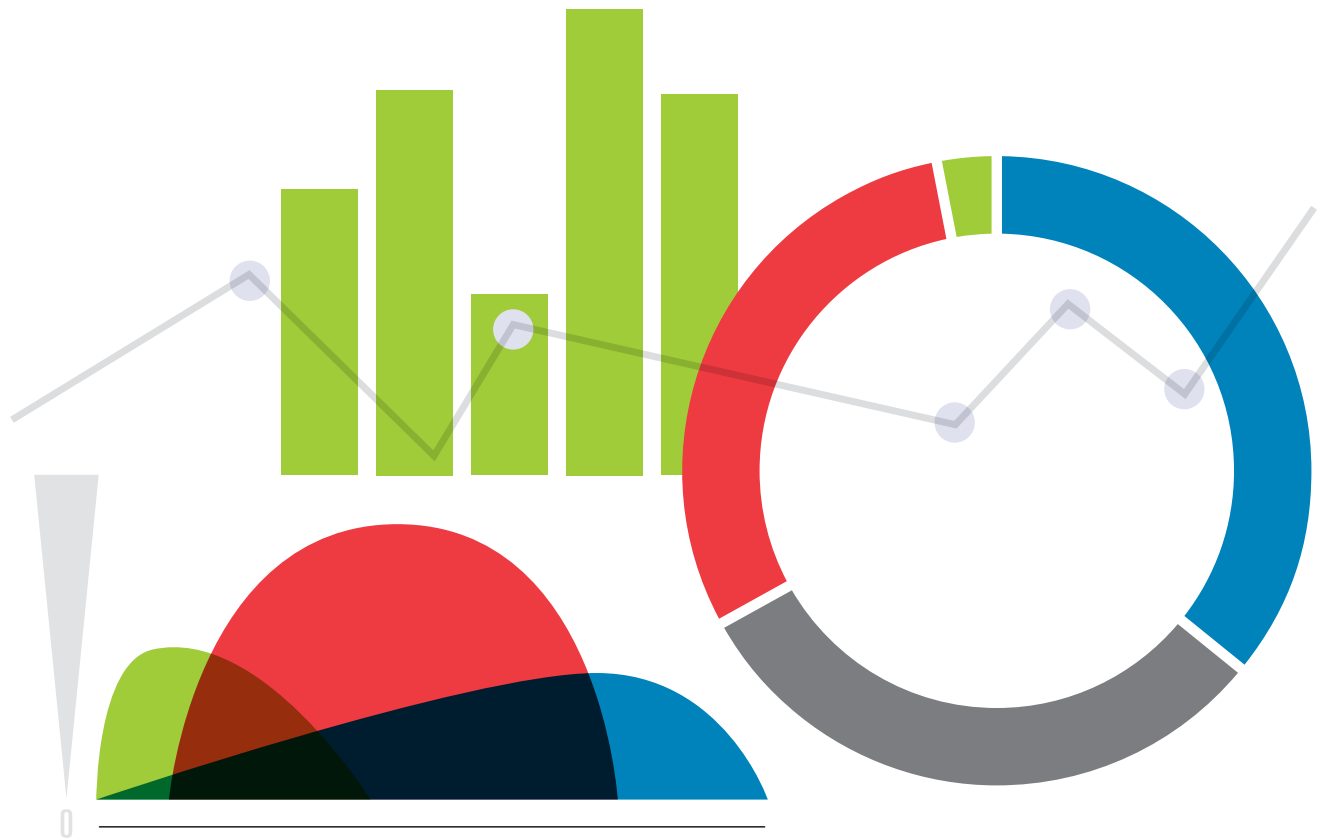


# Common Careers of Physicists in the Private Sector

PhDs educated in the U.S. 10-15 years earlier



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# Common Careers of Physicists in the Private Sector

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PhDs educated in the US 10-15 years earlier

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*June 2015*  
*Statistical Research Center*  
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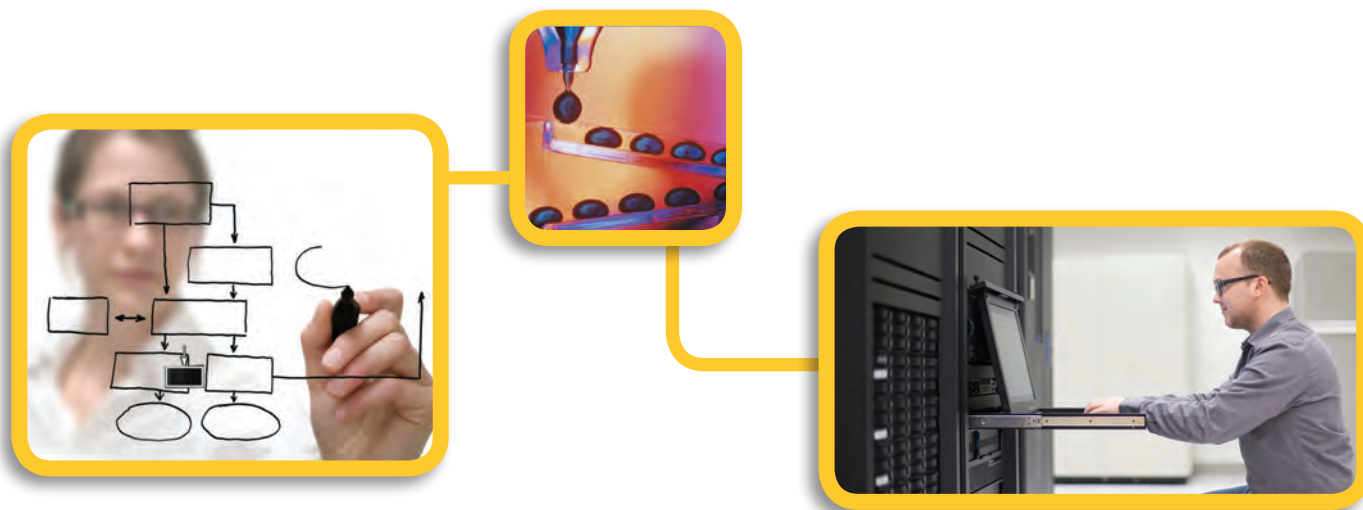
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## Highlights of Findings

This study is unique. It provides an unprecedented and detailed view of the work that mid-career physicists do in the US private sector.

This report is based on 503 physicists who responded to the PhD Plus 10 Study and who worked in the private sector 10 to 15 years after earning their PhDs. These mid-career physicists largely held professional level positions in eight types of careers.

This report is part of a three-report set about physicists in the private sector in the US. The other two reports are compilations of verbatim comments organized by the eight types of careers. One describes “job duties” and the other describes “most rewarding aspects of your job”.

- ✓ The vast majority of physicists employed in the private sector 10 to 15 years after earning their PhDs worked in a STEM field.
- ✓ The types of careers commonly pursued by physicists in the private sector involved solving complex problems, managing projects, and writing for a technical audience.
- ✓ As described in the career profiles in this report, most jobs held by physicists in the private sector required the frequent use of various scientific and technical knowledge.
- ✓ Mid-career physicists employed in the private sector work with people. Virtually all were members of teams with people from diverse professional backgrounds. Mentoring less experienced colleagues and working directly with customers or clients were often cited as common features of their jobs.
- ✓ Physicists who worked in the private sector were asked to identify the most rewarding aspects of their jobs. They wrote that they found their jobs intellectually stimulating and challenging, and that they enjoyed regularly working with smart and interesting people.
- ✓ More than three-quarters of the physicists who worked in the private sector in 2011 earned salaries in excess of \$100,000. Some of these mid-career physicists were awarded significant commissions and bonuses in addition to their salaries.

