

Helix: Investigating the DNA of the Systems Engineering Workforce

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1. Overview of the Helix Project
2. Overview of Helix Research Methods
3. Data Collection to Date
4. Hints of Preliminary Findings
5. Call for Participation

- Major systems engineering (SE) challenges faced by The US Department of Defense (DoD) and the Defense Industrial Base (DIB) in recent years:
 - Mission requirements keep evolving
 - More sophisticated and complex systems are needed
 - SE tools, processes, and technologies keep changing rapidly
 - Budgets and schedules are being compressed dramatically
 - Thousands of systems engineers in the defense workforce are nearing retirement
- Organizations are responding in a variety of ways but there is insufficient understanding of the systems engineering workforce: who they are, what they do, how well they do it, etc.

Helix Research Questions

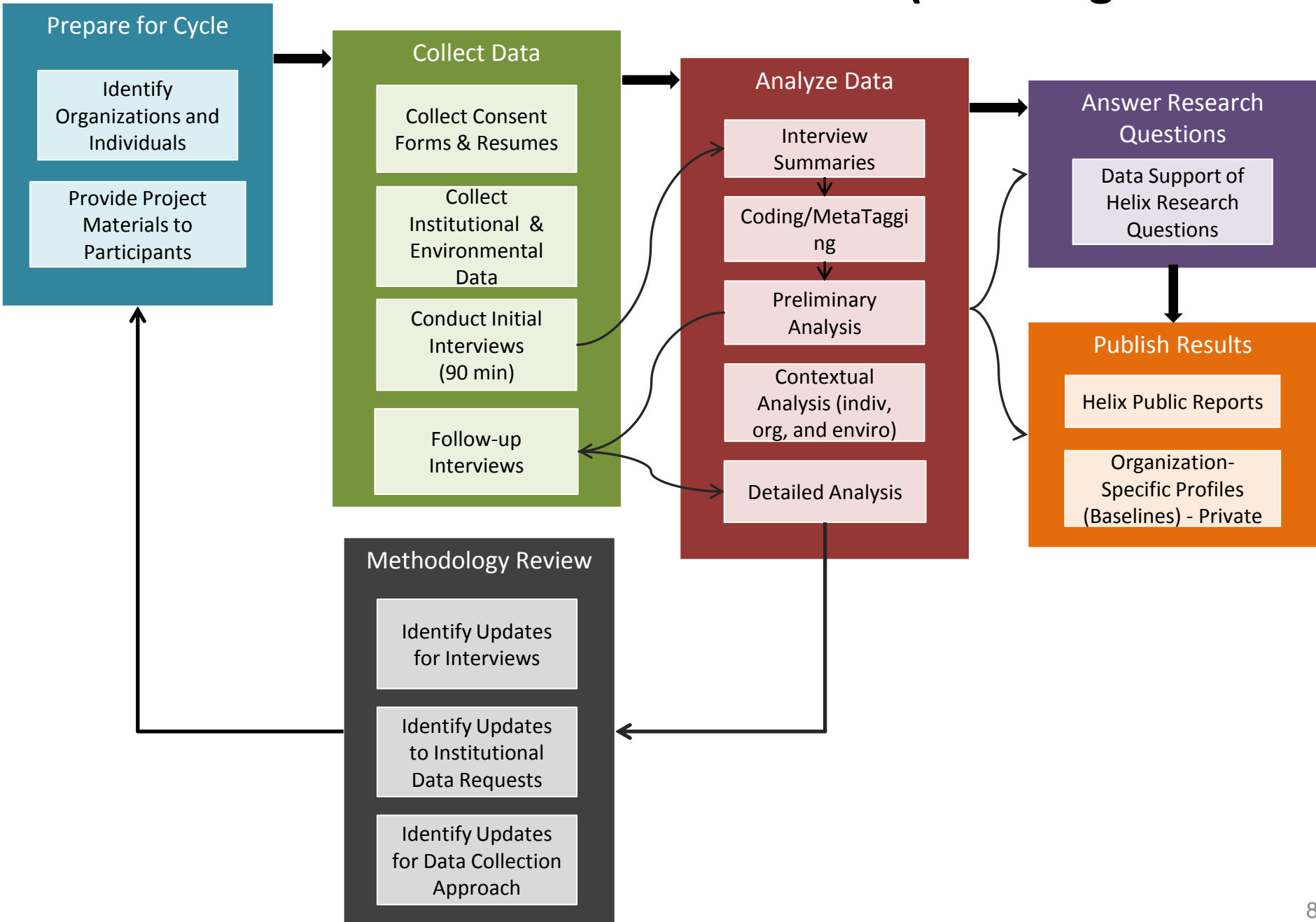
1. **WHAT ARE THE CHARACTERISTICS OF SYSTEMS ENGINEERS?**
 2. **HOW EFFECTIVE ARE SYSTEMS ENGINEERS AND WHY?**
 3. **WHAT ARE EMPLOYERS DOING TO IMPROVE THEIR EFFECTIVENESS?**
- DoD plus Defense Industrial Base
 - Longitudinal study – about 200 people and 10 to 12 organizations per year over 5 years
 - Voluntary participation
 - Non-disclosure agreements
 - Institutional and demographic data
 - In-person initial interviews and virtual follow-up interviews
 - “Raw” data available only to Helix team
 - Aggregated/anonymous results in periodic reports – first report to be published in December 2013

