Helix: Understanding How to Develop Effective Systems Engineers

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• Systems Engineering is a critical factor in the successful development of increasingly complex and interconnected systems

• There is little systematic understanding of what makes systems engineers effective

• US Department of Defense is eager to understand
  — The capabilities of its existing SE workforce
  — The capabilities of the existing defense industry workforce
  — Any capability gaps that will impact the development of future systems
  — How retirement of senior systems engineers will impact overall workforce capabilities

• Findings for defense community should inform and be understood in the context of other business sectors
What is Helix?

• Helix is a multi-year longitudinal research project responding to that challenge, building an understanding of the systems engineering workforce in the defense community and elsewhere.

• Helix focusing on three main 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 the effectiveness of their systems engineers?

• Data collection has primarily been through semi-structured interviews with systems engineers.

• Report aggregated anonymous results that do not reveal the identities of individuals or organizations.
Helix Research Progress

- Initially, Helix used a Grounded Theory approach
  - Open-ended, exploratory interviews intended to provide a broad variety of data
  - Analysis focused on identifying key patterns and themes

- 11 organizations, 165 systems engineers have participated in Helix interviews, yielding > 2500 pages of raw data

- Helix has used those patterns to define Version 0.25 of *Atlas: A Theory of Effective Systems Engineers*

- Focusing additional data collection and analysis to refine and validate *Atlas*
Progression Through Career

**Junior**
- ≤ 3 Years Experience
  - AND
  - 0-1 formal leadership positions
- Experiences primarily in Components
- Experience in ≥ 2 SE process steps
- System Engineer
- Requirements Manager
- Electronics Engineer
- Senior Aerospace Engineer

**Mid**
- > 3 and < 20 Years of Experience
  - AND
  - At least 2 formal leadership positions
- Experiences in Components and Subsystems
- Experience in ≥ 3 SE process steps
- IPT Lead
- Systems Engineer
- Subsystem lead
- Control Systems Engineer

**Senior**
- ≥ 20 Years Experience
  - OR
  - At least 2 formal senior leadership roles (e.g.)
- Chief Systems Engineer
- Project Engineer
- Senior Systems Engineer
- Chief Design Engineer
- Experiences in components, subsystems, and systems
- Experience in ≥ 4 SE process steps

An individual’s *effectiveness* may go up and down as roles, projects, and organizations change.
Effective Systems Engineers

Effectiveness: The ability to Consistently Deliver Value within the Organizational Context

INDIVIDUAL SYSTEMS ENGINEER

- Personal Enabling Characteristics
  - has
  - affect efficiency of

- Consistent Delivery
  - that enables

- VALUE
  - is an

ORGANIZATION

- assign
- defines

- Organizational Characteristics
- Organizational Development Initiatives

- Proficiency
  - level of
  - forces that impact
  - generates
  - has
Commonly Reported High Value

- Translating highly technical information from subject matter experts (SMEs) into common language that other stakeholders can understand
- Balancing traditional project management concerns of cost and schedule with technical requirements
- Asking the right questions
- Seeing relationships between the disciplines
- Staying “above the noise” and identifying pitfalls
- Managing emergence in both the project and the system
- Projecting into the future
- Getting the “true” requirements from the customer
Proficiency Areas for Systems Engineers

- Math / Science / General Engineering
- Technical Leadership
- Interpersonal Skills
- System's Domain & Operational Context
- SE Discipline
- SE Mindset
Proficiency Areas for Systems Engineers

- **Math/Science/General Engineering**: Foundational concepts from mathematics, physical sciences, and general engineering
- **System’s Domain & Operational Context**: Relevant domains, disciplines, and technologies for a given system and its operation
- **Systems Engineering Discipline**: Foundation of systems science and systems engineering knowledge
- **Systems Engineering Mindset**: Skills, behaviors, and cognition associated with being a systems engineer
- **Interpersonal Skills**: Skills and behaviors associated with the ability to work effectively in a team environment and to coordinate across the problem domain and solution domain
- **Technical Leadership**: Skills and behaviors associated with the ability to guide a diverse team of experts toward a specific technical goal
Proficiency of a Systems Engineer

Math / Science / General Engineering

Technical Leadership

System's Domain & Operational Context

Interpersonal Skills

SE Discipline

SE Mindset

- Proficiency Level of a certain Systems Engineer
Developing Individual Targets

Math / Science / General Engineering

Technical Leadership

Interpersonal Skills

System's Domain & Operational Context

SE Discipline

SE Mindset

Desired Proficiency Level

Current Proficiency Level
Effectiveness: The ability to Consistently Deliver Value within the Organizational Context