## Chapter 1 - Introduction

We estimate that as many PhD physicists work in the private sector in the US as work in academe and government combined. However, there is very little accurate, reliable or detailed data about the work that PhD physicists do in the private sector. This report is intended to fill a significant part of the gap in our knowledge, and the authors thank the American Institute of Physics (AIP) for making this study possible.

This report describes eight types of careers commonly pursued by physicists who earned their PhDs in the US 10 to 15 years earlier and who were working in the US private sector in 2011. This document is part of a set of reports about those mid-career physicists. These publications summarize findings from the PhD Plus 10 Study which focused on physicists who earned physics doctorates from US institutions in the classes of 1996, 1997, 2000, and 2001. The study was funded by the American Institute of Physics and conducted by the AIP Statistical Research Center.

The objective of the PhD Plus 10 Study was to examine the longer-term career outcomes of those with physics doctorates. While initial outcomes of physics PhDs are studied regularly including AIP's annual Initial Employment Survey, data about mid-career physicists remain scarce. This report marks the first data-driven profile of the various types of careers that mid-career physicists chose to pursue in the private sector. Forthcoming reports will describe mid-career physicists' careers in academe, government research labs, the medical and health fields, and not-for-profit research institutes.

### Common Types of Careers in the Private Sector

This report describes the work that mid-career physicists do in the private sector. It is intended to provide information that can be used by physics graduate students and their faculty members in considering and evaluating many of the different career options that are available to PhD physicists. Data collected through the PhD Plus 10 Study indicate that the types of careers commonly pursued by mid-career physicists in the private sector are far more varied than anticipated.

Of the mid-career physicists who responded to the PhD Plus 10 Study, 503 were employed in the US private sector. This report provides data rich profiles of the common types of careers pursued by these mid-career physicists. A second report lists the comments that mid-career physicists in the private sector wrote in response to the open-ended question, "What are the most rewarding aspects of your job?" A third report lists the comments that mid-career



physicists wrote in response to the question, “Briefly describe your duties and responsibilities in your current job.” The latter two compilations are available at: [www.aip.org/statistics](http://www.aip.org/statistics)

We are able to identify eight primary types of careers that mid-career physicists chose to pursue in the private sector:

- Physicists who are self-employed,
- Physicists who work in finance,
- Physicists who work for government contractors,
- Physicists in industry primarily engaged in engineering,
- Physicists in industry primarily engaged in computer science,
- Physicists in industry primarily engaged in physics,
- Physicists in industry primarily engaged in other STEM fields, and
- Physicists in industry who are not working in a STEM field.

It should be noted that these categories are neither monolithic nor mutually exclusive. Overlaps between categories do occur, and it is easy to imagine physicists whose employment could be classified into two of the above. However, we decided that each physicist should be classified into only one career type so we used a hierarchical strategy when categorizing individuals into types of careers.<sup>1</sup> The first three types of careers predominated over the next five. Thus, for example, mid-career physicists who indicated that they were self-employed were included in that category regardless of any other type of career that may have also applied.

There were a small but non-trivial number of respondents who worked for other types of private sector employers, i. e. for-profit health and medical organizations that were not included in this report. Their data will be presented in a subsequent report on mid-career physicists working in health and medical fields.

### Cautionary Comments

PhD physicists working in the US private sector were more difficult to locate and contact than those who worked in academe or government research facilities.<sup>2</sup> Despite extensive efforts to overcome this challenge, the private sector is underrepresented compared to academe or government in this study (see Appendix Table A3).

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<sup>1</sup> We assigned respondents to the eight types of careers based on their primary field of employment, employment sector, employer name, job title, and job description. Each respondent was assigned to the best fitting group.

<sup>2</sup> The challenge of locating PhD physicists in the private sector and our methodology are described in the Appendix.

Accordingly, we present data in a way that minimizes the effect of the potential bias in our ability to locate and contact people in the private sector; aggregate data will only be reported by major employment sectors (private sector, government labs, and academe) in lieu of an overall percentage. We caution readers to avoid comparing the number of respondents in one major sector with the number of respondents in another.

After meticulous analysis of the respondents, we found no evidence of bias within the different types of careers in the private sector. Thus, we are confident in the accuracy of the profiles of physicists and the detailed descriptions of the work they do in each of the types of careers described in this report.

### **Demographic Profile of Respondents**

Physicists who earned their doctorates 10 to 15 years earlier had time to progress in their careers. At the time of the survey, the median age of respondents was 43, with 80% of respondents between the ages of 39 and 49. Eighty-six percent of respondents were male and 14% were female, which is similar to the overall distribution of males and females in the four physics PhDs classes that were in the study.

Of all respondents who remained in the US, more than 95% were employed full-time and a little over 3% were working one or more part time jobs. Fewer than 2% were not working, either because they could not find a suitable position or because they opted out of the workforce. Of mid-career physicists working in the US, 86% were US citizens and 14% were non-US citizens with permanent residency at the time of the survey. This represents a change over time. When the physicists who responded to the PhD Plus 10 Study earned their PhDs, 73% were US citizens, 8% were permanent residents, and 19% were in the US on temporary visas.

## Chapter 2 - Comparisons of Types of Careers across the Private Sector

The profiles of the eight types of careers in the private sector represent the main focus of this report. Prior to delving into that level of detail, it is important to consider the big picture. Thus our analysis of mid-career physicists' careers in the private sector begins with several comparisons across the eight types of careers.

This chapter presents salaries, data on the likelihood of holding a postdoctoral appointment prior to working in the private sector and attitudes expressed by mid-career physicists about the level of professional challenge in their work. It also includes the mid-career physicists' opinions about the extent to which a physics PhD is an appropriate background for careers in the private sector. This chapter includes data on whether physicists report that their positions involve research as well as the extent to which these physicists set their own research agenda.

### Salaries

The knowledge acquired and skills developed while earning a physics PhD are applicable to a variety of types of careers. Salary data serve as one indicator of the strength of the demand for a physics PhD in the US workforce. The typical salaries earned by our respondents indicate that the knowledge and skills they possess are highly valued in the private sector (*Figure 2.1*).

