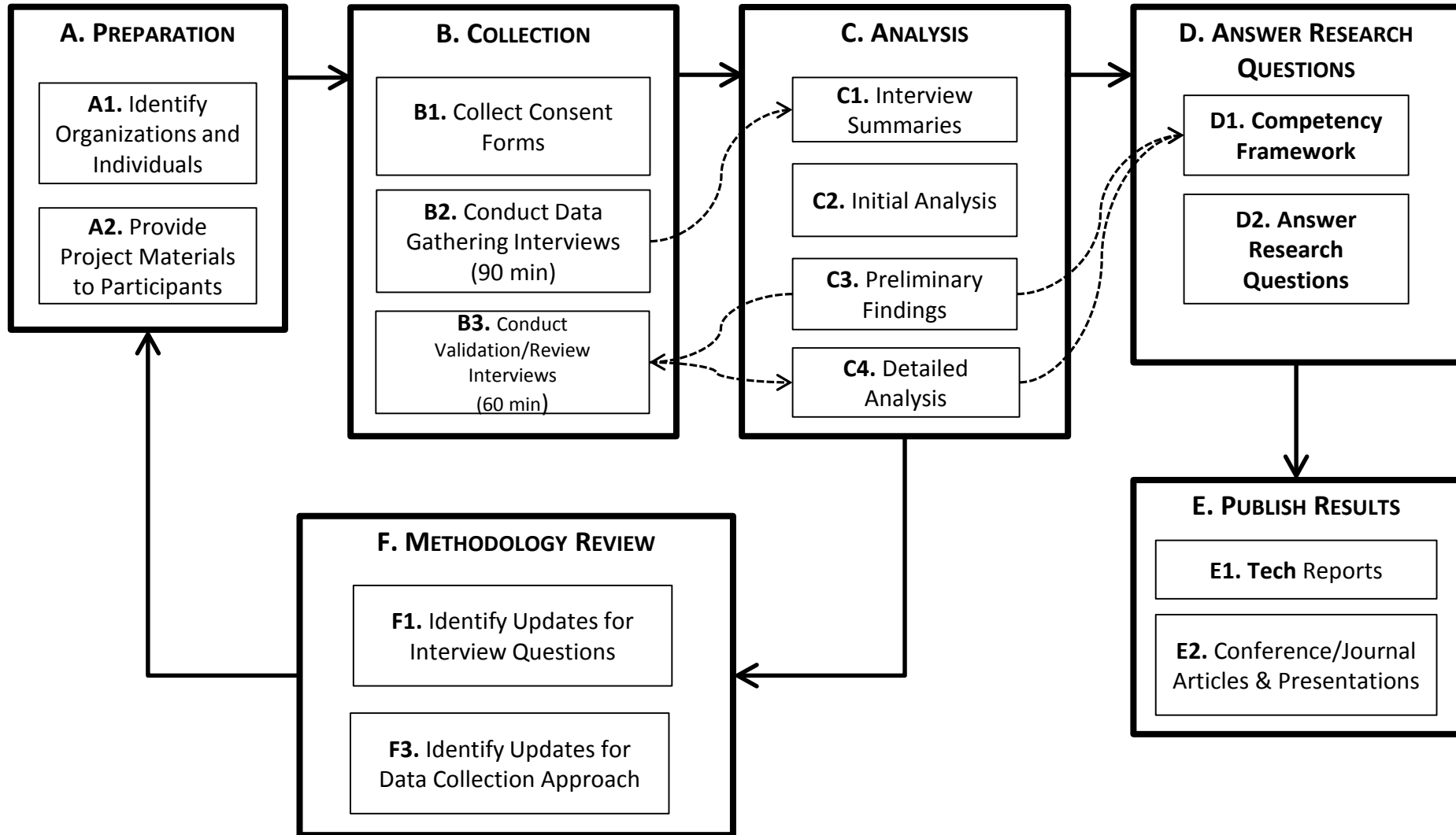
- Mission engineering (ME) competency model lays out the skills, abilities and behaviors that are critical to ME and whether they are unique or overlap with systems engineering.
- The research draws heavily from the Helix methodology on developing effective system engineers.
- Reflects industry approaches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

