Agenda

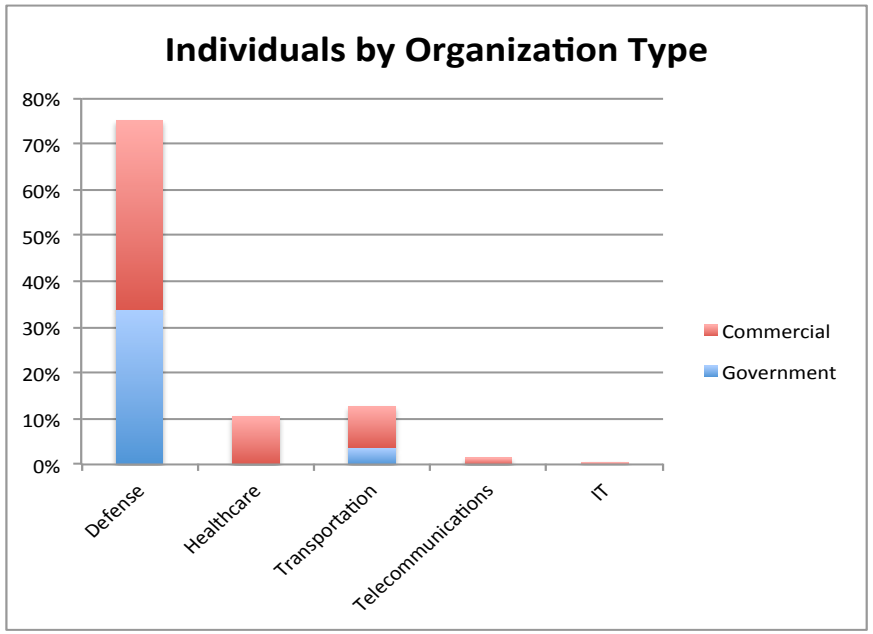
- Background on the Helix Project
- Methodology
- INCOSE Data Set
- Experience Insights on INCOSE SEP Applicants

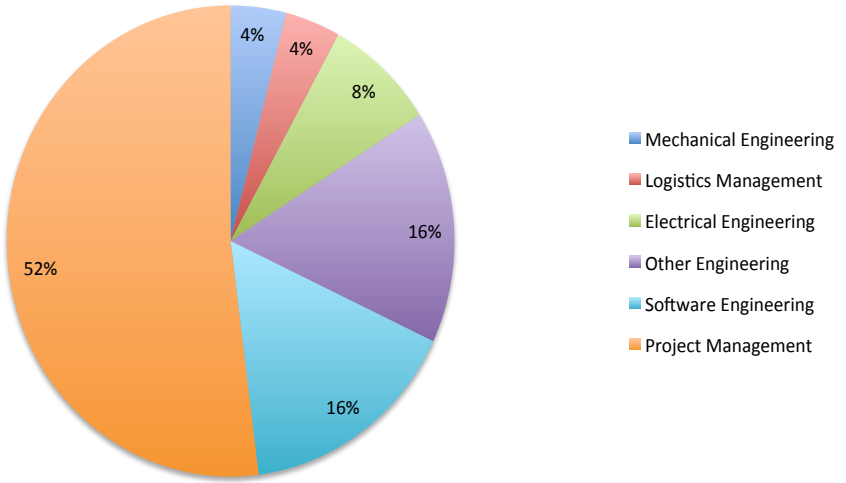
Helix Project Overview

- Helix is a multi-year longitudinal study building an understanding of the systems engineering workforce in the DoD, the Defense Industrial Base (DIB), and other sectors that perform systems engineering.
- Helix is focused on three main research questions:
  1. What are the characteristics of systems engineers?
  2. How effective are those who perform SE activities and why?
  3. What are employers doing to improve the effectiveness of systems engineers?
- Most data collection has been through face-to-face, semi-structured interviews with systems engineers and by examining SEP applications
- Scope includes those who perform SE activities but don't think of themselves primarily as systems engineers, and those organizations that perform systems engineering without calling it so
- Reporting is done in an aggregated anonymous manner that does not reveal the identities of participating individuals or organizations

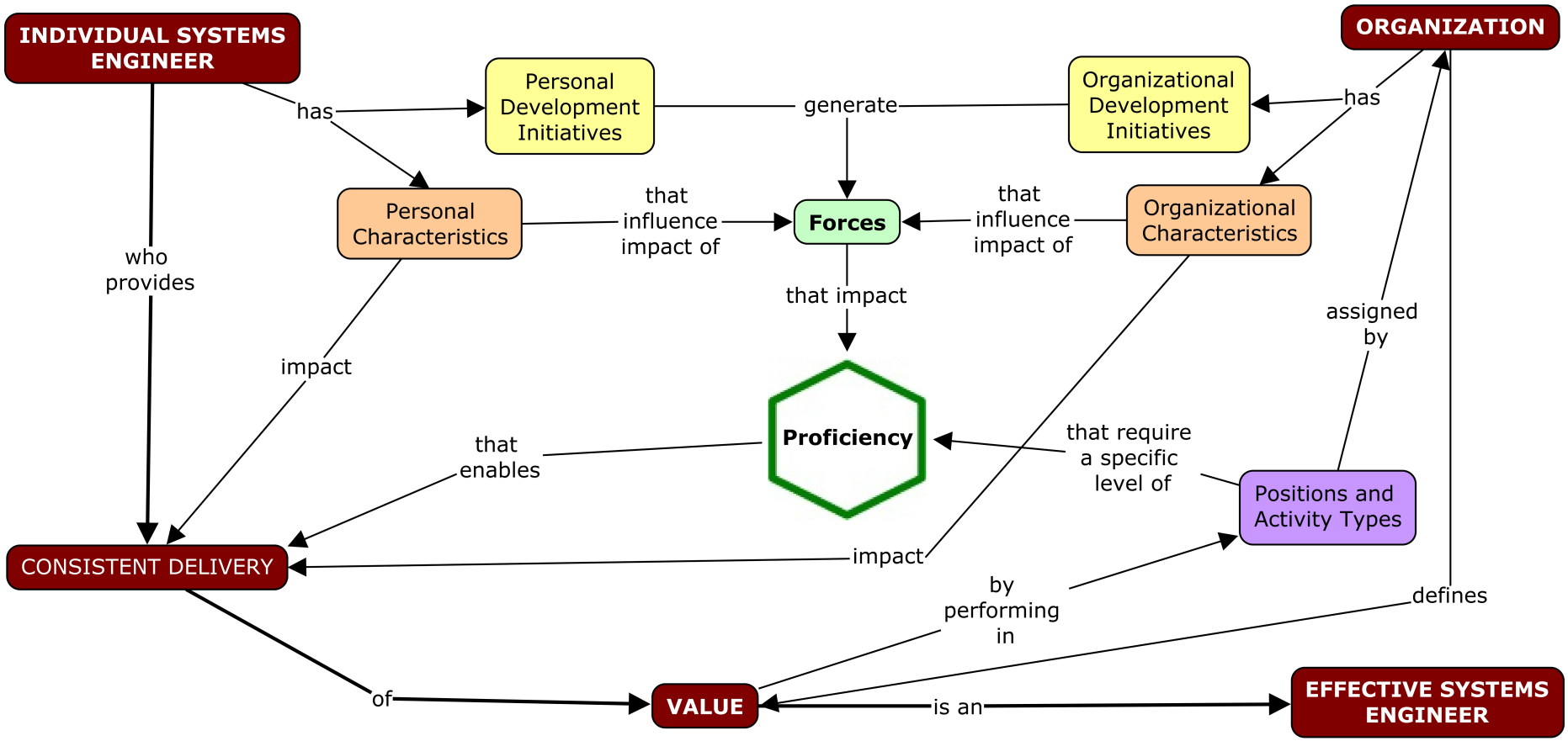
Helix Project Overview (cont.)