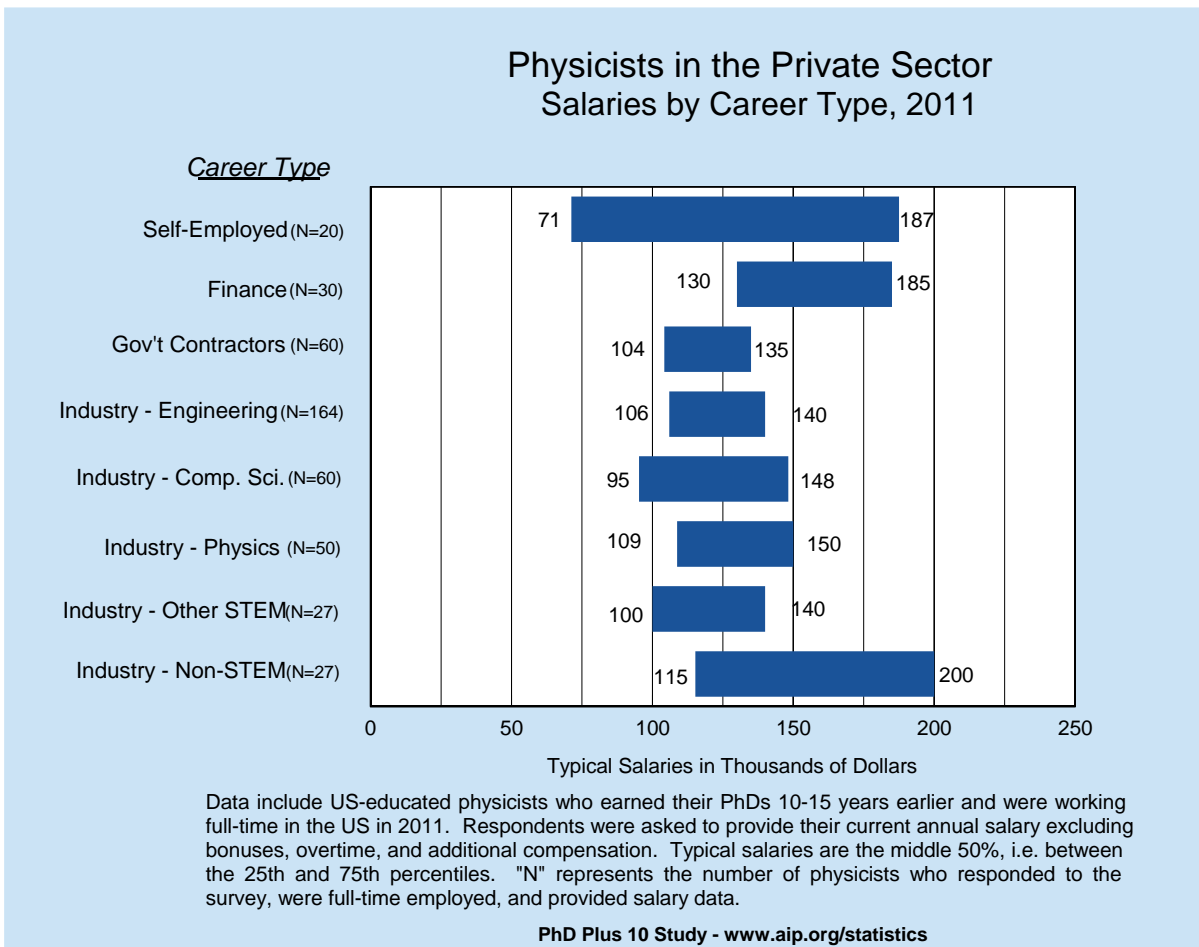
Mid-career physicists who were working full-time for a single employer in the US were asked to provide their annual base salary excluding bonuses, overtime, and any additional compensation. It should be noted that physicists working in some parts of the private sector have opportunities to earn substantial bonuses or commissions to supplement their salaries.

**Table 2.1**

Typical Salaries of Physicists 10-15 Years after PhD by Major Employment Sector, 2011		
Major Sector	Typical Salaries \$ (in thousands)	Respondents N
Private Sector	105 - 150	438
Government Labs	100 - 130	190
Universities, 4-yr colleges	62 - 85	533
Data include US-educated physicists who earned their PhDs 10-15 years earlier and were working full-time in the US in 2011. Respondents were asked to provide their current annual salary excluding bonuses, overtime, and additional compensation. Typical Salaries are the middle 50%, i.e. between the 25 <sup>th</sup> and 75 <sup>th</sup> percentiles. "N" represents the number of full-time employed physicists who provided salary data. Salaries for Universities and 4-Year Colleges include tenure, tenure track and temporary positions. The Government and academic salaries in this table will be published in more detail in future reports.		
PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a>		

Table 2.1 shows typical salary ranges for the three major employment sectors of physics PhDs. Impressively, three-quarters of mid-career physicists who were working in the private sector or for government labs were earning six-figure salaries 10 to 15 years into their careers. Physics PhDs who were working for universities and colleges earned, on average, considerably less than those in the private sector or at government labs. The salaries in Table 2.1 for universities and 4-year colleges include mid-career physicists in temporary positions, but do not include physicists in postdoctoral appointments.

**Figure 2.1**



A small but significant number of mid-career physicists found ways to convert their scientific expertise into profitable independent businesses 10 to 15 years after earning their PhDs. The median salary for these self-employed physicists was \$115,000 (Figure 2.1). Expecting that the success of entrepreneurs is highly variable, it is not surprising that these self-employed physicists had one of the widest salary ranges of all common types of careers in the private

sector. Differences in how the self-employed accounted for their salaries, such as the number of billable hours worked or how much of their gross income they invested back in their businesses, and whether they worked by themselves or started a company with employees, may also have contributed to the breadth of their salary range.

The median salary of mid-career physicists who were working in finance was \$150,000, but a few extremely high salaries exemplified the lucrative earning potential of PhD physicists working in finance. Also, a few respondents who were working in finance commented that significant portions of their total remuneration depended on bonuses or commissions.

Interestingly, physicists who were working for government contractors and industrially employed physicists who were working primarily in engineering, computer science, physics, and other STEM reported having nearly identical typical salaries, with a median close to \$125,000.

Finally, physics PhDs who were working in the private sector but not in a STEM field had a median salary of \$169,000 and a highly variable salary range. This wide salary range was expected given the diverse range of jobs and employers among physicists in this group. Many of these PhDs were in upper-level management and administrative positions of companies, some of whom sold products or services used in the STEM fields. A few earned law degrees and were practicing attorneys.

### Postdoctoral Experience

A majority of respondents took postdocs (see Appendix for a detailed discussion), but the likelihood of physics PhDs starting their careers with postdoctoral appointments was significantly lower among mid-career physicists who worked in the private sector than among those who worked for government labs or in academe – about 40% and 75% respectively (Table 2.2)<sup>3</sup>. On the whole, most mid-career physics PhDs who took postdocs responded in the affirmative to the question “If you could go back in time, would you still accept your postdoc?”

An analysis of verbatim comments to the question “In light of your career development, how did your postdoc affect your career?” revealed that many physics PhDs who eventually worked in the private sector considered their postdoc experience crucial to their career development. The obvious benefit of additional research experience, described by several PhDs as requiring teamwork and adhering to timelines to solve challenging problems, was frequently cited by

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<sup>3</sup> Physics PhDs who took postdocs are overrepresented among the respondents to the PhD Plus 10 Study. Thus, the percentages in Table 2.2 are probably inflated, but we included them to illustrate important differences across the three major employment sectors and eight types of careers in the private sector.

respondents as having a positive impact on their careers. For others, their postdoc positions helped broaden their professional networks, sometimes leading directly to permanent employment opportunities. Some looked back on their postdoc as necessary but not terribly influential, and used phrases like “resume-builder” and “a bridge between graduate school and employment” to characterize their experiences. Some physicists commented that their postdoc experience helped them decide that they were not interested in a career in academe and motivated their migration to the private sector.