- INDIVIDUAL SYSTEMS ENGINEER
  - Personal Enabling Characteristics
  - Personal Development Initiatives
  - has
  - generates
  - Forces that impact
  - level of
  - Proficiency
  - Consistent Delivery
  - affects efficiency of
  - VALUE
  - is an

- ORGANIZATION
  - has
  - Organizational Development Initiatives
  - Organizational Characteristics
  - assigns
  - Roles & Responsibilities
  - defines
  - by performing
Forces and Characteristics

Forces that impact level of Proficiency
*(generated by Personal and Organizational Development Initiatives)*

Proficiency of a Systems Engineer

- **Math / Science / General Engineering**
- **Technical Leadership**
- **Interpersonal Skills**
- **SE Mindset**
- **System's Domain & Operational Context**
- **SE Discipline**

**Personal Enabling Characteristics**
- Learning Ability
- Ethics & Morality
- Professionalism
- Curiosity
- Motivation
- Self awareness
- Diligence

**Organizational Characteristics**
- Culture
- Structure
- Values
- Appreciation of SE
- Org. Definition of SE & Systems Engineer
- Rewards & Recognitions
- Career Growth Potential
Generic Model of Proficiency

- Area 1
- Area 2
- Area 3
- Area 4
- Area 5
- Area 6

Proficiency

Level

Category 1
Category 2
Category 3
...

Topic 1
Topic 2
...

14
Decompose SE Discipline Area

Math / Science / General Engineering

Technical Leadership

Interpersonal Skills

System's Domain & Operational Context

SE Mindset

SE Discipline
SE Discipline Categories

- **Lifecycle** – The organized collection of activities, relationships and contracts that apply to a system-of-interest during its life. (Pyster 2009) This is a roll up of knowledge about lifecycles and proficiency in specific aspects of the life cycle.

- **SE Process** – A set of activities, methods, practices, and transformations that people use to develop and maintain systems and associated products. (SEI 2007) This includes understanding and ability to apply Systems Engineering processes, tailoring it as appropriate to match the goals, constraints, and character of a given system.

- **SE Management** - Managing the resources and assets allocated to perform systems engineering, often in the context of a project or a service, but sometimes in the context of a less well-defined activity. Systems engineering management is distinguished from general project management by its focus on the technical or engineering aspects of a project. (SEBoK 2014).

- **System Complexity** – The degree to which a system's design or code is difficult to understand because of numerous components or relationships among components (ISO/IEC 2009) In this context, the proficiency is the level of Complexity an individual can handle. This may include things such as their ability to work on components, subsystem, systems, or systems of systems as well as the ability to work on products, platforms, services, or enterprises.
Decompose SE Mindset Area

Math / Science / General Engineering

Technical Leadership

System's Domain & Operational Context

Interpersonal Skills

SE Discipline

SE Mindset
SE Mindset Categories

- **‘Big Picture’ Thinking** – Also referred to as ‘systems thinking’ and ‘holistic thinking’, this includes the ability to step back and take a broader view of the problem at hand,

- **Paradoxical Mindset** – the ability to hold and balance seemingly opposed views that are critical to providing value for systems engineers:
  - Big Picture Thinking *and* Attention to Detail
  - Analytic *and* Synthetic
  - Methodical *and* Creative

- **Flexible Comfort Zone** – The overall ability to deal with ambiguity and uncertainty, this involves the abilities to be open minded, understand multiple disciplines, deal with challenges, and ability to take rational risks

- **Self-Driven** – The ability to initiate and complete work with little to no supervision or external impetus

- **Quick Learning and Abstraction** – The ability to synthesize new information from separate pieces of data with multiple sources, e.g. to realize that a problem an EE faces in one component is related to a problem that a ME faces in another component and address the root causes instead of just the symptoms

- **Foresight and Mental Simulation** – The ability to foresee the remaining life cycle of the system, the impact of current decisions, and to visualize possible scenarios.
Decompose Technical Leadership Area

- Math / Science / General Engineering
- System's Domain & Operational Context
- SE Discipline
- SE Mindset
- Interpersonal Skills

Technical Leadership
Technical Leadership Categories

- **Building and Orchestrating Diverse Team** – The ability to identify, build, and effectively guide / coach a team comprising individuals with diverse expertise, perspectives, and personalities.