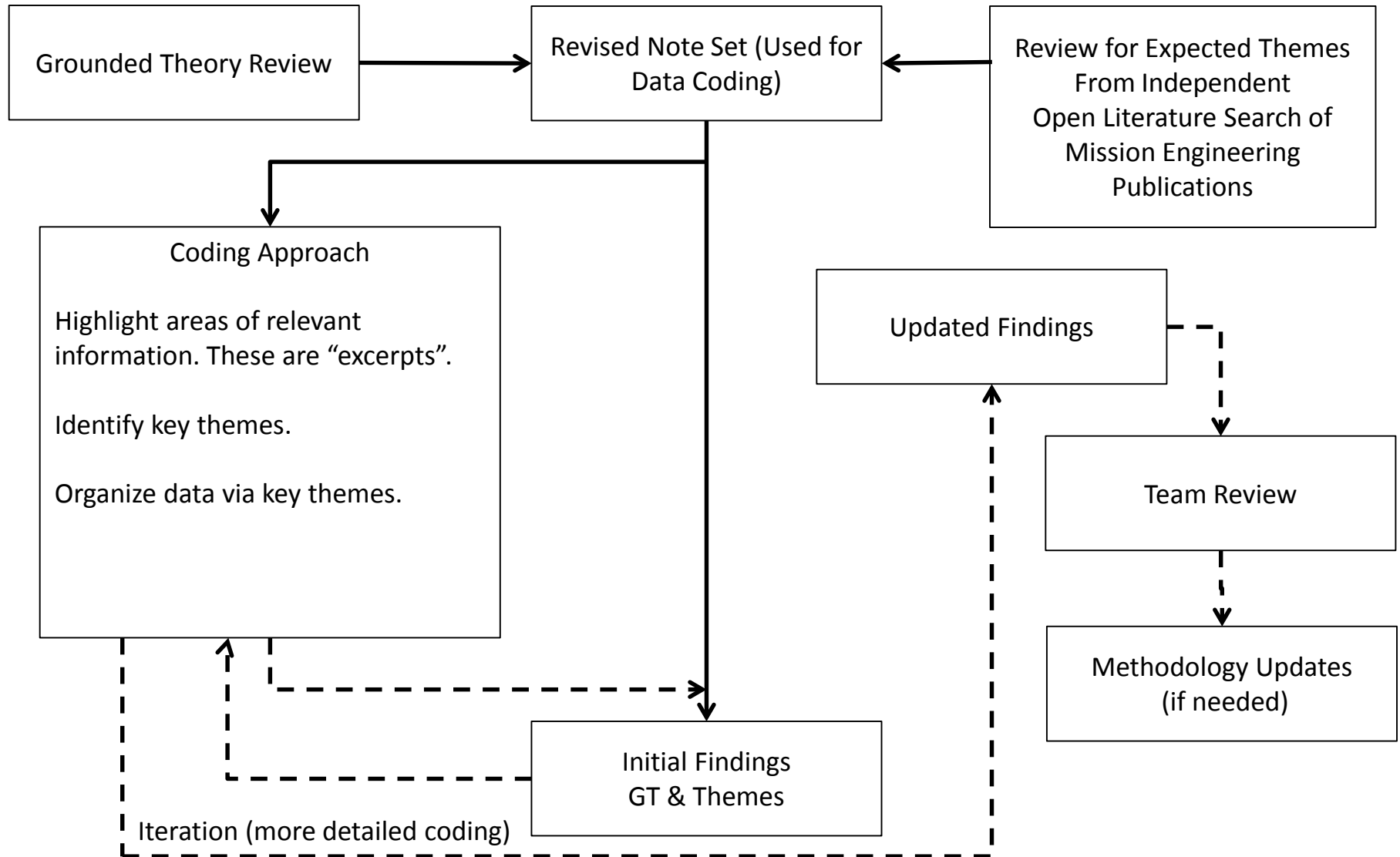


- Provide an analysis comparing Defense Acquisition University's current curricula against the ME competency requirements.
- Review open literature describing ME applications, methods, and tooling.
- Provide recommendations on building an ME curricula to build interdisciplinary ME knowledge and capabilities.

- *(please note that the actual presentation will contain the latest data)*
- Completed 22 ME data gathering interviews to date.
- Ongoing ME expert reviews.
- Rich body of work in the open source literature over the last 10 years including both peer reviewed journals and conferences as well as publically available in-house publications.
- Continuing analysis of interview data and open source literature over the first quarter of calendar year 2018.