Type of Career	Took a Postdoc %	Would Take their Postdocs Again %
Industry - Other STEM	56	73
Industry - Physics	49	85
Gov't Contractor	42	76
Finance	41	65
Industry -Engineering	39	72
Industry - Comp. Sci.	37	57
Industry - Non-STEM	26	75
Self-employed	24	83
<b>Private Sector</b>	<b>39</b>	<b>72</b>
<b>Gov't Lab</b>	<b>73</b>	<b>88</b>
<b>Academe</b>	<b>75</b>	<b>91</b>
Data represent those who took a postdoc and answered “yes” to “If you could go back in time, would you still accept your postdoc?” Data include US-educated physicists who earned their PhDs 10-15 years earlier and were working in the US in 2011.		
PhD Plus 10 Study – <a href="http://www.aip.org/statistics">www.aip.org/statistics</a>		

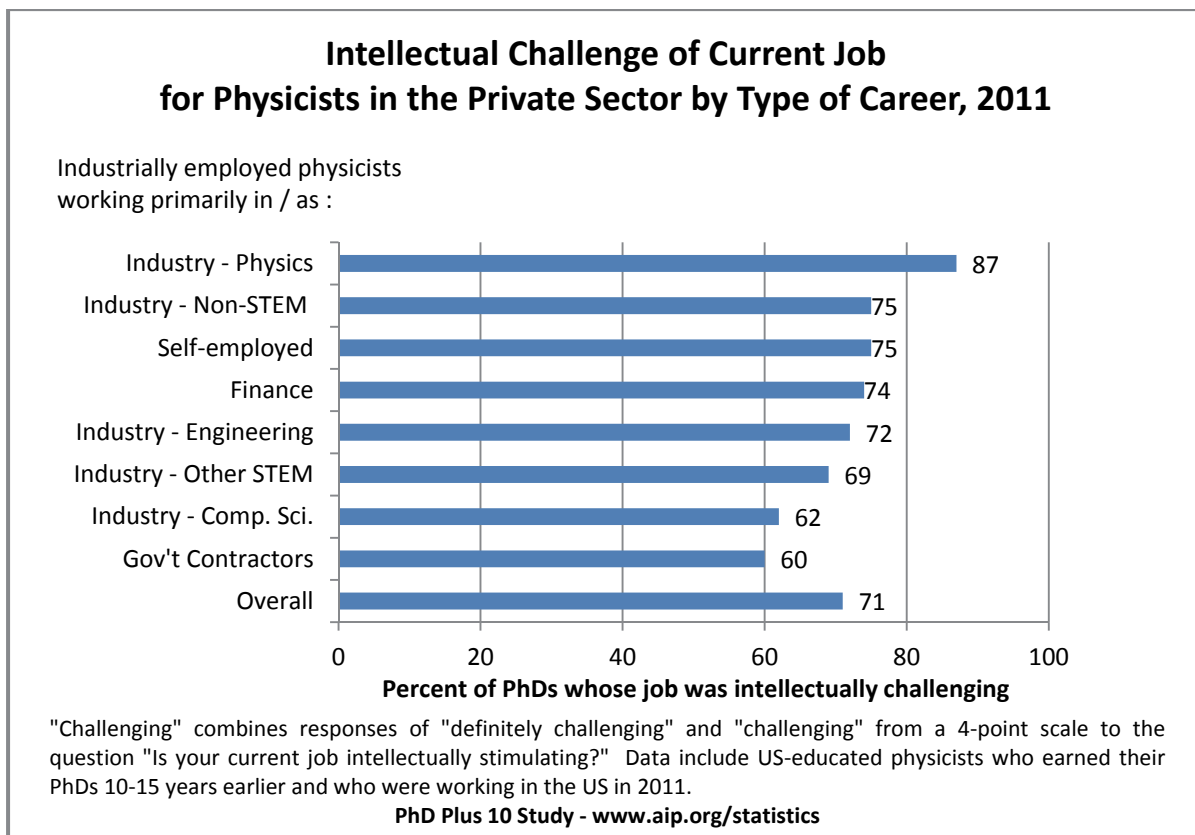
The likelihood of taking a postdoc appointment differed by type of career within the private sector (Table 2.2). Mid-career physicists who were working in the private sector and were primarily engaged in physics were among those most likely to have taken a postdoc after earning their PhDs. Those who were not in STEM careers and the self-employed were among the least likely to have taken a postdoc.

## Qualitative Measures

We analyzed the responses to three opinion questions as part of our assessment of career outcomes for physics PhDs. We asked mid-career physicists to rate the extent to which their jobs were intellectually challenging and the extent to which they believed that their jobs were appropriate for someone with a doctorate in physics. We also asked those physicists who did research how involved they were in setting their own research agenda. These qualitative measures can be viewed as indicators of broad concepts like underemployment or job satisfaction.

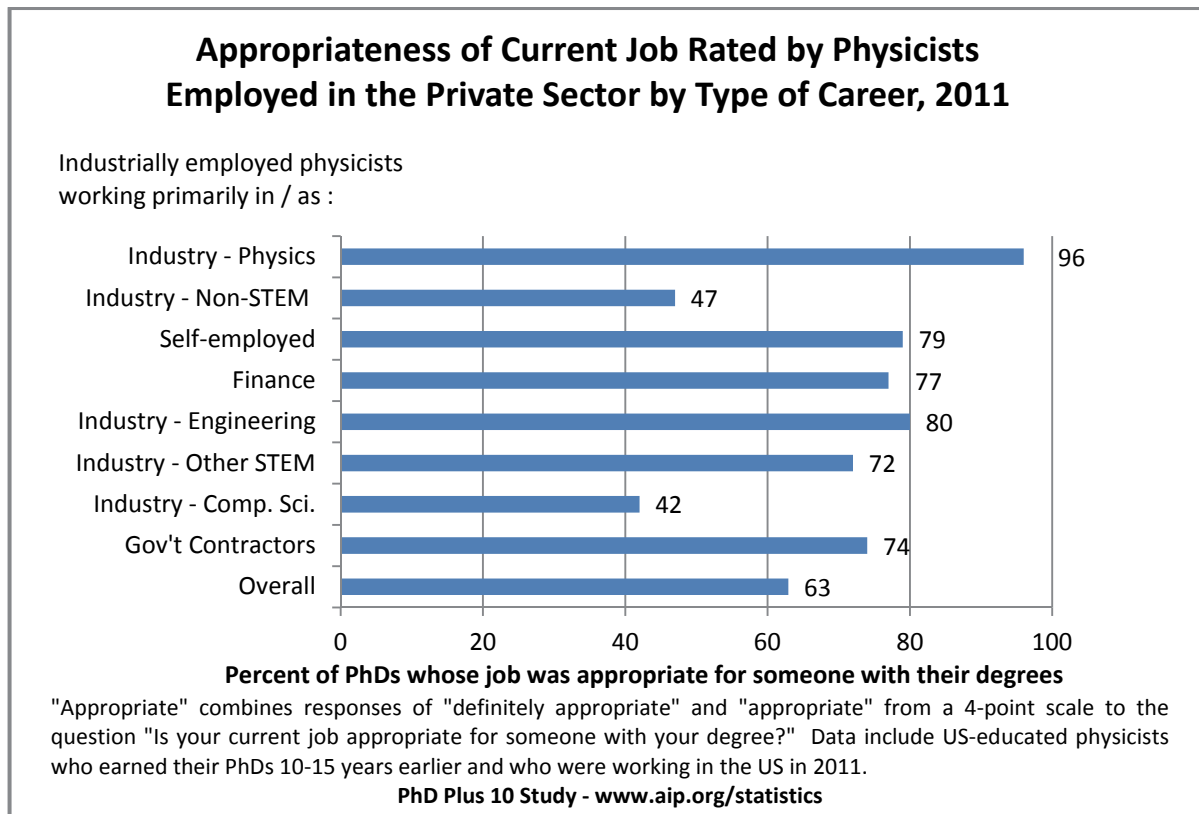
Solving complex problems was cited frequently by mid-career physicists who were working in the private sector as one of the most rewarding aspects of their work. Extensive training in physics equipped these PhDs with a breadth and depth of knowledge they could apply to a variety of challenging problems. In verbatim comments, many physicists valued being on the “cutting edge” of their fields or industries, and reported that they enjoyed their jobs because they were “intellectually stimulating”. Chapters 4 through 11 are profiles of each type of career commonly pursued by physicists in the private sector. These profiles include a summary of the aspects of their careers that physicists found most rewarding.