- In-depth interviews to date
  - 287 individuals
  - 20 organizations
  - Follow up interviews with 75
- Mixture of qualitative and quantitative analyses
- 2014 – *Atlas 0.25*: Theory of Effective Systems Engineers
- 2015:
  - INCOSE education and experience work
  - Expanding outside of defense industry, into related disciplines
  - *Atlas* 0.5
- 2016
  - Detailed implementation of *Atlas*
  - Formalization of *Vector* career path analysis and visualization
  - Creation of *Atlas* 1.0 (Dec 2016)

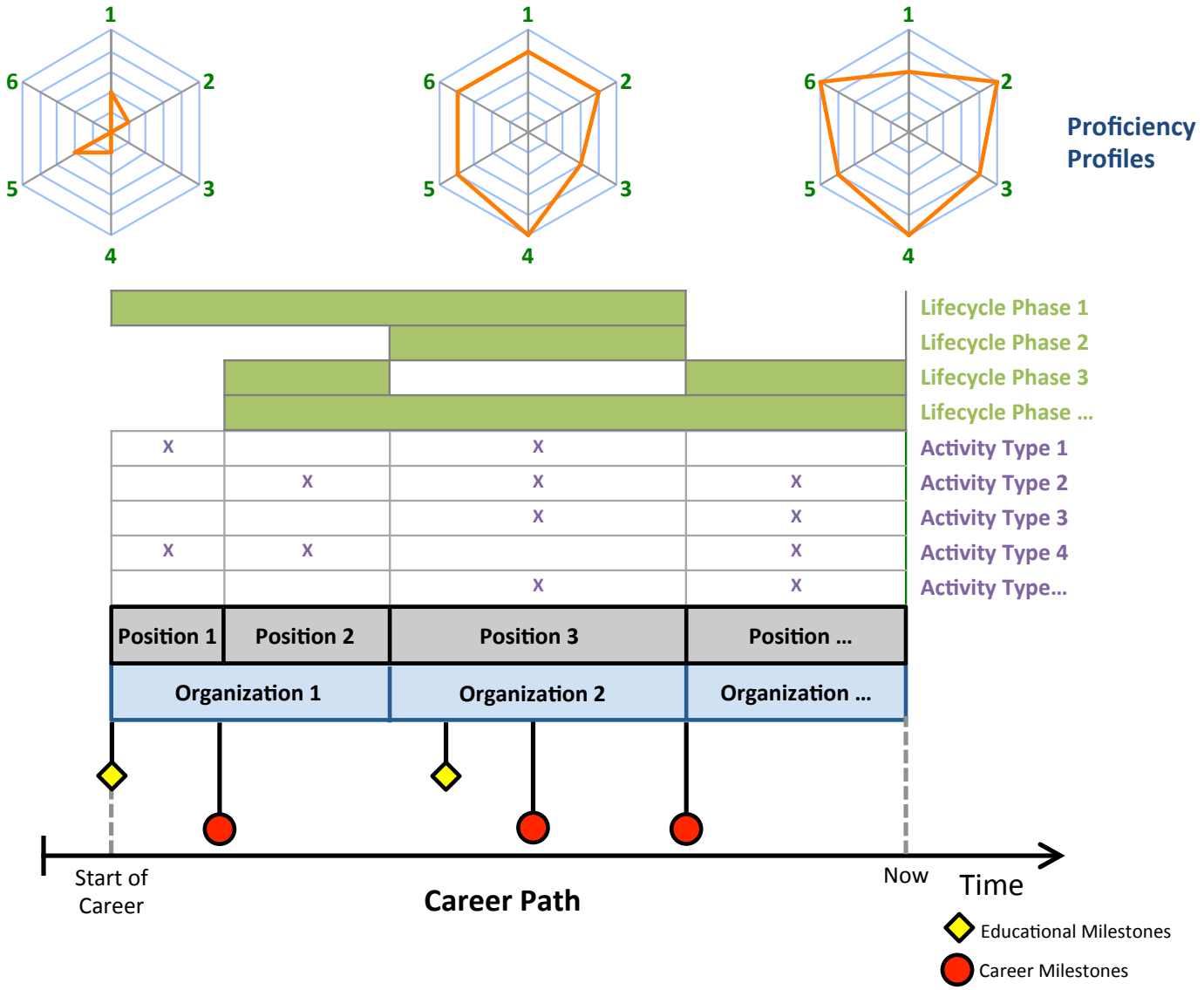




Helix Project Results



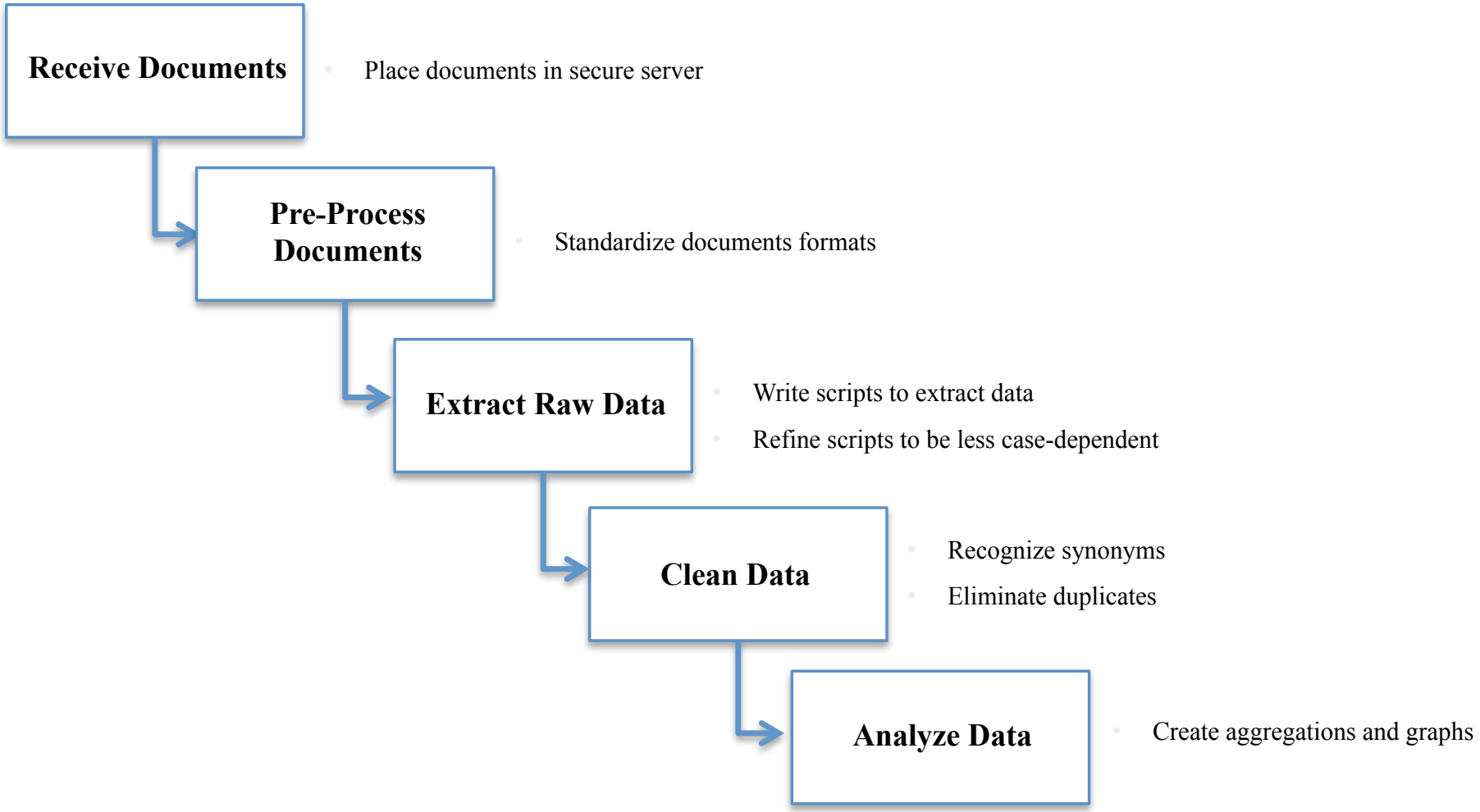
Vector Career Paths & Proficiency



INCOSE Data

- April 2014 – Helix Team Signed Agreement with INCOSE to analyze SEP applications
- August 2014 – Helix team received
  - Over 2,500 applications
  - Almost a dozen different versions of application Form 1 (For ASEP / CSEP Certification) and Form 41 (ESEP Certification)
    - Fields changed and required different data, i.e. birthdate versus birthyear
    - Different file formats made data extraction difficult

