Pirates, Spark Plugs, and Cell Phones: Physicists in Global R&D Careers

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Pirates, Spark Plugs, and Cell Phones

• How much physics do we need to know?
• What skills and behaviors make us successful?
• Alumni surveys

• Anecdotal evidence about physics career paths
• Career preferences of physics Ph.D. students
• NSF survey on physics careers

• Providing information on industrial career paths
• Teaching behaviors required for success in industry
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Introductory Questions

How many of you have

• Worked for a company (after your Ph.D.)?
• Spent a sabbatical in industry?
• Started a company?
• Consulted for a company?
• Written a GOALI NSF proposal?
  (Grant Opportunities for Academic Liaisons with Industry)
• Filed a patent application?
• Licensed a technology to a company?
• Organized an international conference for 1000 people

What skills do these things require?
How much physics does a department chair need to know?
Activity (index cards)

Write down 2-3 skills that make YOU successful as a physics department chair?

1) 
2) 
3)
Activity (index cards)

Write down 2-3 skills that make YOU successful as a physics department chair?
1) 
2) 
3) 

How do we teach these skills to our students?
How much physics does a department chair need to know?

My biggest worries:

• Paying people (on time, correct amount, correct account)
• Conflict resolution (faculty, staff, students, parents)
• Assist faculty and students to navigate the university bureaucracy
• Evaluations (courses & people), program assessment & accreditation
• Managing limited resources, managing multiple constraints

Responses from alumni surveys (detail on next slide):

• Navigating the federal bureaucracy
• Written and oral communication skills
• Working with interdisciplinary teams, Life-long learning

How do we teach these skills to our students?
Alumni Surveys: Skills and Challenges (Engineering Physics BS; not in grad school)

• Skills for success:
  – Problem solving skills in a broad range of topics
  – Working with interdisciplinary teams
  – Commitment to life-long learning, willing to change
  – Written/oral communication skills

• Greatest challenges:
  – Complexity of federal bureaucracy
  – Written/oral communication skills (documentation)
  – Living in a large east-coast city.
  – Consider return on investment (time management).
Physics Degree Holders: What do they do?

• My classmates:
  – Hans-Peter Wagner: University of Cincinnati (physics)
  – Martin Muscholl: University of South Florida (physics)
  – Heidrun Schmitzer: Xavier University (physics)
  – Norbert Kaiser: TU Munchen (physics)
  – Tobias Ruf: Director of spark plug R&D at Bosch GmbH
  – Diego Olego: CTO of Philips Health Care
  – Thorsten Heyen: CFO Wacker Polysilicon
Physics Degree Holders: What do they do?

• Entrepreneurs:
  – John Woollam: J.A. Woollam, Inc (scientific instruments)
  – Keith Bowen: Bede Scientific (scientific instruments)
  – Phil Wyatt: Wyatt Instruments (homeland security)
  – Sam Wurzel: Octopart.com (retail startup)

• Physicists in industry (etc)
  – Ed Stanek: (former) Director of the Iowa Lottery
  – Avoiding pirates!
  – Building cell phones
  – Physicists on Wall Street
  – Many other examples
Physics Career Preferences:
Faculty positions most attractive (58%)
Advisors encourage faculty careers (75%)
Which activities are interesting to students?

Statistical Employment Data for physicists (NSF 2006)

Primary or secondary activity:
- 28% Basic research
- 32% Applied research
- 24% Teaching (instructors)
- 19% IT
- 34% Mgmt, Sales, Admin.
- 36% Design & Development
- 12% Other (incl. services)

34% of ~34300 Ph.D. physicists at colleges (4+)
This includes 1710 postdocs.

Less than 50% list “physicist” as occupation

Sources:
- AIP Statistics
- Characteristics of Doctoral Scientists & Engineers in the US, NSF, September 2009, April 2011 Erratum
- APS Industrial Member Survey (2006)
Statistical Employment Data (NSF 2006)

Median Ph.D. Physicist Salaries:

$ 99,900  Physics Ph.D. overall
$ 52,400  Teachers (High school, community college)
$ 74,700  Colleges and universities (4+)
$ 109,200 Private sector (for-profit)
$ 117,200 Federal government

Source:
• Characteristics of Doctoral Scientists & Engineers in the US, NSF, September 2009
  http://www.nsf.gov/statistics/nsf09317/, Table 54
Sources of information on non-academic careers

- Alumni visits (seminars and informal visits)
- Keep in touch with your alumni. Social networking (Linkedin).
- Give credit to faculty whose alumni go into industry
- Get alumni in touch with current students
- Include modern applications in physics courses (NMSU course on Modern Materials)
- GOALI proposals, interdisciplinary research
- Sabbaticals/internships in industry, consulting for industry
- Professional or technical conferences (with industry)
- Engineering Physics BS, Professional Science MS
Space Physics Agreement with AFRL

- AFRL at Kirtland Air Force Base (Albuquerque, NM)
  - Space Vehicles Directorate
  - Directed Energy Directorate
  - AFRL leadership has NMSU ties

- Educational Partnership agreement signed in 2012.
- Two physics undergrads flew on President Couture’s plane to attend the signing ceremony in ABQ.
- Space Physics MS concentration:
  Physics core, space weather courses, interdisciplinary electives, optional space physics thesis at AFRL.