Mission Engineering Competency Model Development Methodology





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

Internals Interview Summaries

Externals DoD or Service Resources Memos Framework Matrices

Interview Summaries

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

Soft Skills Technical Competencies ME Critical Activities Competencies Interview Summary - D31_01 -

Click to edit

RT-171: Mission Engineering Competencies

Interview Summary from [redacted] (June 16, 2017)

Essentially it's systems engineering

Personal Characteristics

Soft Skills

ME Critical Activities

Competencies

D31

D31_01

Coding Density

Current Effectiveness

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

Code Selection

Code In Vivo Ctrl+F8

Unicode Selection

Links

Document Properties... Ctrl+Shift+P

Code Selection At Existing Nodes... Ctrl+F2

Code Selection At New Node... Ctrl+F3

Code Selection At Current Nodes Ctrl+F9

Recent Nodes

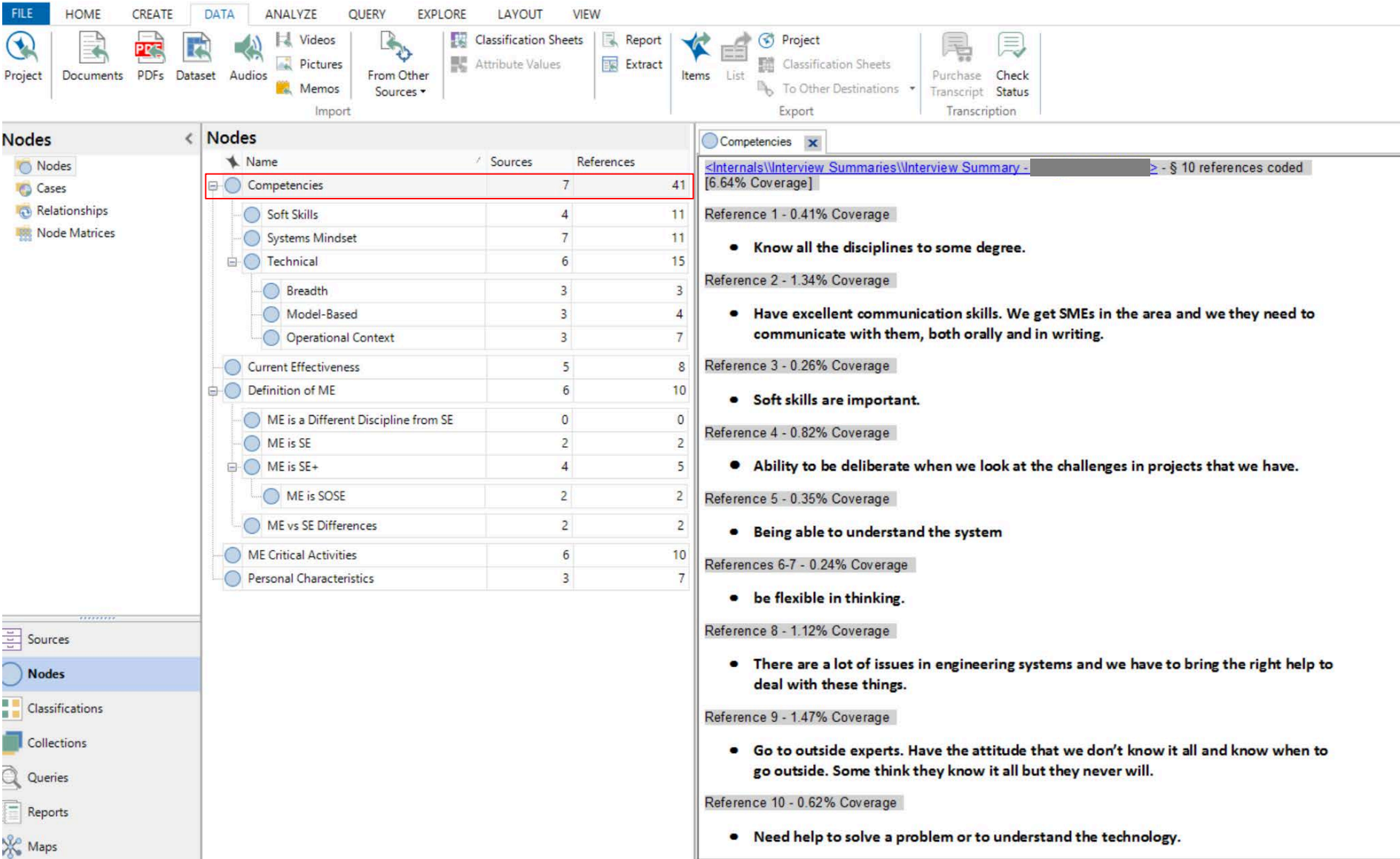
- Breadth (Nodes\Competencies\Technical)
- Systems Mindset (Nodes\Competencies)
- Soft Skills (Nodes\Competencies)
- ME Critical Activities (Nodes)
- Operational Context (Nodes\Competencies\Technical)
- Model-Based (Nodes\Competencies\Technical)
- Competencies (Nodes)
- Technical (Nodes\Competencies)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

Activate Windows

Go to PC settings to activate windows.