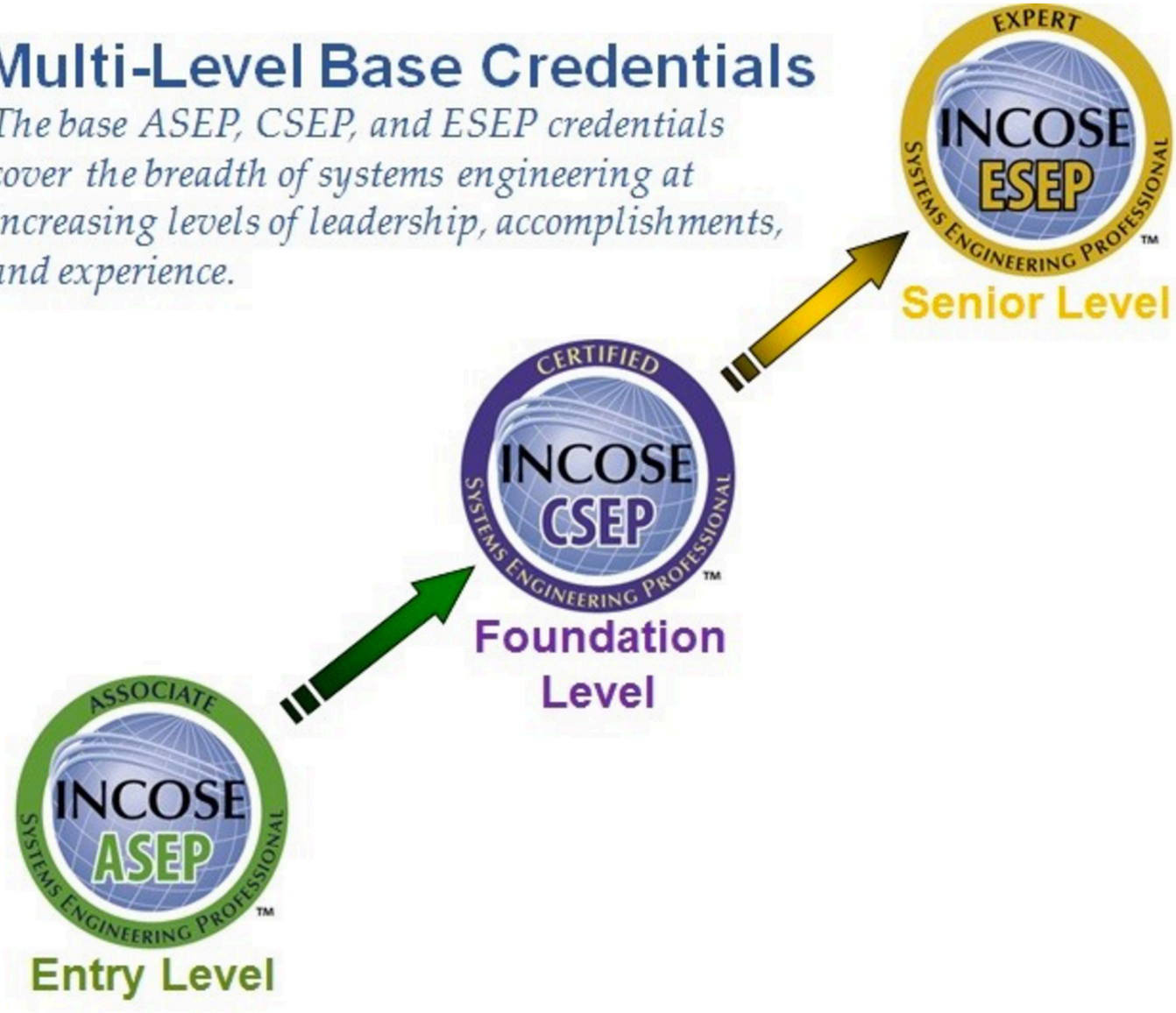
Education Analysis Process



SEP Certification

Multi-Level Base Credentials

The base ASEP, CSEP, and ESEP credentials cover the breadth of systems engineering at increasing levels of leadership, accomplishments, and experience.



Vector Career Path Analysis

- Approach and keywords developed in Helix dataset and applied to SEP data
- Analysis of cleaned SEP application experience data to examine aspects of career paths that could be analyzed consistently :
  - —Titles
  - —Roles
  - —Years of experiences

SEP Experiences

- Relevant System Engineering experiences are reported
  - Information provided ranged from none to 11 positions
    - ASEP's are not required to provide experience
    - CSEP's must provide a minimum of 5 years of experience*
      - *(or a minimum of 10 years with without a technical bachelors, or a minimum of 15 years without any bachelors)
    - ESEP's must provide a minimum of 25 years of experience *
      - *(or a minimum of 30 years with without a technical bachelors, or a minimum of 35 years without any bachelors)

- Extremely Messy Dataset
  - Down selected to certified SEPs (comparison with published list)
  - 644 Applications were individually cleaned
    - Cleaned all ESEP Applications
      - Dataset includes applications from 2008 to 2014
    - Random Selection of Applications
      - Dataset includes applications from 2004-2014

Applicant Age at Time of Application

	CERTIFICATION TYPE		
AGE	ASEP	CSEP	ESEP
20-25	15%	1%	0%
25-30	26%	3%	0%
30-35	21%	16%	0%
35-40	13%	15%	0%
40-45	15%	15%	1%
45-50	0%	18%	11%
50-55	4%	16%	33%
55-60	2%	9%	26%
60-65	4%	5%	17%
65-75	0%	2%	11%
75-90	0%	0%	1%

- Average Age was consistent year by year
  - —47% of ASEPs are between 25 and 35 years old
  - —80% of CSEPs are between 30 and 55 years old
  - —76% of ESEPs are between 50 and 65 years old

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CERTIFIED ESEP YEARS OF EXPERIENCE