- **Balanced Decision Making and Risk Taking** – This includes the ability to make sound decisions in complex situations (e.g. multiple stakeholders, environment pressures), decision making with uncertainty/ambiguity, creative approach to problems in order to reach decisions, etc. It also includes taking rational risks.

- **Managing Stakeholders and their Needs** – This includes ability to manage a variety of internal and external stakeholders, and keeping the team focuses on their needs, especially those of the end user / customer.

- **Conflict Resolution and Barrier Breaking** – This includes the ability to resolve conflict within the team as well as other individuals and groups, keeping the system goals in mind. This also includes breaking barriers that prevent progress towards completion and success.

- **Business and Project Management Skills** – The ability to handle a variety of business and project management activities including accounting, budget, cost estimation, schedule, work breakdown, and profit.
Forces that impact level of Proficiency
 GENERATED BY PERSONAL AND ORGANIZATIONAL DEVELOPMENT INITIATIVES

Experience Force

Experience | Mentoring | Education & Training

Personal Enabling Characteristics
- Learning Ability
- Ethics & Morality
- Professionalism
- Curiosity
- Motivation
- Self awareness
- Diligence

Organizational Characteristics
- Culture
- Structure
- Values
- Appreciation of SE
- Org. Definition of SE & Systems Engineer
- Rewards & Recognitions
- Career Growth Potential

Proficiency of a Systems Engineer

Math / Science / General Engineering

Technical Leadership

System's Domain & Operational Context

Interpersonal Skills

SE Discipline

SE Mindset
Diversity of Application Domain Experience

Experiences Across Domains

<table>
<thead>
<tr>
<th>Domains</th>
<th>Percentage of Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>60%</td>
</tr>
<tr>
<td>Space/Aero</td>
<td>50%</td>
</tr>
<tr>
<td>Marine</td>
<td>40%</td>
</tr>
<tr>
<td>Intel/Electronic Warfare</td>
<td>30%</td>
</tr>
<tr>
<td>Transportation</td>
<td>20%</td>
</tr>
<tr>
<td>Weapons</td>
<td>10%</td>
</tr>
<tr>
<td>IT/Networks</td>
<td>0%</td>
</tr>
<tr>
<td>Medical</td>
<td>0%</td>
</tr>
<tr>
<td>Finance</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
</tr>
</tbody>
</table>

Math / Science / General Engineering
Technical Leadership
Interpersonal Skills
SE Disciplines
SE Mindset
System’s Domain & Operational Context
Diversity in Number of Experiences in Different SE Process Activities

- Terminology for SE Life Cycle is not always consistent.
- Helix team translated into common framework from the SEBoK

- Concept Definition
- System Definition
- System Realization
- System Deployment and Use
- Product and Service Life Management
- Systems Engineering Management

Experience across SE Process Activities

<table>
<thead>
<tr>
<th>Number of Process Activities</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td>2</td>
<td>25%</td>
</tr>
<tr>
<td>3</td>
<td>20%</td>
</tr>
<tr>
<td>4</td>
<td>15%</td>
</tr>
<tr>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>6</td>
<td>5%</td>
</tr>
</tbody>
</table>

Junior
Senior
Typical CAREER PATH of Chief Systems Engineers

<table>
<thead>
<tr>
<th>Period</th>
<th>Organizations</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 10 Years</td>
<td>2-3 Orgs</td>
<td>1-3</td>
</tr>
<tr>
<td>Second 10 Years</td>
<td>1-2 Orgs</td>
<td>3-4</td>
</tr>
<tr>
<td>Third 10 Years</td>
<td>No Org Changes</td>
<td>1-3</td>
</tr>
</tbody>
</table>

Bachelor's Degree

Master's Degree
Avg 5-10 Years after Bachelor's

First CSE Role
Avg 15-20 Years

Work Experience (Avg 20-30 years)

Typical ROLES of Chief Systems Engineers

(S): Sheard’s 12 Systems Engineering Roles

(H): Helix
Mentoring Force

Forces that impact level of Proficiency
*(generated by Personal and Organizational Development Initiatives)*

**Experience**

**Mentoring**

**Education & Training**

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**Personal Enabling Characteristics**

- Learning Ability
- Ethics & Morality
- Professionalism
- Curiosity
- Motivation
- Self awareness
- Diligence

---

**Organizational Characteristics**

- Culture
- Structure
- Values
- Appreciation of SE
- Org. Definition of SE & Systems Engineer
- Rewards & Recognitions
- Career Growth Potential

---

Proficiency of a Systems Engineer

Math / Science / General Engineering

Technical Leadership

Interpersonal Skills

SE Mindset

System's Domain & Operational Context

SE Discipline
Importance of Mentoring for Systems Engineers

- **Systems Engineers Can be a Rare Commodity**: In some organizations, there are not enough systems engineers to perform the required SE activities.

- **Identifying and Recruiting SE talent**: In many organizations recruitment directly into the SE division or into a systems engineer’s role does not happen.

- **Support for New Systems Engineers**: “It isn’t rare and it isn’t uncommon to end up doing SE if you were not a systems engineer before”. Mentoring plays a key role in equipping non-systems engineers to be effective systems engineers.

- **Changing Face of Systems Engineers**: Depending on organizational policies and practices, engineers may become systems engineers without a lot of experience in SE or in domain knowledge.

- **Nature of Systems Engineering**: Due to the nature of systems engineering, and particularly how it is performed in the organization, there is much to be learned hands-on that cannot be learned before entering the organization.
Education and Training Force

Forces that impact level of Proficiency
(generated by Personal and Organizational Development Initiatives)

Experience | Mentoring | Education & Training

Personal Enabling Characteristics
- Learning Ability
- Ethics & Morality
- Professionalism
- Curiosity
- Motivation
- Self awareness
- Diligence

Organizational Characteristics
- Culture
- Structure
- Values
- Appreciation of SE
- Org. Definition of SE & Systems Engineer
- Rewards & Recognitions
- Career Growth Potential

Proficiency of a Systems Engineer

Math / Science / General Engineering
- Technical Leadership
- System's Domain & Operational Context
- Interpersonal Skills
- SE Discipline
- SE Mindset
Education of Interviewed Senior Systems Engineers

- 69% of Senior Systems Engineers have a Master’s degree
- 55 Master’s Degrees earned by 40 Senior Systems Engineer
- 6 Senior Systems Engineers have PhDs
INCOSE certifies systems engineers professionals (SEPs) at 3 levels:

- Associate SEP, Certified SEP, and Expert SEP
- Mix of test, experience, references, and interviews depending on the level

Helix given access to all SEP applications for period 2004 to 2013 – approximately 16 GB of raw data – under non-disclosure agreement

Completed analysis of the educational background of 2504 applicants who collectively earned 4963 degrees
### Countries and # of Degrees

#### Country from Which Applicant Applied

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th># Applicants</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>US</td>
<td>1847</td>
<td>74%</td>
</tr>
<tr>
<td>2</td>
<td>India</td>
<td>179</td>
<td>7%</td>
</tr>
<tr>
<td>3</td>
<td>Germany</td>
<td>151</td>
<td>6%</td>
</tr>
<tr>
<td>4</td>
<td>France</td>
<td>101</td>
<td>4%</td>
</tr>
<tr>
<td>5</td>
<td>UK</td>
<td>49</td>
<td>2%</td>
</tr>
<tr>
<td>6</td>
<td>Sweden</td>
<td>41</td>
<td>&lt;2%</td>
</tr>
<tr>
<td>7</td>
<td>Spain</td>
<td>36</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>100</td>
<td>4%</td>
</tr>
</tbody>
</table>

#### Degree Ranking

<table>
<thead>
<tr>
<th>Degree</th>
<th># Awarded</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doctorate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Associate**: Associate of [Science, Arts, ...]  
- **Bachelors**: Bachelor of [Science, Engineering, Technology, Arts, ...]  
- **Masters**: Master of [Science, Engineering, Technology, Arts, ...]  
- **Doctorate**: Doctor of [Philosophy, Engineering, Science, ...]  
- **Other**: Certificate  
- **Other**: Fellowship

---

### Highest Degrees Awarded

<table>
<thead>
<tr>
<th>Degree</th>
<th># Awarded</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctorate</td>
<td>193</td>
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</tr>
<tr>
<td>Masters</td>
<td>1533</td>
<td>61%</td>
</tr>
<tr>
<td>Bachelors</td>
<td>746</td>
<td>30%</td>
</tr>
<tr>
<td>Associate</td>
<td>10</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Other</td>
<td>22</td>
<td>&lt;1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2504</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
Variants of Associate and Bachelor

Without Regard to Whether They Were Highest Degree Awarded

<table>
<thead>
<tr>
<th>ASSOCIATE Degree</th>
<th>COUNT</th>
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<tbody>
<tr>
<td>Associate of Science</td>
<td>40</td>
</tr>
<tr>
<td>Associate of Applied Science</td>
<td>32</td>
</tr>
<tr>
<td>Associate of Arts</td>
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<tr>
<td>Associate</td>
<td>15</td>
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<tr>
<td>Diploma</td>
<td>5</td>
</tr>
<tr>
<td>Vordiplom</td>
<td>3</td>
</tr>
<tr>
<td>Associate of Science- Equivalent</td>
<td>2</td>
</tr>
<tr>
<td>Associate of Engineering Technology</td>
<td>1</td>
</tr>
<tr>
<td>Institute associateship In engineering</td>
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</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>119</strong></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>BACHELORS Degree</th>
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<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Science</td>
<td>1813</td>
<td>77%</td>
</tr>
<tr>
<td>Bachelor of Engineering</td>
<td>316</td>
<td>13%</td>
</tr>
<tr>
<td>Bachelor of Arts</td>
<td>203</td>
<td>9%</td>
</tr>
<tr>
<td>Bachelor</td>
<td>8</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Bachelor of Technology</td>
<td>5</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Baccalaureate</td>
<td>3</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Post Graduate Diploma</td>
<td>3</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Bachelor of Civil Engineering Technology</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Bachelor of Business Administration</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Bachelor of Arts/Bachelor of Science</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Bachelor of Law</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Bachelor of Science in Business Administration</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Bachelor in General Studies</td>
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<td>&lt;1%</td>
</tr>
<tr>
<td>Bachelor of Commerce</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Bachelor of Professional Studies</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2359</strong></td>
<td></td>
</tr>
</tbody>
</table>

Most of those with Associate degrees have gone on to obtain higher degrees

Bachelor of Science dominates
Without Regard to Whether They Were Highest Degree Awarded

<table>
<thead>
<tr>
<th>MASTERS Degree</th>
<th>#</th>
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</thead>
<tbody>
<tr>
<td>Master of Science</td>
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<td>69%</td>
</tr>
<tr>
<td>Master of Engineering</td>
<td>337</td>
<td>16%</td>
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<tr>
<td>Master of Business Administration</td>
<td>196</td>
<td>9%</td>
</tr>
<tr>
<td>Master of Arts</td>
<td>70</td>
<td>3%</td>
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<tr>
<td>Master</td>
<td>24</td>
<td>1%</td>
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<tr>
<td>DEA</td>
<td>5</td>
<td>&lt;1%</td>
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<tr>
<td>Diplom</td>
<td>3</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Diplom-Informatiker</td>
<td>3</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Master of Public Administration</td>
<td>3</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Master of Technology</td>
<td>2</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Master in Management</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Master of Business</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Master of Engineering Management</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Master of Engineering sciences</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Master of Library Science</td>
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<td>&lt;1%</td>
</tr>
<tr>
<td>Master of Public Policy</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Master of Science (Software Systems)</td>
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<td>&lt;1%</td>
</tr>
<tr>
<td>Master of Science/Master of Business Administration</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Specialised Master</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Diplom-Physiker</td>
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<td>&lt;1%</td>
</tr>
<tr>
<td>TOTAL</td>
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<table>
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<th>DOCTORATE Degree</th>
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<th>%</th>
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<td>95%</td>
</tr>
<tr>
<td>Juris Doctor</td>
<td>6</td>
<td>3%</td>
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<tr>
<td>Doctor of Science</td>
<td>2</td>
<td>1%</td>
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<td>Promotion Doctor of Philosophy-Ing.</td>
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Master of Science dominates

Doctor of Philosophy heavily dominates
### Most Popular Majors

#### Popular Bachelors Majors

<table>
<thead>
<tr>
<th>Major</th>
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<tbody>
<tr>
<td>Electrical Engineering</td>
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<tr>
<td>Mechanical Engineering</td>
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<tr>
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<tr>
<td>Aerospace Engineering</td>
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<td>Physics</td>
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<td>Mathematics</td>
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#### Trend in Popular Bachelors Majors

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#### Popular Masters Majors

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<td>Engineering Management</td>
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#### Trend in Popular Masters Majors

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<td>22</td>
<td>9</td>
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</table>
2015 Plans

- Continue to collect and analyze data to refine and validate *Atlas*

- Expand the population to include software engineers, project/program managers, and “classical” engineers in order to understand their systems engineering characteristics

- Expand the organizations examined to reach beyond the defense community

- Work with a small number of organizations to pilot the application of *Atlas* to better understand their workforce and strengthen their development activities