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

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



The screenshot displays a software interface for analyzing data. On the left, a 'Nodes' panel shows a hierarchical tree structure. The 'Competencies' node is selected and highlighted with a red box. The main area shows a table of nodes with columns for Name, Sources, and References. The 'Competencies' node is expanded, showing sub-nodes like 'Soft Skills', 'Systems Mindset', 'Technical', etc. On the right, a detailed view of the 'Competencies' node is shown, listing 10 references with their respective coverage percentages and excerpts.

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 [x]

<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

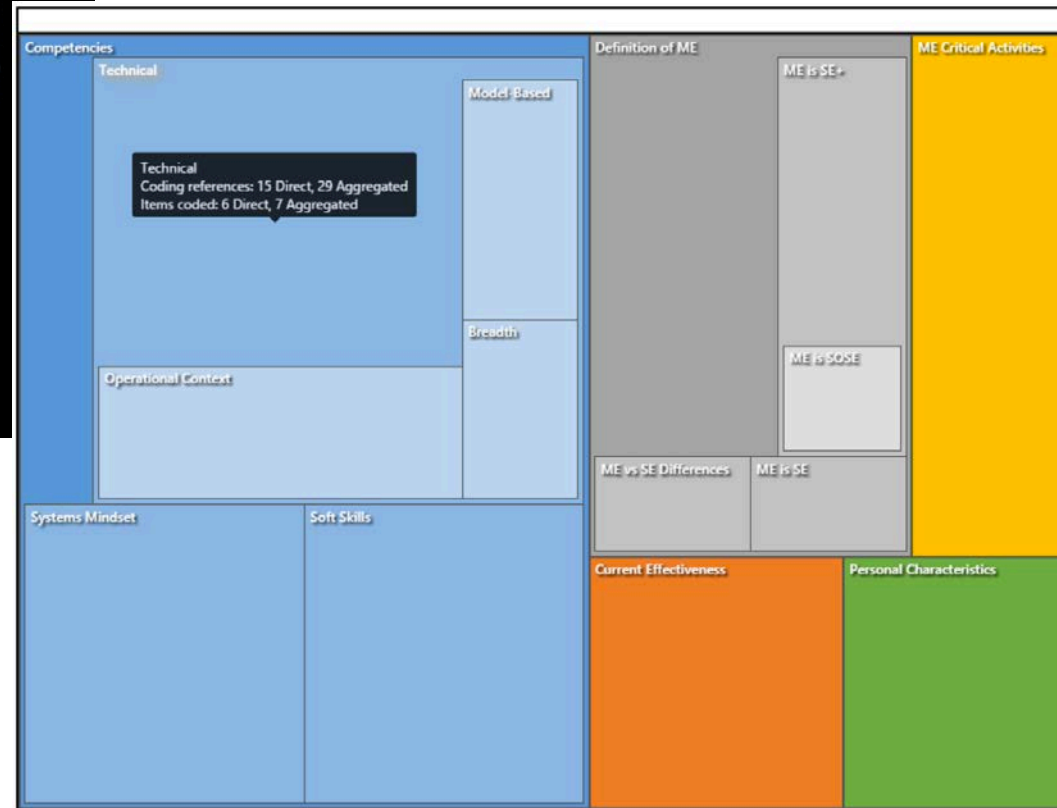
Nodes			
Name	Sources	References	
Competencies	7	41	
Soft Skills	4	11	
Systems Mindset	7	11	
Technical	6	15	
Breadth	3	3	
Model-Based	3	4	
Operational Context	3	7	
Current Effectiveness	5	8	
Definition of ME	6	10	
ME is a Different Discipline from SE	0	0	
ME is SE	2	2	
ME is SE+	4	5	
ME is SOSE	2	2	
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 general align with the three types of competencies outlined in Helix:
 - Soft Skills
 - Systems Mindset
 - Technical Skills