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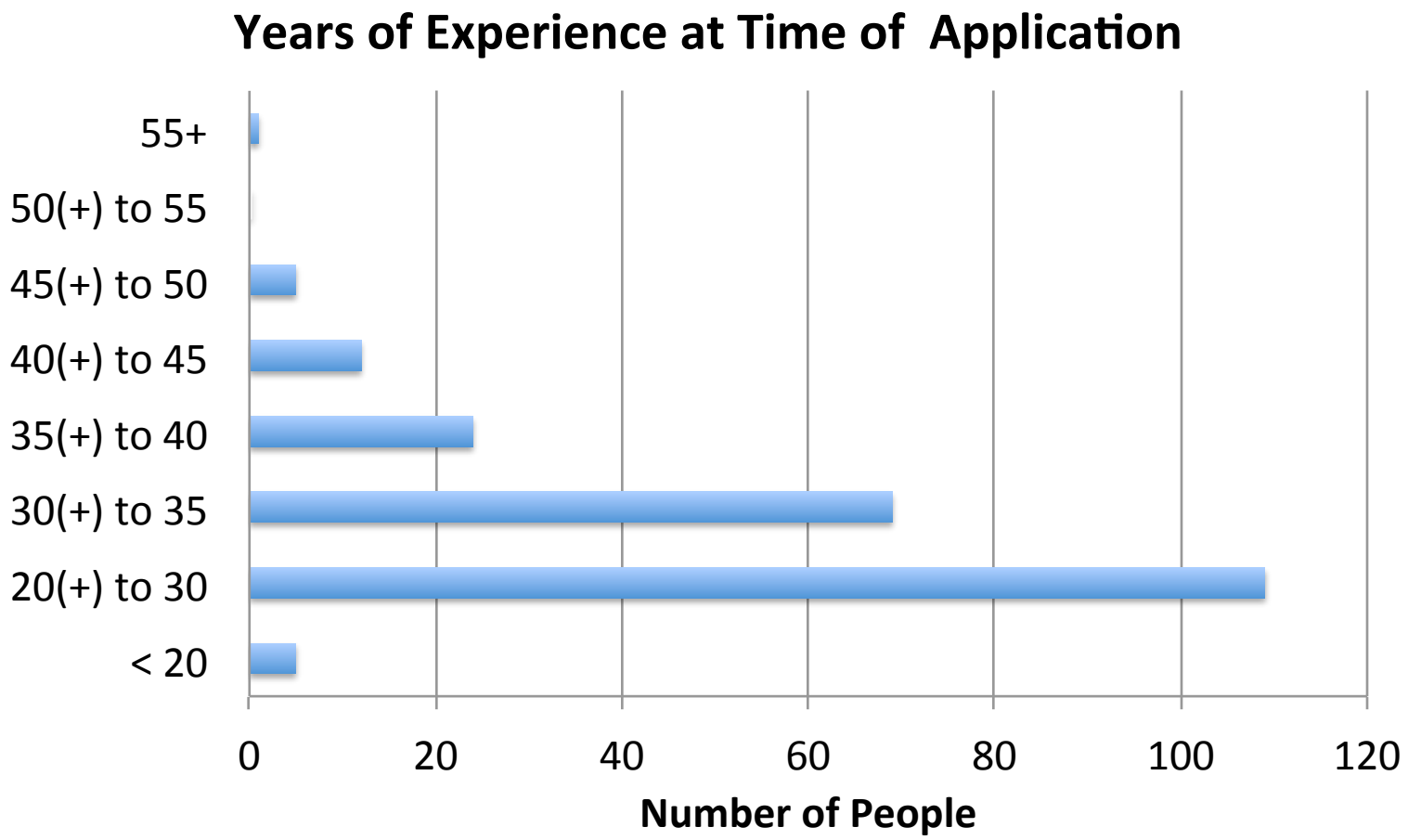
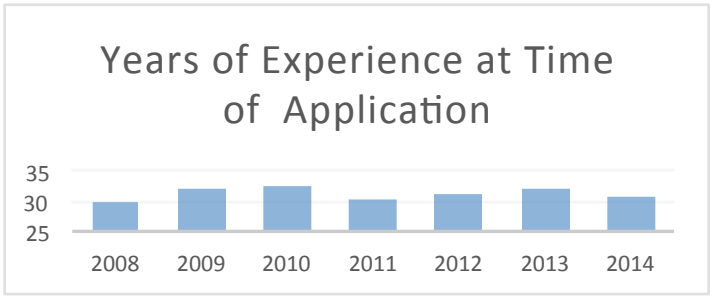


The average across all years is 31 years of experience at the time of application.



Definition of Position and Role, Keywords

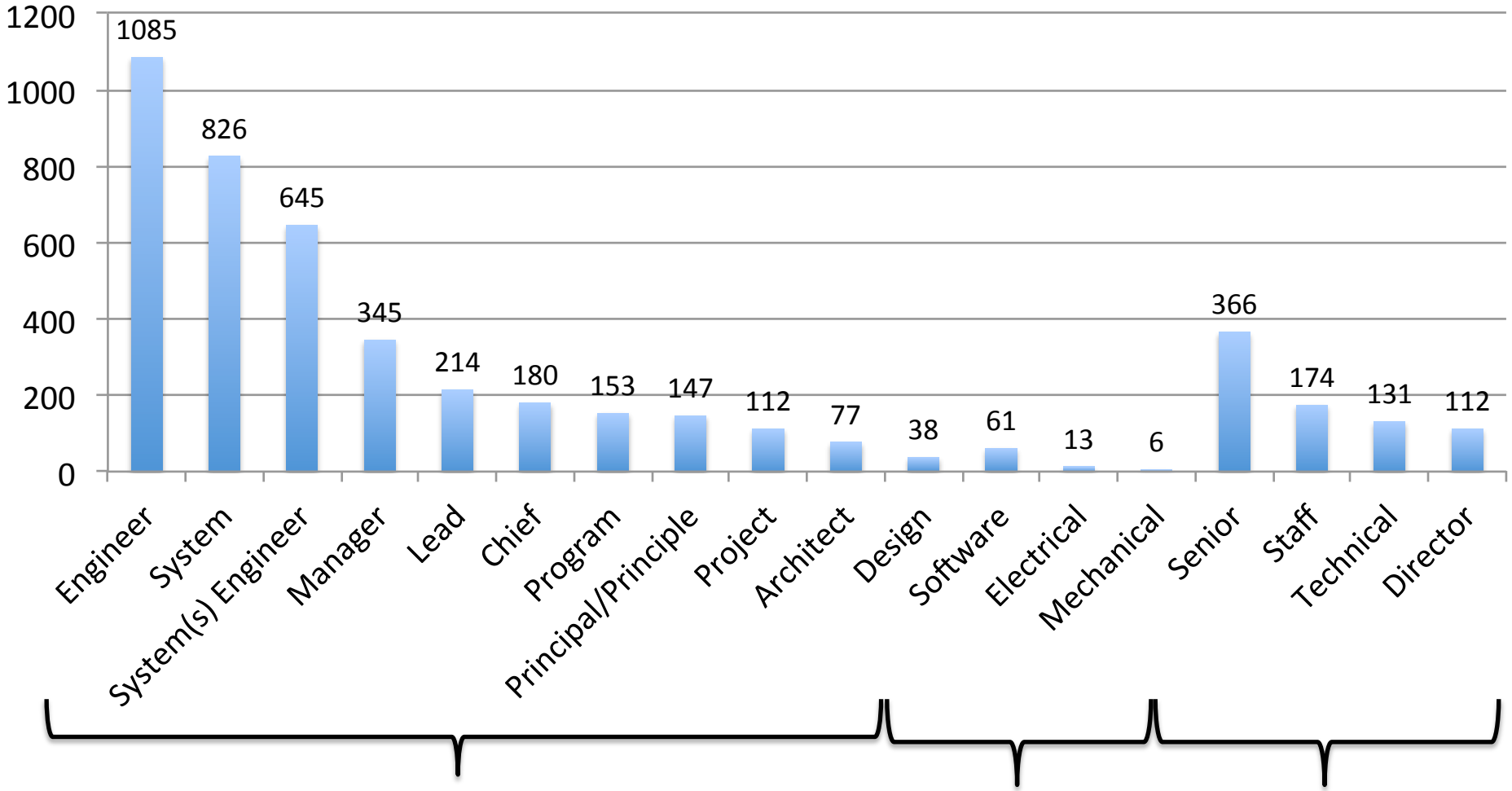
- A *position* is equivalent to an individual's title. Organizations will define what roles and responsibilities each position contains and this may not translate across organizations. (Hutchison and Pyster 2015)

- A *role* is a specific set of related systems engineering activities. (Hutchison 2015) The Helix team uses an expanded set of Sheard's "Twelve Roles of Systems Engineers". (1996)
  - —Keywords were used to uncover roles described in application position descriptions, see examples below:

Source	Sheard (1996)	Sheard (1996)	Sheard (1996)	Sheard (1996)	Sheard (1996)	Sheard (1996)	Sheard (1996)
Role (Abbreviation)	**Requirements Owner (RO)**	**System Designer (SD)**	**System Analyst (SA)**	**V&V Engineer (VV)**	**Logistics/ Operations Engineer (LO)**	**Glue (GL)**	**Customer Interface (CI)**
Keywords	"*create/ed/ing Requirement*" "*Generate/ed/ing Requirement*" "*develop/e/ed/ing Requirement*" "*Requirement*" "*manage/ed/ing Requirement*" "*requirement database*" "*requirements database*" "*Requirement manage*" "*Requirements manage*" "*Requirement develop*" "*Requirements develop*"	"*system Design*" "*architect*"	*Analy*" "*system model*" "*model*" "*simulat*"	"*verif*" "*validat*" "test"	"*logistic*" "*operat*" "*site support*"	"*integrat*" "*system interface*" "*design interface*"	"*customer coordinat*" "*customer*" "*coordinat*with customer*" "*customer interface*"

