



SYSTEMS ENGINEERING
Research Center

The Helix Project

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ABSTRACT

The Helix project is a multi-year investigation of the demographics and effectiveness of systems engineers in the US Department of Defense (DoD) and the defense community. This project is sponsored by the DoD and the National Defense Industrial Association - Systems Engineering Division (NDIA-SED), and has been initiated in response to the many challenges concerning the systems engineering (SE) workforce. This report highlights the project activities since September 2012 until April 2013 in preparation for further data collection and analysis to be performed from May 2013 onwards.

Initial months of the Helix project have been spent in formulating the research approach; deciding the data collection methodology; preparing the instruments for data collection; obtaining necessary clearances and permissions; setting up and interacting with the advisory panel; presenting the Helix project to various systems engineering groups and professional societies to identify participating organizations; interacting with points-of-contacts of individual organizations towards further data collection; setting up protocols and procedures to handle data in a secure manner; obtaining IRB and DoD approvals; and selecting software tools for qualitative and quantitative data analysis.

From May 2013 onwards, the project team expects to begin conducting actual data collection, perform extensive qualitative and quantitative data analysis, and to then report findings periodically.

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INTRODUCTION

The Helix project is a multi-year investigation of the demographics and effectiveness of systems engineers in the US Department of Defense (DoD) and the defense community. This project is sponsored by the DoD and the National Defense Industrial Association Systems Engineering Division (NDIA-SED), has been initiated in response to the many challenges concerning the systems engineering (SE) workforce. This report highlights the project activities since September 2012 until April 2013 in preparation for further data collection and analysis to be performed from May 2013 onwards.

THE CHALLENGE

Many systems engineers in the defense workforce are nearing retirement. Budget and schedules are being dramatically compressed. Mission requirements demand ever more sophisticated and complex systems. The tools, processes, and technologies that systems engineers must master keep changing ever more rapidly. Organizations respond in many different ways to these winds buffeting their systems engineers. Yet, there is scant agreement or understanding on what the most important levers are that affect the effectiveness of systems engineers, how to measure that effectiveness, and the impact various workforce improvement efforts are having.

THE RESPONSE

The Helix project will address this challenge by addressing three primary 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?

Answers to these questions will be obtained by analyzing data collected in two primary modes for the project: (1) face-to-face interviews, and (2) institutional data in the form of artifacts. Analyses of the data will be reported in an aggregated manner without revealing the identity of the participants or their organizations.

GOVERNANCE AND PROJECT TEAM

The Helix project is being run as a project of the Systems Engineering Research Center (SERC), a DoD University Affiliated Research Center. To ensure Helix delivers the greatest value and to help Helix obtain access to the necessary data, DoD and NDIA-SED have formed the Helix Advisory Panel (HAP) with representatives from both organizations and chaired by Dr. Don Gelosh, Worcester Polytechnic Institute, and co-chaired by Mr. Nicholas Torelli, Office of the Deputy Assistant Secretary of Defense for Systems Engineering. The research team at the Stevens Institute of Technology is led by Dr. Art Pyster, co-led by Dr. Stan Rifkin, and supported by Deva Henry, Nicole Hutchison, and Dr. Kahina Lasfer.

PROJECT ACTIVITIES AND STATUS [SEP 2012 – APR 2013]

Initial months of the Helix project have been spent in formulating the research approach; deciding the data collection methodology; preparing the instruments for data collection; obtaining necessary clearances and permissions; setting up and interacting with the advisory panel; presenting the Helix project to various systems engineering groups and societies to gather participating organizations; interacting with points-of-contacts of individual organizations towards further data collection; setting up protocols and procedures to handle data in a secure manner; obtaining IRB and DoD approvals; and selecting software tools for qualitative and quantitative data analysis.

RESEARCH APPROACH AND DATA COLLECTION

The primary mode of data collection would be face-to-face interviews with systems engineers representing a wide cross-section of the SE workforce. Two broad categories of interviewees are being addressed initially: individual systems engineers who can provide their perspectives on the research question, and organizational spokespersons who can provide the organization's perspective on the research questions. Resumes / career-briefs will be collected from all interviewees, with proper consent. In addition, institutional data will be collected from participating organizations to better understand the characterization, structure, organization, and improvement initiatives of the SE workforce. Further details are included in the following appendices:

- **Appendix A:** Sample Interview Questions (Individual Level)
- **Appendix B:** Sample Interview Questions (Organizational Level)
- **Appendix C:** Institutional Data

Data collection will be performed in three rounds:

- **Round 1: Introduction** – Interactions with organizational points of contacts to clarify research objectives and mutual expectations, and to establish ground rules. Collection of institutional data will be initiated.
- **Round 2: Small scale interviews** – Interviews will be conducted with a small number of employees (up to 6); more institutional data will be collected; preliminary data analysis will be performed and shared with participating organization
- **Round 3: Full scale interviews** – Based on experiences and preliminary data analysis from Round 2, interviews will now be conducted with a larger number of individuals from the organization (about 50).