- 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

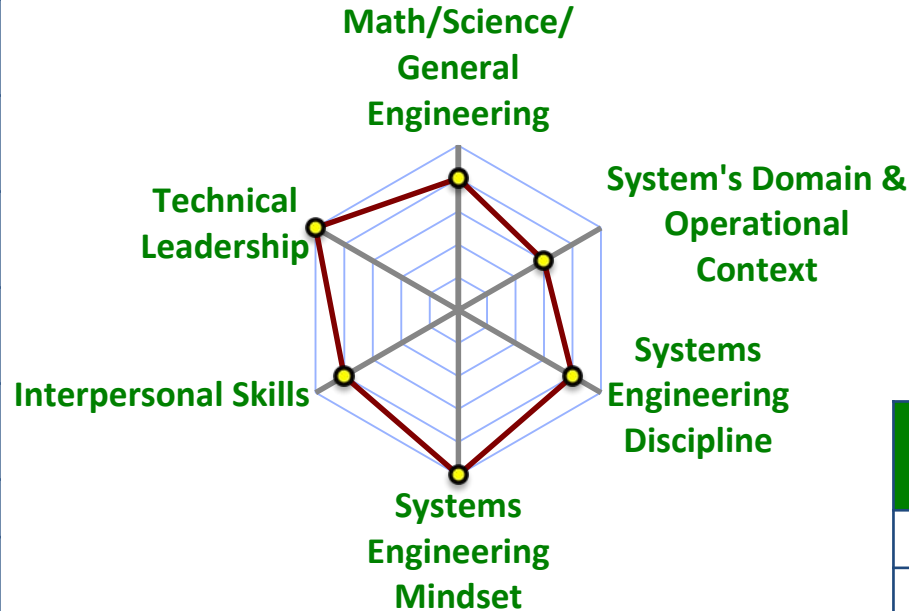
Proficiency of a Systems Engineer (Helix)

6. Technical Leadership

- Building & Orchestrating a Diverse Team
- Balanced Decision Making & Risk Taking
- Guiding Stakeholders with Diverse/Conflicting Needs
- Conflict Resolution & Barrier Breaking
- Business & Project Management Skills
- Establishing Technical Strategies
- Enabling Broad Portfolio-Level Outcomes

5. Interpersonal Skills

- Communication
- Listening & Comprehension
- Working in a Team
- Influence, Persuasion, & Negotiation
- Building a Social Network



●—● An Example Systems Engineer's Proficiency

4. SE Mindset

- 'Big Picture' Thinking
- Paradoxical Mindset
- Flexible Comfort Zone
- Multi-Scale Abstraction
- Foresight & Vision

3. SE Discipline

- Lifecycle
- Systems Engineering Management
- Systems Engineering Methods, Processes, & Tools
- Systems Engineering Trends

1. Math / Science / General Engineering

- Natural Science Foundations
- Engineering Fundamentals
- Probability & Statistics
- Calculus & Analytical Geometry
- Computing Fundamentals

2. System's Domain & Operational Context

- Principle and Relevant Domains
- Familiarity with System's Concept of Operations (ConOps)
- Relevant Domains
- Relevant Technologies
- Relevant Disciplines and Specialties
- System Characteristics

Math/Science/General Engineering are Foundational Skills

6. Technical Leadership
Guiding Stakeholders with Diverse/Conflicting Needs
Conflict Resolution & Barrier Breaking
Team Building
Trade-off Analysis
...

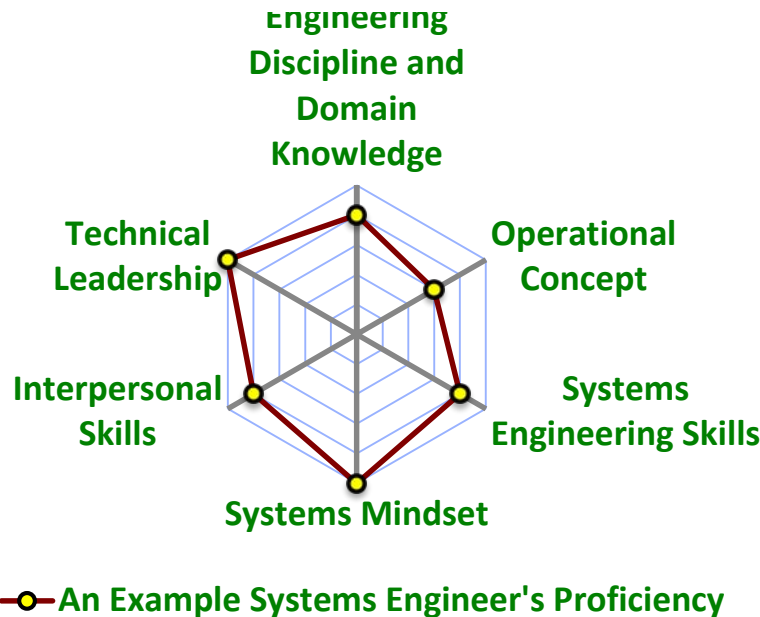
5. Interpersonal Skills
Communication
Translation (b/t Operators, Engineers, and Acquisition)
Influence, Persuasion, & Negotiation
Building & Utilizing a SME Network
Organizational Know-How (How work actually gets done in org.)
...