**Figure 2.2**



For most of the types of careers in the private sector, about 70 to 75 percent of mid-career physicists described their jobs as extremely challenging or challenging (Figure 2.2). Physicists employed in industry and who were primarily engaged in physics were the most likely to consider their jobs intellectually challenging. Mid-career physics PhDs who were employed in industry primarily doing work in computer science or who were working for government contractors 10 to 15 years after earning their degrees were the least likely to find their jobs challenging. But even in these two types of careers, 60% or more of the physicists found their jobs intellectually challenging.

**Figure 2.3**



PhD physicists' responses to the question "Is your current job appropriate for someone with your degree?" varied significantly across types of careers within the private sector (Figure 2.3). Not surprisingly, the proportion answering in the affirmative was by far the highest among those mid-career physicists who were working in industry and primarily in the field of physics. It is evident and reasonable that a strong majority of those who were working in engineering, another STEM field, or as government contractors considered their jobs to be appropriate for physics PhDs.



It may be surprising, however, that such high proportion of mid-career physicists who were working in finance (nearly 80%) considered their physics PhDs as appropriate background for their jobs. However, analysis of respondents' descriptions of their jobs revealed physicists who were working in finance described applying high-level mathematics, modeling, and developing algorithms - concepts learned and practiced in their physics training - to meet the goals of their employers. In fact, a surprising proportion indicated that they regularly collaborate with other physicists.

Physicists who were working in computer science were the least likely to consider their jobs appropriate for someone with a physics doctorate. This is a curious finding especially in light of the fact that physicists possess sophisticated levels of knowledge in computer science and that there has been a strong demand for that knowledge in the workplace over the last 15 years.

Table 2.3: Research Agenda Autonomy Rated by Physicists Employed in the Private Sector 10-15 Years after PhD by Type of Career, 2011		
Type of Career	Performs Research %	Has at least Equal Say in Research Agenda %
Industry - Physics	98	47
Gov't Contractors	90	29
Self-Employed	86	54
Industry - Other STEM	83	52
Finance	80	69
Industry - Engineering	79	30
Industry – Comp. Sci.	71	35
Industry - Non-STEM	35	55
<b>Private Sector</b>	<b>80</b>	<b>40</b>
<i>Gov't Lab</i>	90	68
<i>Academe</i>	90	93
<p>Respondents were asked "Is your research agenda dictated by your own expertise and intellectual curiosity or the needs of others (e.g., your clients, company, institution)?" Data represent the responses "Exclusively my own expertise and curiosity" to "Equally both my own expertise and curiosity and the needs of others" from a 5-point scale. Data include US-educated physicists who earned their PhDs 10-15 years earlier and were working in the US in 2011.</p>		
<p><b>PhD Plus 10 Study – <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b></p>		

The extent to which physics PhDs prefer to determine their research agenda undoubtedly varies depending on their individual curiosities, ambitions, and talents. One can imagine that many PhD physicists are passionate about following their own curiosities to advance scientific knowledge, while others are fulfilled by conducting research to serve the needs of their external clients or clients within the corporation. Jobs in a particular type of career may be more or less desirable to physics PhDs depending, in part, on how important research autonomy is to them.

Among mid-career physicists, there were marked differences in the extent to which they are engaged in research and the extent to which they direct their own research agenda (Table 2.3). These differences are marked across the three major employment sectors and across the eight types of careers in the private sector.

Interestingly, a very large percent of mid-career physicists employed in the private sector report that they are engaged in research. Not surprisingly, the research agenda of these physicists is driven largely by the needs of their companies and clients. Virtually all mid-career physicists who were working in industry primarily engaged in physics conducted research in their jobs, but fewer than half had at least an equal say (compared to the needs of others) in determining their research agenda.

Physics PhDs who were employed by government contractors and those working in industry and were engaged primarily in engineering were the least likely to have an equal say in their research agendas.

## Chapter 3 - A Guide to the Profiles of Each Type of Career

The following chapters profile each of the eight types of careers commonly pursued by mid-career physicists in the private sector. For the profile of each type of career, we summarized typical employers and common job titles held by the physicists based on write-in answers from respondents. Descriptions of the type of work done by mid-career physicists in each type of career were synthesized from physicists' verbatim comments describing their job duties. We noted that occasionally job titles were out of alignment with job descriptions. We concluded that, in the private sector, duties change more quickly than job titles. A separate report has been published listing the verbatim comments written by physicists working in the private sector in response to the open-ended question, "Please describe your duties and responsibilities in your current job." The comments are organized by the eight types of career.

For each type of career, a set of bar graphs depicts the extent to which these mid-career physicists utilized specific knowledge and skills in their jobs. Respondents were asked about twenty-four items which we collapsed into five groups: cognitive skills, interpersonal skills, scientific and technical knowledge, managerial skills, and communication skills. Physicists were asked "How often do you use or do the following in your current job?" with response choices of daily, weekly, monthly, less than monthly, and rarely or never. From this 5-point scale, responses of monthly, weekly, or daily are combined into frequently. To facilitate comparisons, the organization of these figures is repeated in the same order across the eight types of careers.

Concluding each profile are highlights from physicists' verbatim responses to the question "What are the most rewarding aspects of your current job?" A careful reading of the responses revealed several recurring themes: intellectual freedom, good working conditions, working with smart people, having a real-world impact, work that is intellectually stimulating, remuneration or compensation, the application of physics, contributing to the success of a company, recognition, and responsibility or leadership. We tallied up the number of statements that matched each of these ten themes to determine which were most often cited in each type of career.

A separate report has been published listing the verbatim comments written by physicists working in the private sector in response to the open-ended question, "What are the most rewarding aspects of your job?" The comments are organized by type of career. Both reports listing verbatim comments can be found at: [www.aip.org/statistics](http://www.aip.org/statistics)

The Appendix follows the profiles of the types of careers and it provides a detailed description of how the study was conducted.

## Chapter 4 – Physicists who were Self-Employed

This profile is based on the responses from 29 mid-career physicists who reported that they were self-employed at the time of the PhD Plus 10 Study. Many of these physicists worked by themselves, often as consultants. However, many founded or co-founded small companies and supervised or collaborated with other employees. A small number of entrepreneurs who founded businesses that grew quite large did not classify themselves as self-employed and were not included in this chapter.

### Job titles

Table 4.1 lists common job titles of mid-career physicists who referred to themselves as self-employed 10 to 15 years after earning their physics PhDs.