- DOE EPSCoR partnership grants provide similar links to National DOE Laboratories (not funded since 2009).
Should students take courses in other fields?

- Engineering
- Computer science (C++, Java)
- Finance
- Management, HR policies
- Technical writing
- Foreign languages (especially Asian)
- Should the APS offer seminars for our members?

This question misses the point:
More courses won’t help, we need **activities**.
Companies measure results and behaviors

- **Results**
  - Describe the employee’s contributions to the goals of the organization.
  - Based on SMART goals
- **Behaviors** (also called competencies)
  - Describe HOW the results were obtained

*If I meet my goals, why does it matter if I’m in a good mood or not?*

Baldridge winner states: Our leaders are held accountable for both results and behaviors and we are driving this mental framework down through the rest of our population.
5 E’s of success (adopted from General Electric)

• **Envision:**
  Creates the future, imagines what’s next.
  Thinks in terms of the big picture and how the pieces fit together.
  Comes up with the **vision, strategies, and viable plans** that turn a dream into reality.
  Questions assumptions and challenges conventional thinking.
  Generates breakthrough ideas that improve the way the organization operates.

• **Energize:**
  Creates energy among employees to work on projects.
  **Excites coworkers** around activities, projects, and events.
  Creates an atmosphere where everyone has passion to excel and opportunity to contribute.
  Sustains a **positive attitude in the face of difficult** challenges or adversity.

• **Edge:**
  Makes **tough decisions** when needed to achieve goals. Takes responsibility for problems.
  Convinces people to **collaborate**. Challenges people to do their best.
  Holds people accountable, takes action when their performance does not meet expectations.

• **Execute:**
  Completes projects on time and on budget. Meets **commitments** and keeps promises.
  Follows tasks/projects through to successful **completion**. Communicates about projects to ensure completion. Has strong **problem-solving skills**.

• **Ethics:**
  Professional integrity while working on projects. Is honest at all times.
  Builds personal credibility. Treats all people with respect and dignity (diversity)

Source: Chris Galvin Interview, Business Week Online, 17 April 2000.
Implementation in a physics curriculum

• **Results**
  – Students are trained to achieve results
    – through formal physics courses (homework, exams, grades, etc)
    – and with their research (experiments, calculations, data analysis)

• **Behaviors** (also called competencies)
  – We also need to include activities in our physics curriculum, which teach desirable behaviors.

• **Results and behaviors must be balanced.**
Less is more (FIAP Newsletter summer 2012)

• Teaching behaviors means teaching less physics.
• “Information about industrial careers does not help students make progress with their research.”

• FIAP tutorial on industrial careers (not much interest).
• FIAP Lunch with the Experts (first to sell out, 30/4000).

• FIAP Newsletter: “The APS needs to raise … networking opportunities (at the March meeting).”
  “I barely remember talks and sessions”, but many networking events.
Extracurricular learning opportunities

- **Teaching assistants (2-3 years, lab TAs)**
  - Communication skills (oral and written)
  - Professionalism (fairness, dependability, on time, follow instructions)

- **Participate in student organizations (department & university-wide)**
  - Governance (many students from less democratic countries)
  - Planning and budgeting activities (open house)
  - Graduate student speaker series
  - Community service (science fair, outreach)
  - Applying for institutional travel funds

- **Advising undergraduate research**

- **Teaching an introductory course (rare: 1-2 students)**
  - Preparing students to be future faculty

- **Team-teaching:** exams, clicker quizzes, lecture demos

- **Professional societies:** APS unit ExComm may have student members
Performance = Results + Behaviors

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Behaviors for physics graduate students

- Behaviors are used to achieve goals.
- Define SMART goals!
  - Courses, exams, teaching, research
  - Hold students accountable for success or failure.
- Define behavioral standards! (4e+E will work)

**Assign tasks to train behaviors:**
- Teaching: Tardiness, recordkeeping, ethics, customer focus, communication, execution
- Team teaching, team research
- Interdisciplinary assignments

- Provide **feedback** on goals and behaviors!
Milestones in our NMSU Ph.D. Program

• English language skills (international students):
  – Written test (can student write a thesis?) or high TOEFL (>79)
  – Oral test (can student teach a lab/recitation section?)
• Core courses and electives (GPA>3.0)
• TA performance affects financial support (5-year limit).
• Qualifying and comprehensive exams (2 attempts)
• Find an advisor who support the student (w/ RA)
• Research, publications, conference presentations
• Thesis, defense

• Most milestones are outcomes-based.
  Behaviors don’t matter much!
Conclusions

• Only 20% physics Ph.D.s become physics faculty. (Half of these 20% will be at undergrad institutions.)
• Almost half of physics Ph.D.s work in the private sector.
• Inform students about industrial and government careers.
• Use activities to teach behaviors that ensure the success of your students in industry and government.

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