4. SE Mindset
'Big Picture' Thinking
Paradoxical Mindset
System of System Thinking
Multi-Scale Abstraction
...

3. Systems Engineering Skills
Architecture
System of Systems Engineering
Modeling
Analysis
...

1. Discipline & Domain Knowledge
Principle and Relevant Domains
Relevant Domains
Relevant Technologies
Complexity
Acquisition Context
...

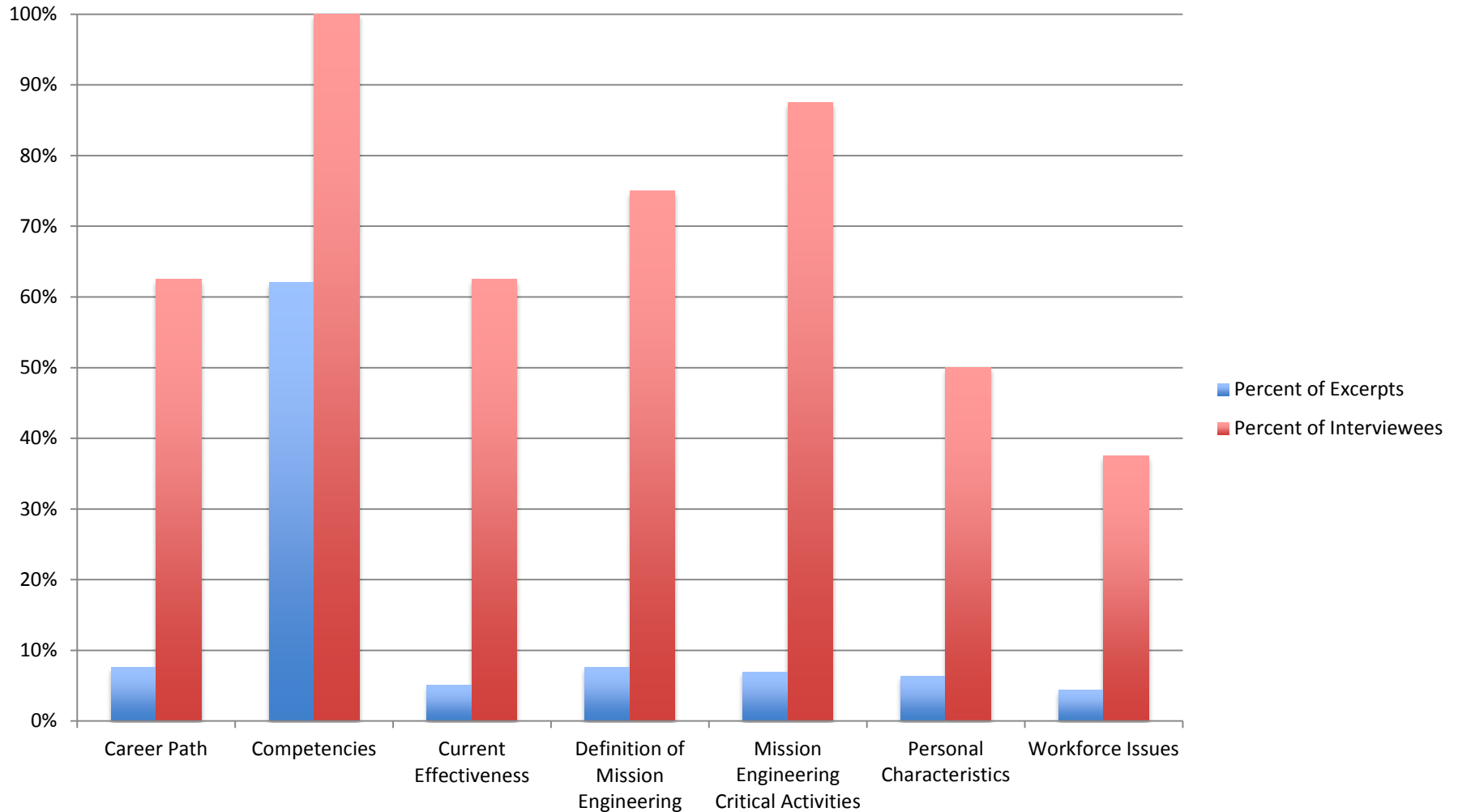
2. Operational Concept
Familiarity with the Mission Concept
Familiarity with Mission Scenarios
Familiarity with Relevant Systems in the Mission Space
Understanding of DOTMLPF Space
...