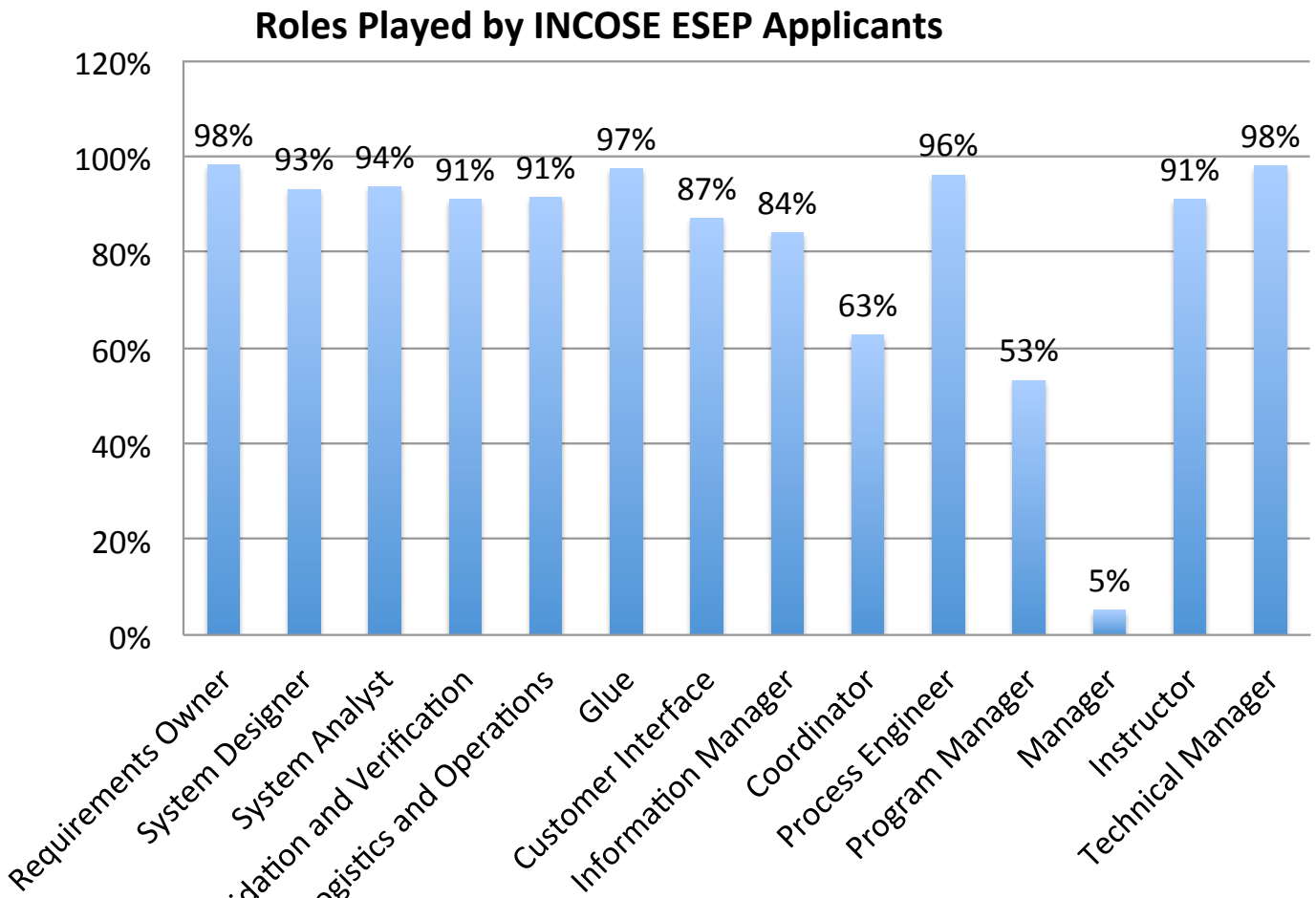
Certified ESEP Analysis

Analysis of Keywords in Position Titles



Certified ESEP Analysis

- Keywords were defined for each role – **position descriptions** were **searched** using **keywords**.
- Starting Point: Sheard's 12 SE Roles (1996)
- Full set of roles defined by Helix team based on Helix analysis (some modifications, additions from Sheard's original 12)
- If the same role was identified in multiple positions – it was counted for each position



"CHIEF X" ANALYSIS

- Further investigation into experience and education background of people who have had the following "Chief" titles and were certified as ESEPs:
  - Chief Engineer,
  - Chief Systems Engineer,
  - Chief Architect,
  - Chief Systems Architect,
  - Chief Principal Engineer, and
  - Chief of Systems Engineering
- Identified by title, but responsibilities confirmed by position description
- 65 "Chief X's" exist in the ESEP dataset – they held a total of 108 "Chief X" titles

In the Helix interview data, Chief Systems Engineers are a special class of senior systems engineers, with unique characteristics.

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Reported Years of Experiences

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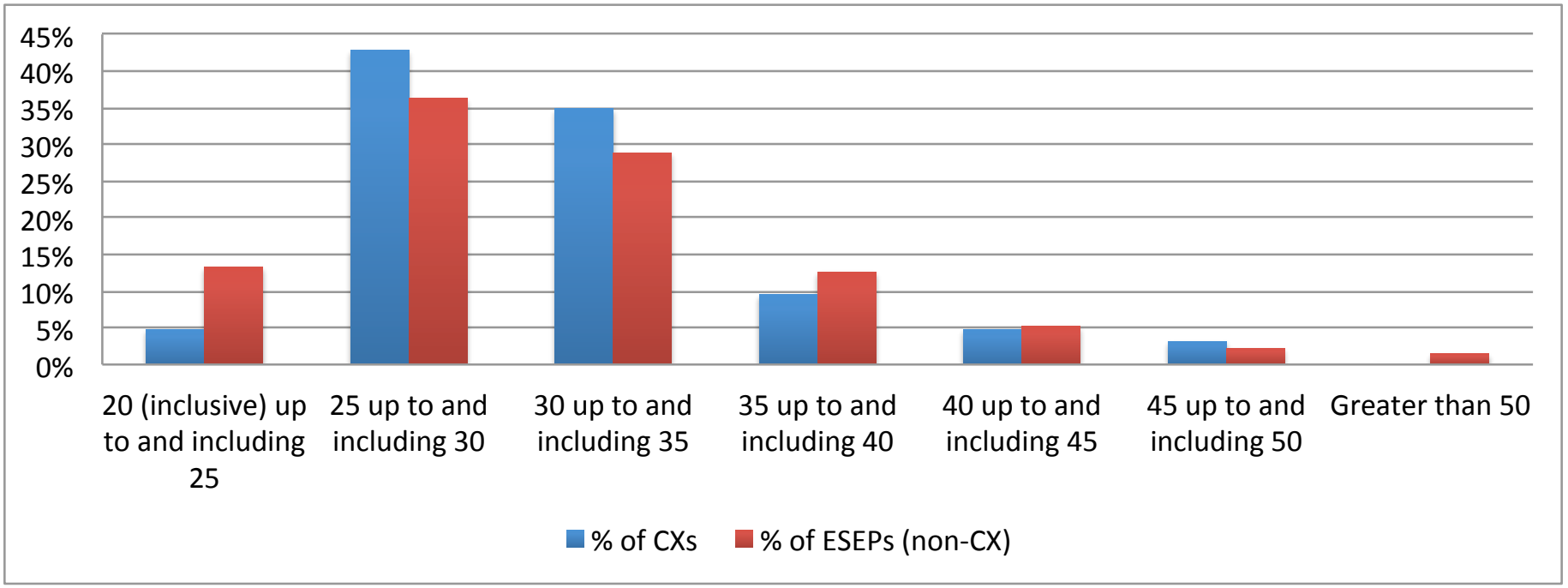