<b>Table 4.1: Common Job Titles of Physicists in the Private Sector as Self-Employed, 2011</b>
Consultant
Chief Executive Officer
President
Manager
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

### Job duties

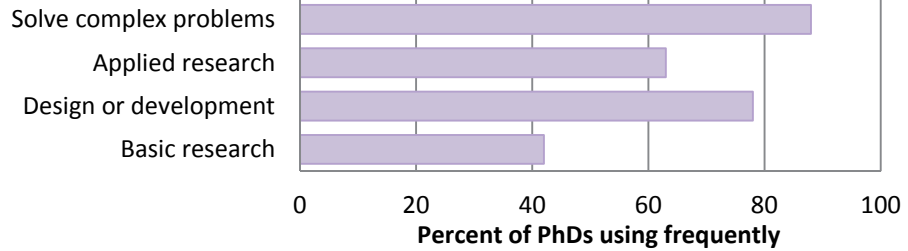
Many of the self-employed were responsible for most or all of the administrative needs of their businesses. The products and services offered by the self-employed were closely linked to their scientific expertise and served specific niches within the STEM enterprise, with a few exceptions.<sup>4</sup> Of several consulting companies founded by physicists, specializations included developing computing software for neutrino astrophysics, designing life science instrumentation, and improving inhalation exposure equipment for those working with infectious diseases. Some mid-career physicists who were self-employed were contracted to provide research & development, as well as analysis in various subfields.

Other self-employed physics PhDs founded their own small firms specializing in product design and in a few cases manufactured their own products. One new company founded by a self-employed physicist advocated for and advised scientists through major career steps like getting published and submitting proposals for funding. Physics PhDs also went into business for themselves as software engineers.

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<sup>4</sup> A custom furniture maker, a photographer, and one who carried on the family business.

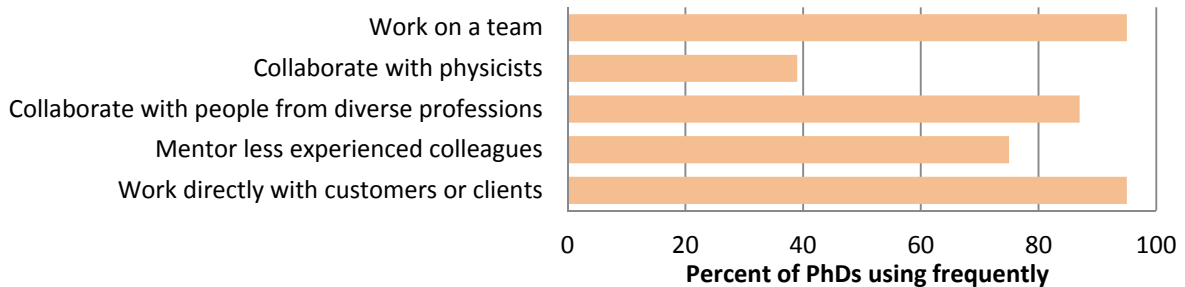
**Figure 4.1: Cognitive Skills Used Frequently by Physicists Working as Self-Employed**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and who were self-employed.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

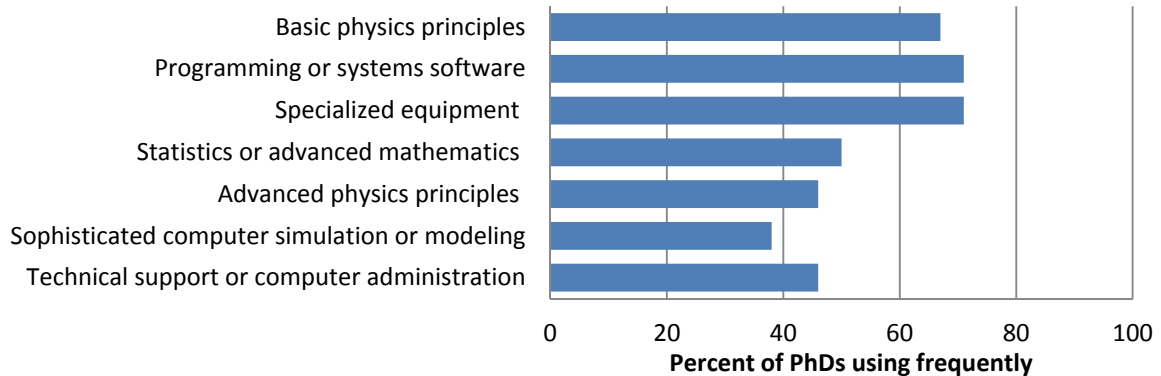
**Figure 4.2: Interpersonal Skills Used Frequently by Physicists Working as Self-Employed**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and who were self-employed.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

**Figure 4.3: Scientific and Technical Knowledge Used Frequently by Physicists Working as Self-Employed**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and who were self-employed.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

**Knowledge and skills used on the job**

PhDs who worked *for* themselves did not work *by* themselves. Nearly all of the self-employed PhDs were working on a team and working directly with clients or customers (Figure 4.2). Nearly 90% reported that they frequently collaborated with people from diverse professions, and quite a few reported that they regularly mentored less experienced colleagues. A significant percent reported that they frequently solved complex problems or engaged in design and development (Figure 4.1).

Mid-career physicists who were self-employed relied on knowledge from a variety of scientific and technical fields (Figure 4.3). Many reported frequently using knowledge of programming or systems software, and they frequently used specialized equipment. More than two-thirds frequently used their knowledge of basic physics.

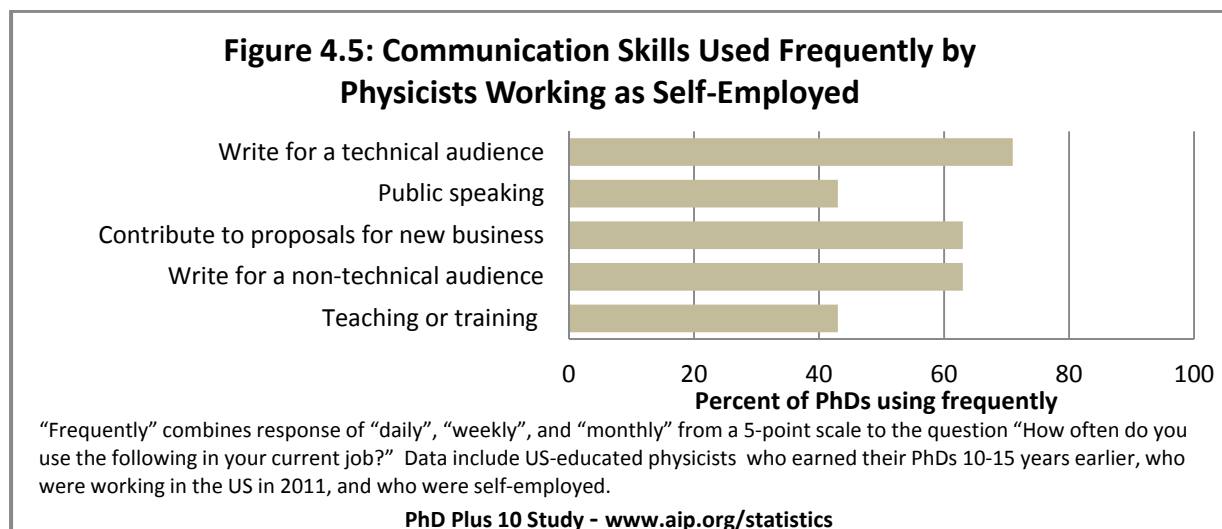
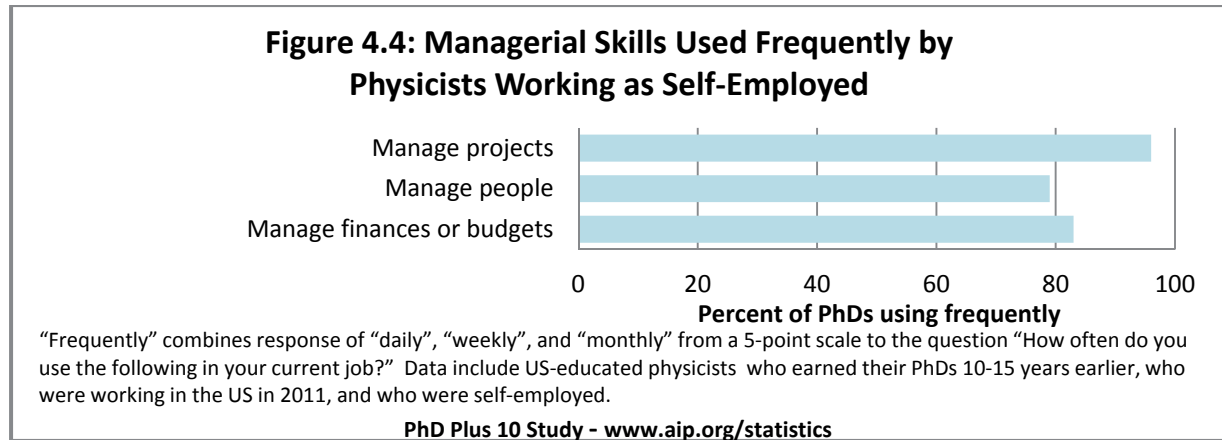
The administrative and managerial demands on self-employed physicists are quantified in Figure 4.4. Nearly all reported that they frequently managed projects and over 80% managed budgets and finances, and nearly as many reported that they regularly managed people.