Round 1 is currently in progress with a number of different organizations from within DoD and the NDIA-SED companies. It is expected that Round 2 will be performed during May-July 2013 and Round 3 from August 2013 onwards. It is expected that new organizations that enter the Helix project will still go through Rounds 1-3.

HELIX ADVISORY PANEL (HAP)

The Helix Advisory Panel (HAP) has been formed with representatives from DoD and NDIA-SED; and chaired by Dr. Don Gelosh and co-chaired by Mr. Nicholas Torelli. The HAP will be responsible for providing (a) strategic advice on the direction of Helix, (b) feedback on methodology and findings, and (c) access to data sources, including people and databases.

Three meetings of the HAP have been held in January, February, and April 2013. During these meetings, the project team briefed panel on progress with the research approach, research instruments, and status of interactions with participating organizations. The HAP has been instrumental in providing feedback to the research team and also in identifying venues for the Helix project to be presented to various SE related groups and forums with an objective to attract more participating organizations.

The HAP will convene next in June or July 2013 following some initial interviews and data analysis.

GATHERING PARTICIPATING ORGANIZATIONS

Presentations about the Helix project have been delivered at meetings of various groups and forums including NDIA Systems Engineering Division (SED), NDIA SED Education and Training (E&T) sub-committee, INCOSE Corporate Advisory Board, AIAA Systems Engineering Technical Committee (SETC), Navy Systems Engineering Stakeholders Group (SESG) – Systems Engineering Educational Continuum (SEEC) Working Group, Army RDECOM, and Army SE Forum.

The Helix project expects to provide the following value to all participating organizations:

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

PERMISSIONS, PROTOCOLS, AND DATA HANDLING

The Helix project includes face-to-face interviews as a primary mode of data collection. Therefore, necessary permissions and approvals need to be obtained from Institutional Review Board (IRB) and relevant authorities from DoD. Potential interviewees will be first screened for his or her eligibility to participate in the Helix project and their voluntary consent will be obtained before proceeding with the interview. In addition, organizations will need individual Non-Disclosure Agreements (NDA) to be signed by the project team before they could share any institutional data. Organizations may also have their policies on the logistics and conduct of interviews, since all interviews would be conducted on-site.

High level of data encryption and security protocols will be deployed by the research team on all project related data that will be stored, shared or analyzed by the team. Additional security measures will be taken to isolate personally identifiable information (PII) that will be stripped off all data before any analysis. All physical items including paper documents and electronic storage devices will be stored securely.

The identity of individuals or their organizations will never be reported. All analysis results will only be presented in an anonymous aggregated manner.

PROJECT PLANS [MAY 2013 ONWARDS]

From May 2013 onwards, the project team expects to begin conducting actual data collection (from face-to-face interviews and institutional data). Based on the initial data collection, the research methodology, analysis tools & techniques, and working procedures for data handling will be validated. Initial analysis is not expected to provide much insight mainly because the data collected will be limited. But as data continues to be collected, and when there is sufficient data to be able to present results in an anonymous aggregated manner, reports will be generated by the project team.

Beginning in the second half of 2013, Helix will publish quarterly reports addressing the main research questions, including such demographic data as age, education, experiences, roles, and activities. Each new report will fold into the analysis new insights gained from the previous quarter's data collection. The reports will identify forces (such as experiences, education, and competencies) that most affect workforce effectiveness and what organizations are doing to address those forces. Reports will include anonymous aggregated data only. Based on the data, Helix will be able to benchmark different segments of the community and even individual organizations.

While the current study is focused on the systems engineering workforce within the US DoD community, considerable interest has been shown by INCOSE to extend this study to non-DoD and non-US companies (including defense communities outside the US). These extensions to the Helix project will be considered in 2014.

APPENDIX A: SAMPLE INTERVIEW QUESTIONS (INDIVIDUAL LEVEL)

Getting to know you

- IND01 Do you consider yourself a systems engineer?
- IND02 What are you responsible for in your current position?
- IND03 What activities do you perform most frequently?
- IND04 What are the most important activities that you perform?
- IND05 Are you spending the right amount of time on the most important activities?
- IND06 What were your expectations when you first took this position? Does that align with what you do now?
- IND07 How well does your management understand and appreciate what you do?

What are the characteristics of systems engineers?