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Bachelor's Degree Majors

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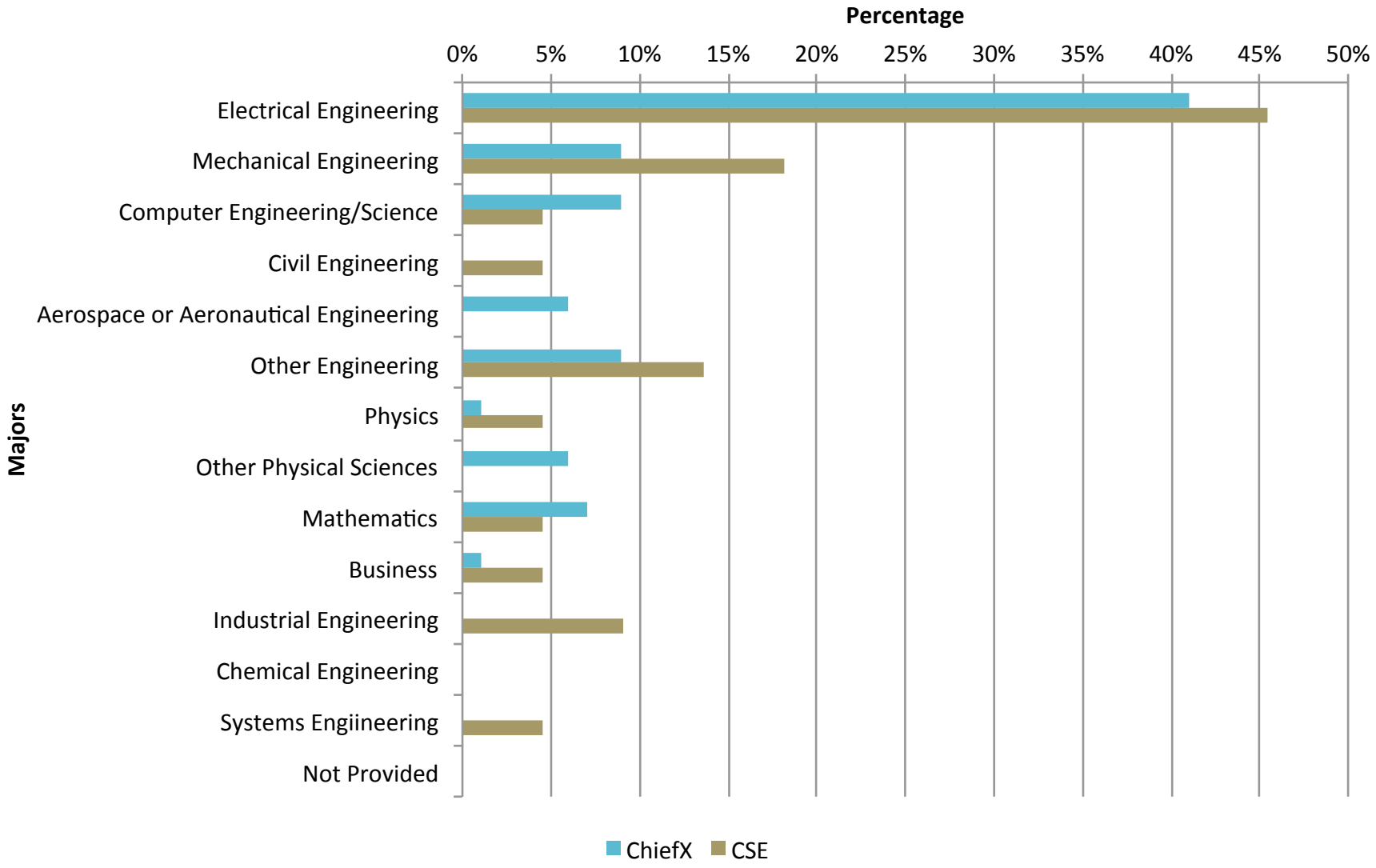

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Master's Degree Majors

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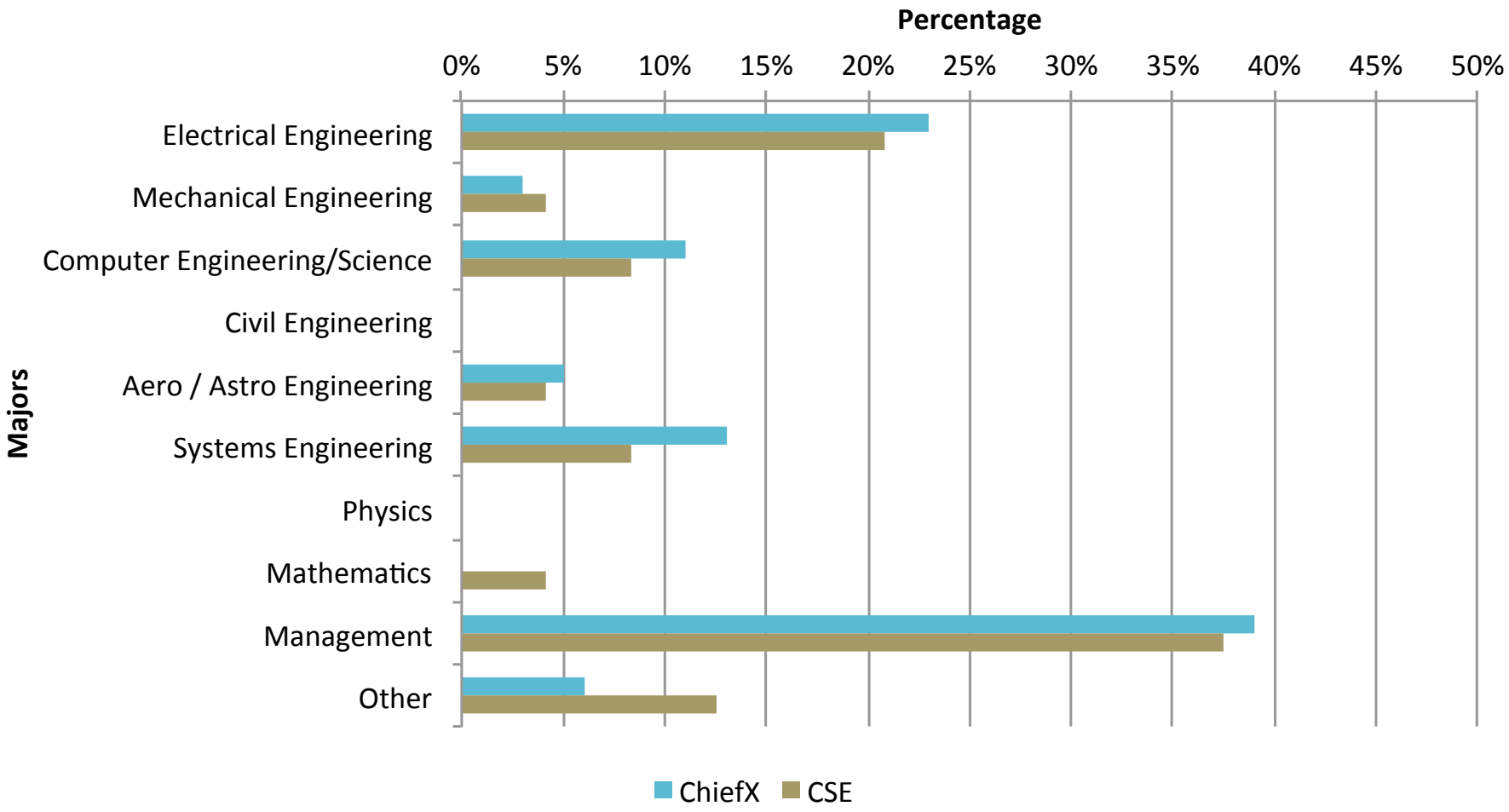
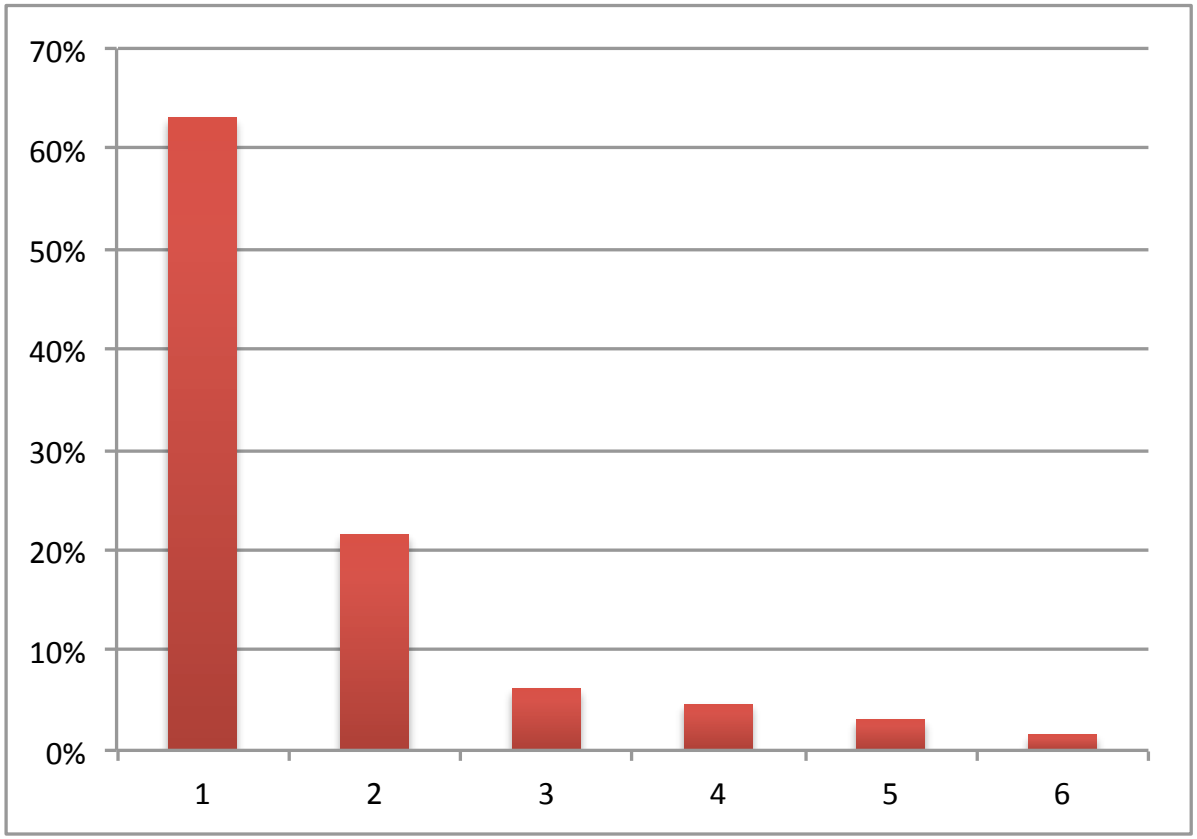
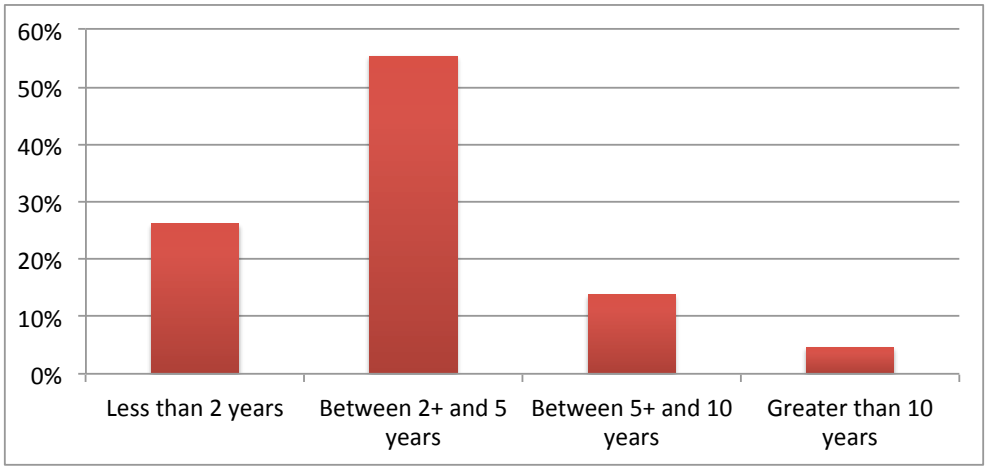


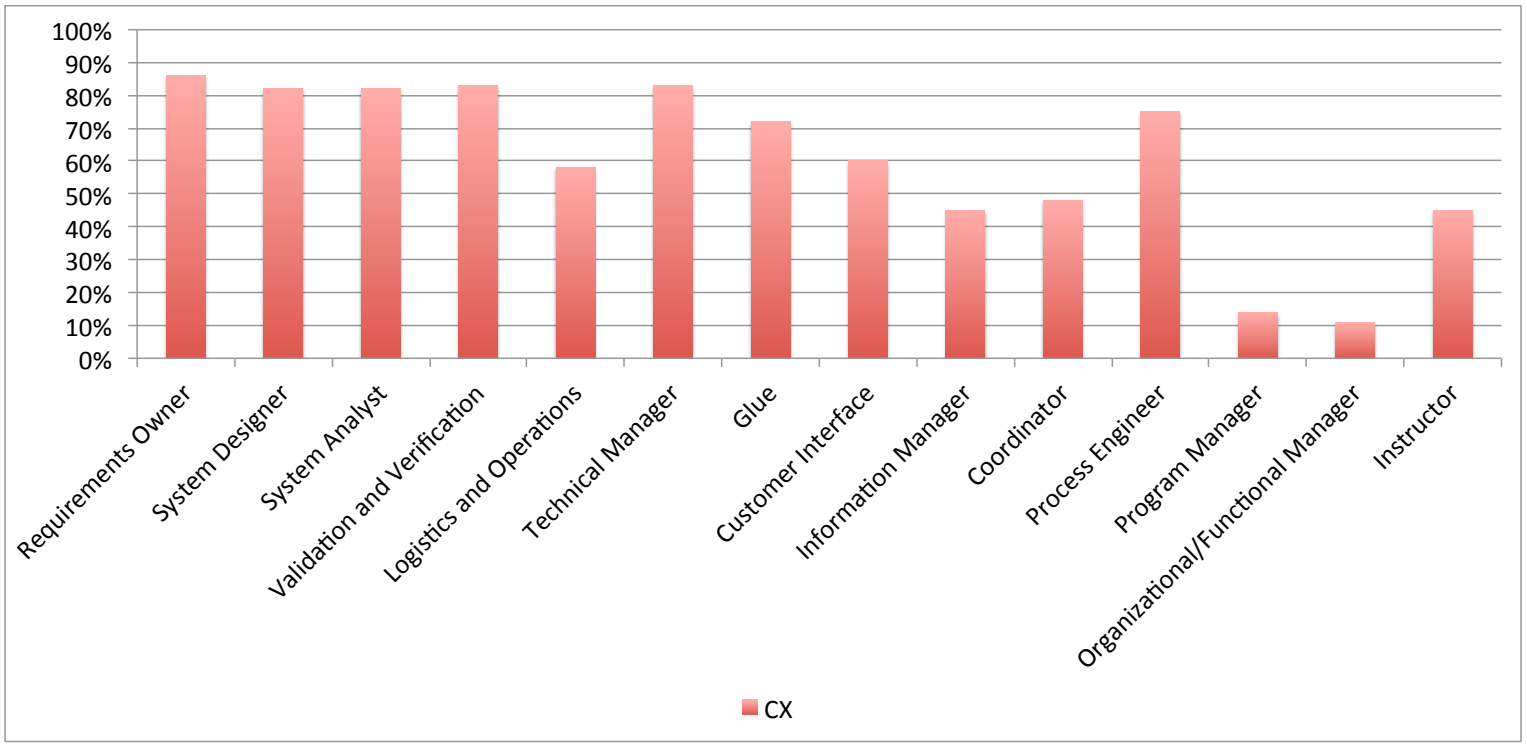
Number of Chief "X" Positions Held



- 35% were in a "Chief X" (CX) position when they applied to become an ESEP
- Most people obtain a CX title during the 3 most recent positions reported
- Very few report being CX during their first/oldest 3 positions.