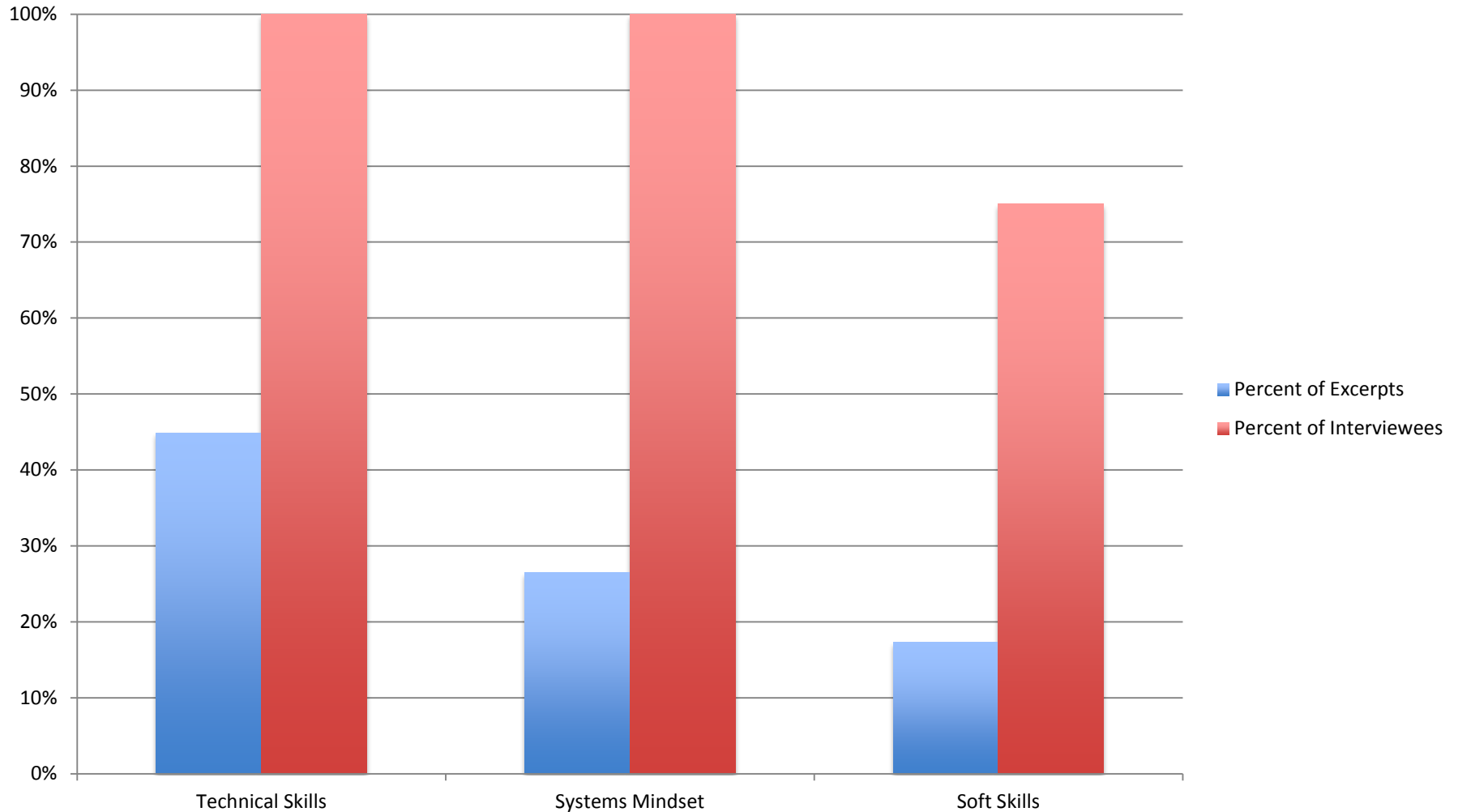
Variations in Responses to the Interview Questions