- IND08 *Establish definition of systems engineer and definition of systems engineering workforce to be used in the rest of the interview (from Helix, organizational, individual definitions)*
- IND09 Do you still consider yourself a systems engineer in light of this definition?
- IND10 How does this definition of a systems engineer match what you see in practice?
- IND11 What are typical systems engineering activities performed in your organization? How are they related to other engineering and management activities?
- IND12 How common is it for people to perform systems engineering activities who are not classified as systems engineers and vice-versa?

How effective are systems engineers and why?

- IND13 *Establish definition of the interviewee's effectiveness and effectiveness of systems engineering workforce to be used in the rest of the interview (from Helix, organizational, individual definitions)*
- IND14 What are the most important personal traits that make you an effective systems engineer? Why?
- IND15 What are the most important forces that increase your effectiveness as a systems engineer? Why?
- IND16 What are the most important forces that inhibit your effectiveness as a systems engineer? Why?
- IND17 Do you think that the impact of those forces is uniform across the systems engineering workforce?
- IND18 How could you become a more effective systems engineer?
- IND19 How is your performance as a systems engineer evaluated and rewarded? What metrics are used?
- IND20 Do you think your effectiveness is appropriately considered in that evaluation and reward?

What are employers doing to improve their effectiveness?

- IND21 What personal initiatives have you been taking to improve your own effectiveness?
- IND22 Which organizational initiatives in the last 5 years have been helping improve your effectiveness?
- IND23 Are these initiatives adequate? What more should be done?

APPENDIX B: SAMPLE INTERVIEW QUESTIONS (ORGANIZATIONAL LEVEL)

Getting to know you

- ORG01 Do you consider yourself a systems engineer?
- ORG02 What are you responsible for in your current position?
- ORG03 What activities do you perform most frequently?
- ORG04 What are the most important activities that you perform?
- ORG05 Are you spending the right amount of time on the most important activities?
- ORG06 What were your expectations when you first took this position? Does that align with what you do now?
- ORG07 How well does your management understand and appreciate what you do?

What are the characteristics of systems engineers?

- ORG08 *Establish definition of systems engineer and definition of systems engineering workforce to be used in the rest of the interview (from Helix, organizational, individual definitions)*
- ORG09 Do you still consider yourself a systems engineer in light of this definition?
- ORG10 How does this definition of a systems engineer match what you see in practice?
- ORG11 What are typical systems engineering activities performed in your organization? How are they related to other engineering and management activities?
- ORG12 How common is it for people to perform systems engineering activities who are not classified as systems engineers and vice-versa?

How effective are systems engineers and why?

- ORG13 *Establish definition of an individual systems engineer's effectiveness and effectiveness of systems engineering workforce to be used in the rest of the interview (from Helix, organizational, individual definitions)*
- ORG14 What are the most important personal traits that make a systems engineer effective? Why?
- ORG15 If you had to do it all over again, what would you do differently?
- ORG16 What are the most important forces that increase the effectiveness of a systems engineer? Why?
- ORG17 What are the most important forces that inhibit the effectiveness of a systems engineer? Why?
- ORG18 Do you think that the impact of those forces is uniform across the systems engineering workforce?
- ORG19 Is there a gap between the effectiveness of your systems engineering workforce and your organizational need?
- ORG20 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?
- ORG21 Do you think the effectiveness of a systems engineer is appropriately considered in that evaluation and reward?
- ORG22 What are the primary risks to the systems engineering workforce in the next 5 years? How are these risks being addressed?

What are employers doing to improve their effectiveness?

- ORG23 What personal initiatives have you been taking to improve your own effectiveness?
- ORG24 Which organizational initiatives in the last 5 years have had the greatest impact on the forces that improve workforce effectiveness? How do you know this?
- ORG25 How did your workforce respond to these initiatives?
- ORG26 Are these initiatives adequate to close the gap between effectiveness and organizational need? What more should be done?

APPENDIX C: INSTITUTIONAL DATA

Institutional data requested from each participating organization:

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 in the organization in each year since 2009, divided into engineers and non-engineers, including the number of people hired and departed
4. Total number of systems engineers in the organization in each year since 2009 including the number of people hired and departed, however the organization defines "systems engineer"
5. A characterization of the systems engineer population with respect to highest college degree, number of years of professional experience, number of years of experience as a systems engineer, age, gender, title or rank (such as systems engineer, senior systems engineer, chief systems engineer, etc. using whatever titles or ranks that are part of the human resources system), and years to retirement eligibility
6. The way in which systems engineers are primarily organized; e.g., in a matrix structure or project structure
7. Major organization initiatives now underway to improve the quality or quantity of systems engineers
8. Policies that are particularly relevant to systems engineers, including organizational competency model, definition of systems engineer, and career paths
9. Major SE-relevant workforce initiatives and how the organization is tracking their impact.
10. Overview of how evaluation is performed within the organization (process, metrics, etc.)