Communication skills are very important for self-employed physicists (Figure 4.5). Mid-career physicists especially needed to be able to write well for technical audiences. They also regularly contributed toward proposals intended to acquire new business as well as write for non-technical audiences.

**Most rewarding aspects of their jobs**

Self-employed physicists wrote about the aspects of their work that they found to be most rewarding. The following were the most commonly cited themes in the verbatim comments that self-employed physicists shared with us:

- They thrived on the fact that their efforts directly impacted the success of their businesses.
- They delighted in the intellectual challenge of solving a variety of problems, often in collaborative teams comprised of talented individuals.
- They enjoyed the freedom and autonomy of being self-employed. They enjoyed having authority over which projects to pursue and how to invest their efforts. While work could be time-intensive, many of the self-employed had flexibility over their schedules to balance work with their personal or family lives.
- A few self-employed physicists took great pride in the real-world impact their work had for their clients or the larger community.



<b>Table 4.2: What Are the Most Rewarding Aspects of Your Job?</b>
Selected verbatim comments from PhD physicists working as self-employed, 2011
<i>[The] satisfaction of creating a viable, sustainable company that can provide a real service to the scientific and engineering community, helping customers... having a work life that supports a balanced personal life... working with optics.</i>
<i>The fact that all my endeavors, whether they are glorious and challenging (solving basic research problems) or small and annoying (paying the phone bill) advance my own cause...</i>
<i>Flexibility to manage my own research interests and my own schedule with young children at home.</i>
<b>PHD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

## Chapter 5 - Physicists in the Private Sector: Finance

### Employers

This chapter is based on the responses from 46 mid-career physicists who reported that they worked in the world of finance at the time of the survey. A large number of these physicists worked for trading companies, investment groups and firms that managed investment funds. The second largest group of them worked for large national and international banks. Some physicists worked for companies that produced and sold financial information, business news, and investment advice. Some worked for companies that provided portfolio management analytics, that is, they provided quantitative tools, numerical models, and investment research. Finally, some mid-career physicists worked for companies that provided software designed to optimize financial decisions in real time.

### Job titles

Table 5.1 lists common job titles of mid-career physicists who were working for financial institutions 10 to 15 years after earning their PhDs. Job titles were often preceded by words like “senior” to indicate levels of experience and responsibility.

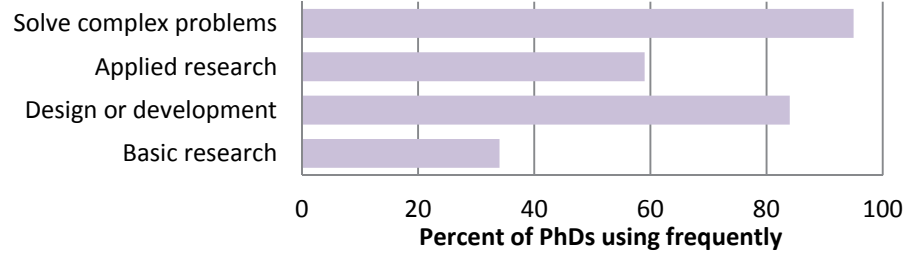
<b>Table 5.1: Common Job Titles of Physicists Working in the Private Sector in Finance, 2011</b>
Portfolio Manager
Partner
Director of Research
Quantitative Analyst
Financial Analyst
Software Engineer
Financial Software Developer
Vice President
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

### Job duties

A small but notable number of physicists applied their knowledge of high-level mathematics, software, and modeling to the field of finance. Some physicists were employed as investment managers and market risk managers; some worked on teams or led teams that built financial risk models or developed financial modeling software. These models and algorithms are often used for the buying and selling of financial instruments and predicting movement in prices in a broad set of arenas including: futures and equity markets, bonds, currency markets, bank commodity trading, hedge fund strategies, and mortgage refinancing rates.



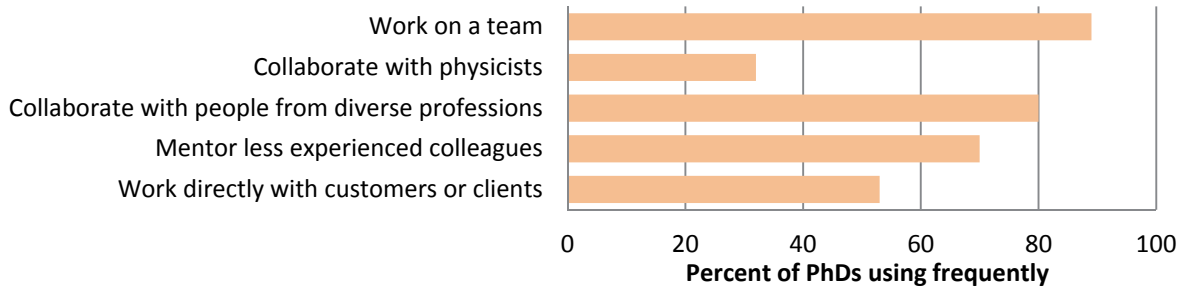
**Figure 5.1: Cognitive Skills Used Frequently by Physicists Working in Finance**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was finance.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