- Mission Engineering is System(s) of Systems Engineering
- Mission Engineering is Systems Engineering
- Mission Engineering is Different than Systems Engineering
- Mission Engineering is Systems Engineering +
- Mission Engineering is a Subset of Systems Engineering

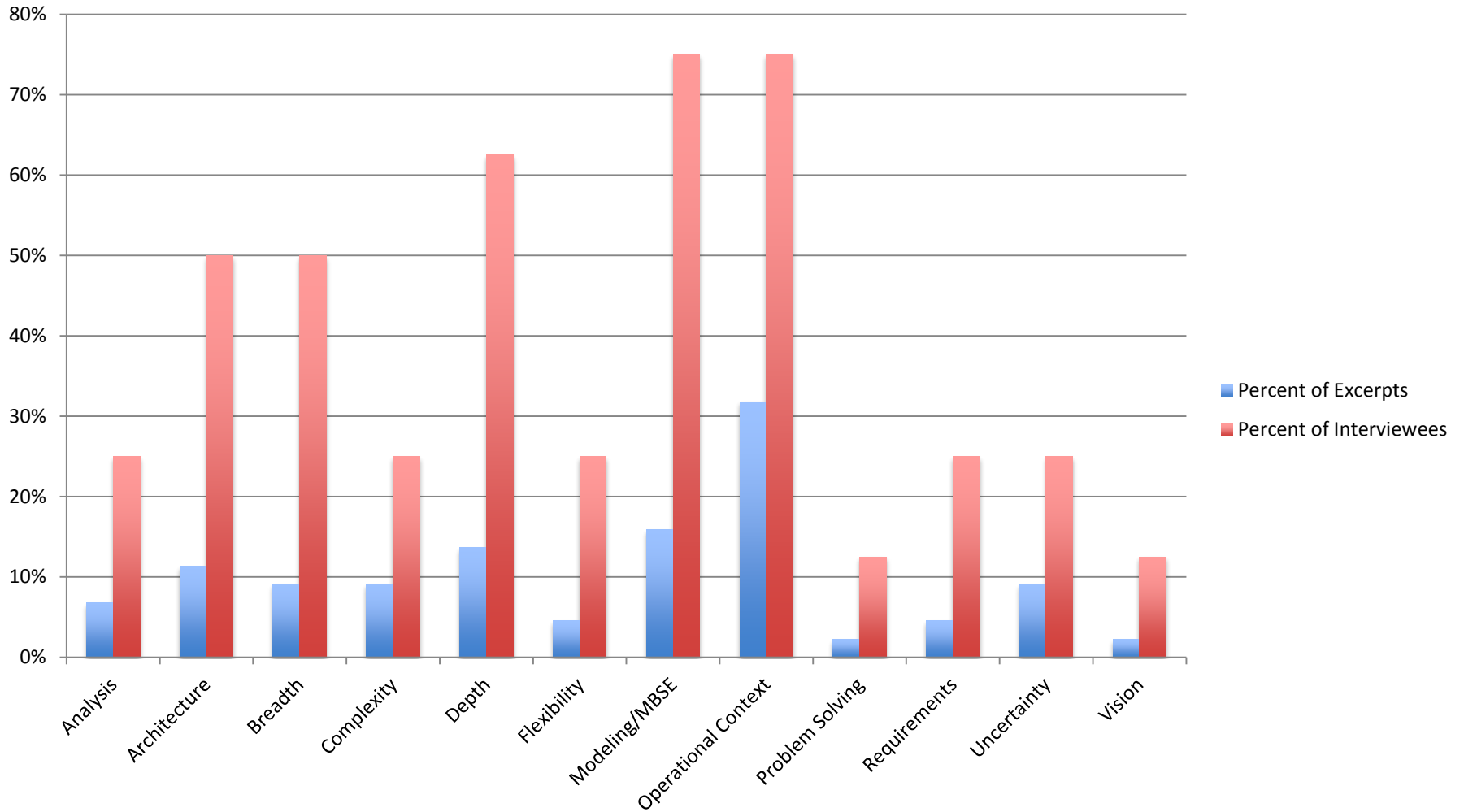
Major Coding Categories



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

Interim Results

- Mission engineering as the application of systems of systems (SoS) engineering in a operational context.
- 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?