First Chief "X" Position





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First Chief Position: Comparison with Helix Interviewees

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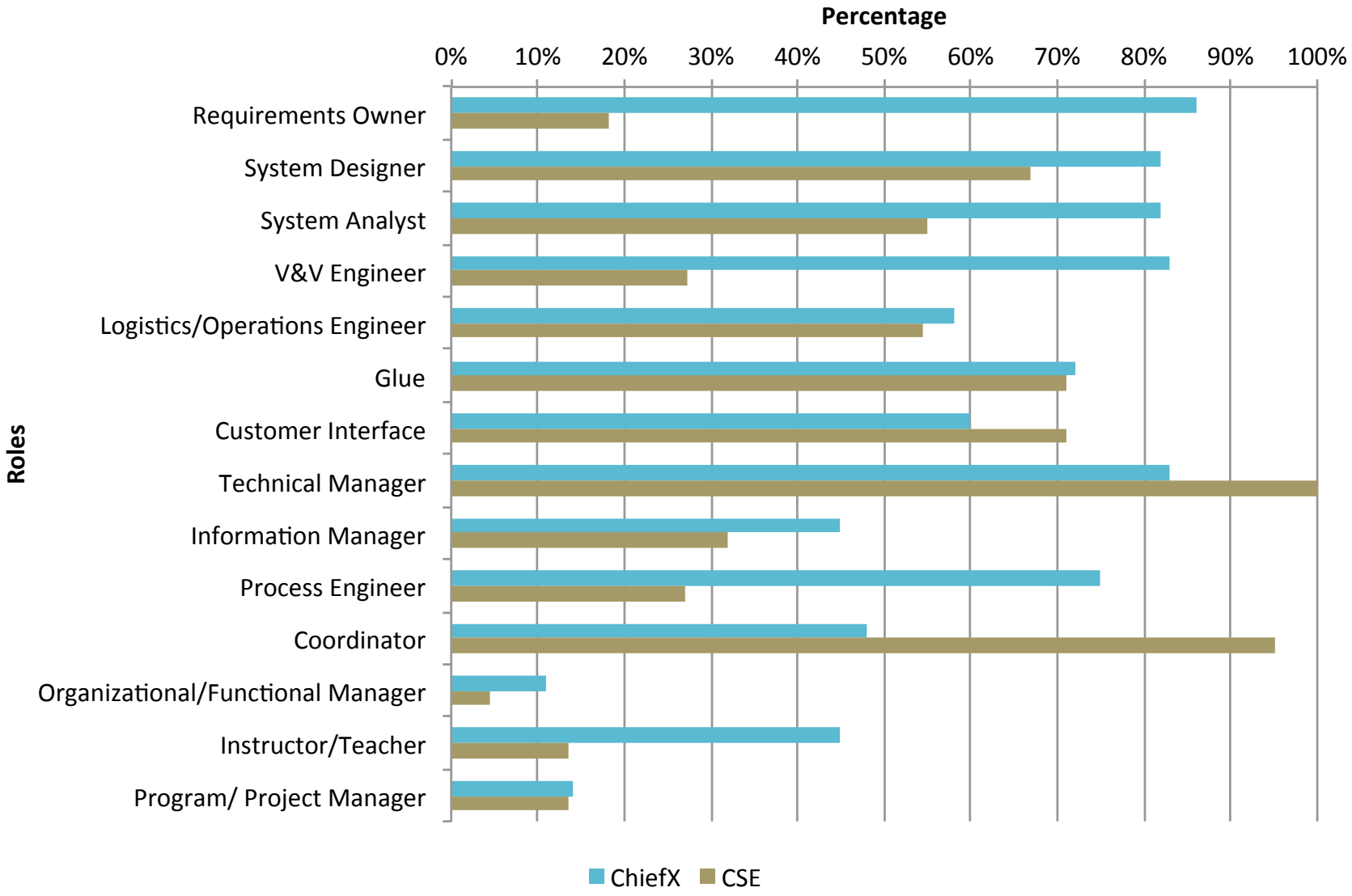
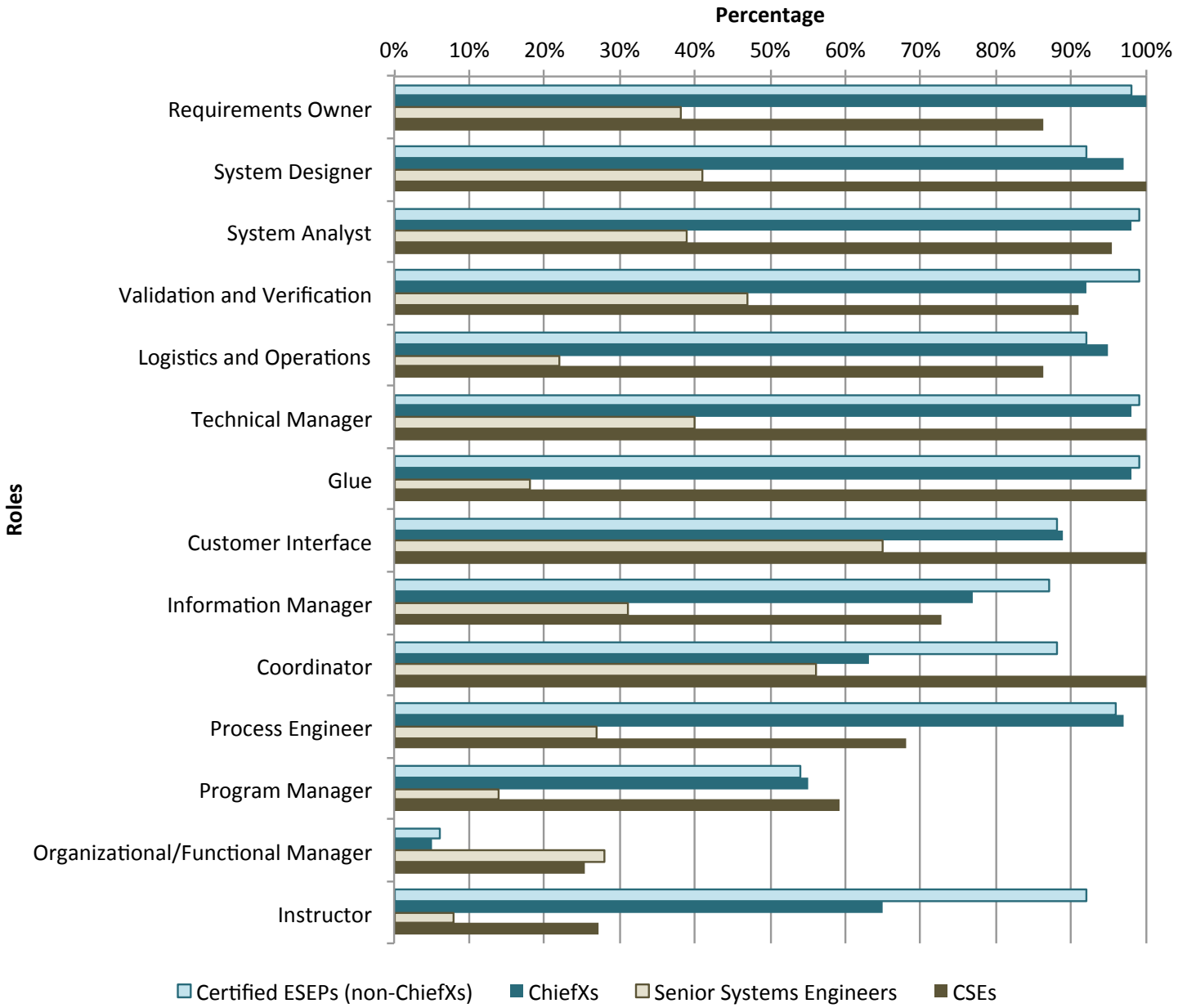


Roles across Careers



Experiences Conclusions

- For both certified ESEPs and CXs, experience in all roles is prevalent
  - This implies that the most advanced are the ones who have experienced multiple SE roles
  - CXs have much more experience in almost every role except organizational/functional manager and instructor
- Evidence of the "T" shape profile:
  - Discipline specific education for bachelors degrees
  - Masters in some type of management shows the requirement of developing the "soft" skills required of leaders

- Cleaned data and analyses delivered to INCOSE in 2016
- ESEP Data – historical perspective on how very senior systems engineers have grown
- ASEPs are the senior systems engineers of tomorrow – but experience data is not required! What are the differences?
  - —Helix junior systems engineers – less "deep dive" time
  - —Broadening experiences earlier, specialization later
  - —Master's degree attainment in systems or similar (as opposed to a discipline)
- Helix team is working on updating a framework for the roles – how do they differ for novice, journeyman, and expert SErs?
  - —CSEP data can be used to validate this information

Questions?

Contact the Helix team at:

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