1. Deepen their understanding of their systems engineering workforce over time
2. Identify gaps and where to focus investments to improve their systems engineering workforce
3. Benchmark their systems engineering workforce
4. Deepen their understanding of what makes their workforce effective
5. Receive recommendations on how to improve the effectiveness of their systems engineers

- Helix is creating a theory about what systems engineers do, their important traits, and what makes them more or less effective – this is the “DNA” of systems engineers from which the Helix Project takes its name
- We began with grounded theory to establish a bare bones theory of the DNA of systems engineers and will gradually flesh out that theory
- We are constructing that theory now and will refine and confirm or invalidate it through additional focused interviews, surveys, institutional data, and other means
- For example, one hypothesis that is emerging from interviews indicates that the best systems engineers are often “average” specialty engineers who have extremely strong “soft” skills. Many who have been interviewed have said that specialty engineers who are exceptional at their specialty often have trouble rising above the details.
- The Helix team will explore this hypothesis by looking at resumes, institutional data, and conducting focused interviews.

- Longitudinal study
- Interview-based approach (group interviews)
- Data Collection at multiple levels
 - Individual (demographic and at least 2 interviews)
 - Organizational
 - Environmental
- Modified Grounded Theory Approach
 - 2013 research is gathering data to construct an initial theory of systems engineers
 - 2014 will focus on validation and refinement of that theory
- Mixed Methods Analysis
 - Quantitative data about the population of systems engineers
 - Qualitative data from interviews contextualized by the organization and the environment
 - Transcript or Summary
 - Coding
 - Analysis by subject
 - Meta Analysis

Research Process (Each Organization)



- Helix is interviewing people who:
 - Are knowledgeable about the characteristics of systems engineers across the organization,
 - Perform systems engineering on programs – the team desires a mix of senior and junior personnel
 - Supervise systems engineers, and
 - Use the products of systems engineers
- Individuals provide demographic information prior to the interviews, including education, experiences, training, etc.
- Originally expected to interview one person at a time, but quickly moved to interviewing groups of two or three most of the time. Creates interesting discussion dynamic.

1. The charter or primary purpose of the organization
2. The primary business of the organization, including revenue, primary customer, organization chart, and types of products and services delivered
3. Total number of employees (overall and systems engineers) in the organization in each year since 2009 including the number of people hired and departed
4. An explanation of how the organization defines “systems engineer”
5. A characterization of the systems engineer population (college degrees, years of professional experience, years of experience as a systems engineer, age, gender, etc.)
6. The way in which the systems engineers are primarily organized
7. Major organization initiatives previously and currently underway to improve the quality or quantity of systems engineers
8. Policies that are particularly relevant to systems engineers, including organizational competency model and career paths

- Recently suggested that we should capture information about the environment in which the organization is operating (budget and mission uncertainty, technological change, ...) to provide context for the responses from those interviewed
- Still deciding how to do this

Sample Questions to Apprentice Systems Engineers

1. What are the most frequent and most important activities that you perform?
2. Are you spending the right amount of time on the most important activities?
3. How well does your management understand and appreciate what you do?
4. What are the most important personal traits that make you an effective systems engineer? Why?
5. What are the most important forces that increase or inhibit your effectiveness as a systems engineer? Why?
6. How is your performance as a systems engineer evaluated and rewarded? What metrics are used?
7. What personal initiatives have you been taking to improve your own effectiveness?
8. Which organizational initiatives in the last five years have been helping improve your effectiveness?

1. Is there a gap between the effectiveness of your systems engineering workforce and your organizational need?
2. How is the performance of your systems engineering workforce evaluated and rewarded? What metrics are used? Are they uniform across the roles and levels of the systems engineering workforce?
3. What are the primary risks to the systems engineering workforce in the next five years? How are these risks being addressed?
4. Which organizational initiatives in the last five years have had the greatest impact on the forces that improve workforce effectiveness? How do you know this?
5. How did your workforce respond to these initiatives?
6. Are these initiatives adequate to close the gap between effectiveness and organizational need? What more should be done?

- The Helix team has interviewed people from 4 organizations to date (3 private sector and 1 DoD government)
- More than 80 individuals interviewed
- Uneven amounts of institutional data available
- Five more organizations committed to participating – discussions with many others

- Baseline technical competency is required to understand and lead the specialists, to be credible, and to translate between the customer and the specialists, but a mediocre general engineer with strong “soft skills” often makes the best systems engineer
- There is no agreement among those interviewed that the imminent loss of many very senior people is a terrible problem:
 - “Good riddance” – these senior people are fossils
 - Opportunity for younger people to advance and bring in new ideas
 - Mentoring, succession planning, and recalling retired people is working well enough for now

But some think it is a serious risk

- Get involved!
- We are looking for government and defense industrial organizations to participate in this novel investigation.
- If you are interested in participating, please contact us at helix@stevens.edu or contact Dr. Art Pyster (art.pyster@stevens.edu).