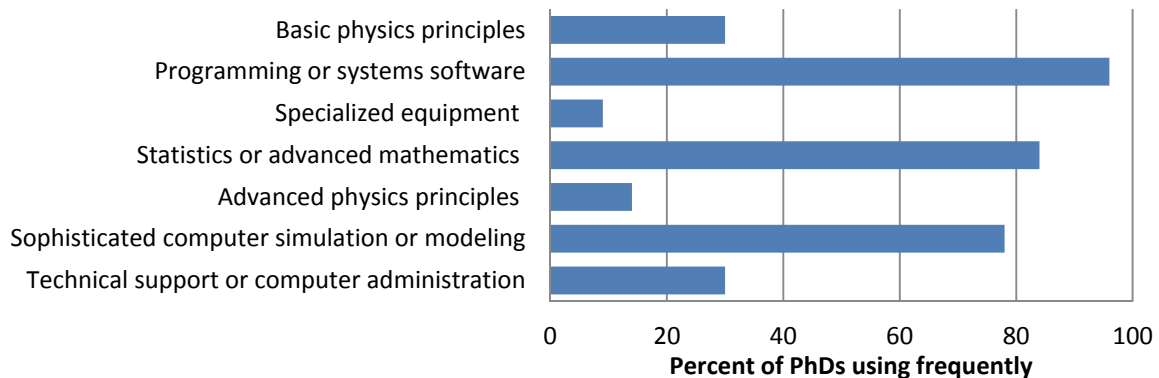
**Figure 5.2: Interpersonal Skills Used Frequently by Physicists Working in Finance**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was finance.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

**Figure 5.3: Scientific and Technical Knowledge Used Frequently by Physicists Working in Finance**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was finance.

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**Knowledge and skills used on the job**

Programming and software development was an integral part of the knowledge that virtually all of the physicists in finance used regularly (Figure 5.3). A significant percent of these mid-career physicists noted that they frequently used advance mathematics and computer simulations and modeling. Despite the scientific and technical knowledge they used on the job, the vast majority categorized their work as not in STEM.

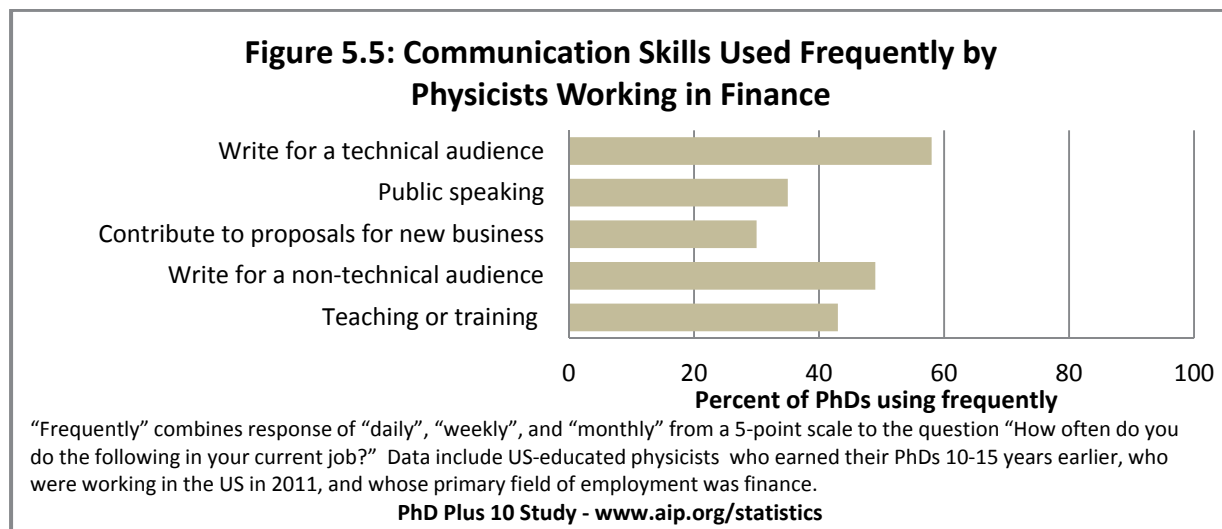
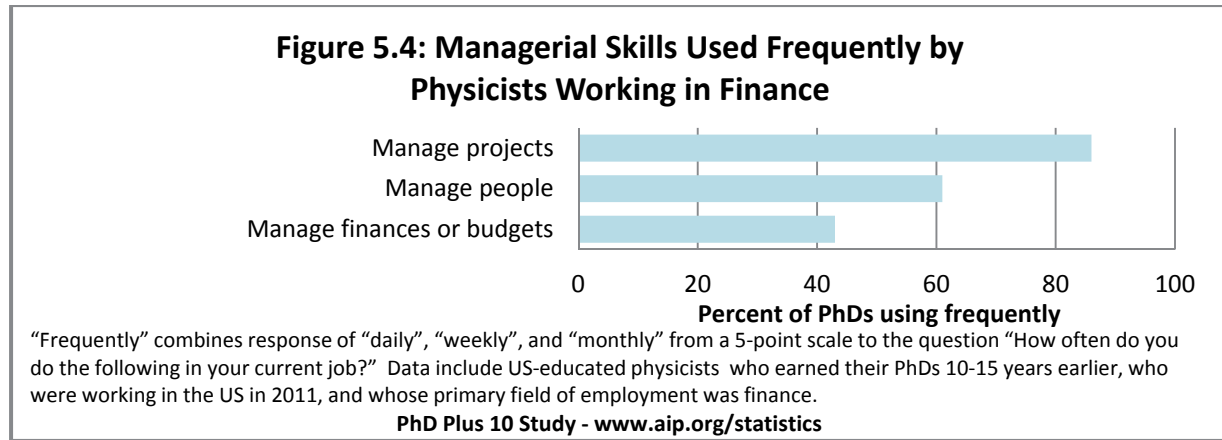
About 90% reported that they worked on a team and nearly as many worked with professionals from diverse backgrounds (Figure 5.2). A significant percent reported that they regularly mentored less experienced colleagues. Managing projects (Figure 5.4), design and development, and solving complex problems (Figure 5.1) were often cited as important aspects of this type of career.

Communication skills are important in the world of finance. The mid-career physicists in this study often had to write for technical as well as non-technical audiences (Figure 5.5).

**Most rewarding aspects of their jobs**

Mid-career physicists in finance were asked to describe the aspects of their work that were the most rewarding. The verbatim comments written by these physicists were consistent with the knowledge and skills data in Figures 5.1 through 5.5. The following were the most common stated themes:

- Solving complex problems was identified by most physicists in finance. They wrote phrases like “working at the cutting edge”, “intellectually stimulating projects”, and “interesting challenges.”
- Money and high remuneration were the next most commonly cited rewards of this work.
- Working with smart people was a very common theme. These physicists also wrote phrases like “working with great people”, “capable people”, and “researchers from different backgrounds.”
- The working environment was mentioned often with comments like a very flexible environment, freedom to innovate, and a great environment.



<b>Table 5.2: What Are the Most Rewarding Aspects of Your Job?</b>
Selected verbatim comments from PhD physicists working in finance, 2011
<i>Successful problem-solving against a backdrop of highly-variable conditions. Explaining complex goals and ideas in clear terms that can allow hundreds of people to collaborate effectively.</i>
<i>Since I work to support a global trading organization, the environment is very dynamic. The traders are always looking to trade new commodities / contracts that keep us quite challenged to make sure that those contracts are modeled properly in our systems.</i>
<i>Interesting and challenging work, good balance of math and computational work, exciting work environment, financially rewarding.</i>
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

## Chapter 6 - