NIGHT VISION FOR FUN AND PROFIT

Sebastian Requena, PhD
Optical Systems Engineering Manager
My Background
What do I do?

• Systems Engineering
  – AKA “Adult Supervision”
  – AKA “Herding cats”
Optical Systems Engineering

- In the beginning there was light... and then what?

**Industry Standard DRI Requirements**

<table>
<thead>
<tr>
<th></th>
<th>Detection</th>
<th>Recognition</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>3.6 pixels by 1 pixel (Something is there)</td>
<td>13 pixels by 5 pixels (A person is there)</td>
<td>28.8 pixels by 8 pixels (The person looks like a soldier)</td>
</tr>
<tr>
<td>Vehicle</td>
<td>2.8 pixels by 1 pixel (Something is there)</td>
<td>13 pixels by 5 pixels (A vehicle is there)</td>
<td>28.8 pixels by 8 pixels (The vehicle may be a humvee)</td>
</tr>
<tr>
<td>Boat</td>
<td>4.5 pixels by 1 pixel (Something is there)</td>
<td>18 pixels by 2 pixels (Some kind of boat is there)</td>
<td>36 pixels by 4 pixels (The boat is a small inflatable boat)</td>
</tr>
</tbody>
</table>

- How do we make sure that the materials used can survive harsh conditions?
- How do we make sure the system performs as expected?
- How do we make sure the system doesn’t cost too much?
- How do we make sure the system doesn’t weight too much?
The V of Systems
What skill do I need to do my job?

- Able to translate big picture ideas into a series of small digestible pieces

- **The user wants to be able to recognize a person from 500 meters away under overcast starlight**
  – There is 100,000 times less light during night that during a regular sunny day
  – To have a system optical amplification of 100,000x:
    – The image intensifier needs to be able to have a gain factor \(X\)
    – The objective lens needs to have a light collecting power of \(Y\)
    – The eyepiece needs to have light transmission ability of \(Z\)

- Strong mathematical modeling and problem solving skills
- Knowledge of optical, electronical, and mechanical technologies
- Data analysis and experimental design
- Effective communicator that can work with many types of engineers
Why did I go into STEM?

- Many teachers and professors encouraged me
- Scientists and engineers gave talks to class about what they did
- Class field trips to engineering facilities and research labs
- Hands-on lab classes where I got to “tinker”
The landscape for Physics PhDs

Employment Fields for New Physics PhDs in Potentially Permanent Positions, Classes of 2011 through 2016

- Physics: 18%
- Engineering: 20%
- Computer Software: 17%
- Computer Hardware: 6%
- Education (Physics): 11%
- Education (non-Physics): 4%
- Business: 10%
- non-STEM: 6%
- Other STEM: 6%
- Medicine: 2%

Salaries for Physicists

Typical Starting Salaries for New Physics Bachelors, Classes of 2015 & 2016 Combined

Sector of Employment
- Private Sector STEM
- Private Sector non-STEM, Regularly Solves Technical Problems
- Private Sector non-STEM, Rarely or Never Solves Technical Problems
- Civilian Govt. (Incl. Natl. Labs)
- Active Military
- High School Teachers
- College or University

Typical Salaries (in thousands of Dollars)

Figure includes only bachelors in full-time, newly accepted positions.

Typical salaries are in the middle 50% i.e., between the 25th and 75th percentiles. STEM refers to positions in natural science, technology, engineering and math. Regularly solving technical problems refers to respondents who selected “Daily”, “Weekly”, or “Monthly” on a four-point scale that also included “Rarely or Never” when asked how frequently they solved technical problems in their positions.
Starting Salaries of Astronomy PhDs, Classes of 2014, 2015, & 2016 Combined

-sector of employment:
  - Postdoc
  - Academic
  - Government
  - Potentially Permanent
  - Academic
  - Private Sector

The full starting salary range is represented by the lines extending to each side. The box represents the middle 50% (25th to 75th percentile) of salaries. The vertical line within the box represents the median starting salary in the field.
Why was I successful in STEM?

• In owe a lot of my success to two high school teachers
  – Told my parents I needed math help and offered resources
  – Directed me to scholarship opportunities before I started college

• Mentors, mentors, mentors!
  – Continually was directed to apply for more scholarships and funding
  – Activities allowing me to understand the STEM “way of life”
  – Engineers and scientists giving class talks about their careers
  – Opportunities to teach and complete the feedback loop
What were challenges I faced in STEM?

Teachers’ Perception of Student Math Preparation: Private Schools and Public Schools by SES*

2008-09 US High School Physics Teachers

<table>
<thead>
<tr>
<th></th>
<th>Inadequately prepared</th>
<th>Adequately prepared</th>
<th>Very well prepared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>19%</td>
<td>58%</td>
<td>23%</td>
</tr>
<tr>
<td>Public, worse off</td>
<td>43%</td>
<td>49%</td>
<td>8%</td>
</tr>
<tr>
<td>Public, average</td>
<td>29%</td>
<td>61%</td>
<td>10%</td>
</tr>
<tr>
<td>Public, better off</td>
<td>24%</td>
<td>60%</td>
<td>16%</td>
</tr>
</tbody>
</table>

* Teacher / principal assessment of student economic circumstances relative to those of students at other schools in the local area.

http://www.aip.org/statistics
What were challenges I faced in STEM?

Teachers’ Perceptions of Problems They Face
2008-09 US High School Physics Teachers

- Insufficient funds for equipment or supplies
- Inadequate student mathematical preparation
- Not enough time to prepare labs
- Students don’t think physics is important
- Inadequate space for lab or facilities outmoded
- Not enough time to plan lessons
- Difficulties in scheduling classes and labs
- Insufficient administration support or recognition

http://www.aip.org/statistics
Resources for Physics

Data on high school physics teachers

Latest reports

- **FOCUS ON**
  - High School Physics Teacher Preparation
  - September 2015

- **FOCUS ON**
  - What High School Physics Teachers Teach
  - December 2014

- **FOCUS ON**
  - Who Teaches High School Physics?
  - December 2014

- **FOCUS ON**
  - High School Physics Textbooks, Resources and Teacher Resourcefulness
  - July 2014

- **FOCUS ON**
  - Challenges High School Teachers Face
  - April 2012

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2019 Summer Issue Available Now

Resources for:

Current Members  Advisors  Chapters  New Members  Alumni
Thank you!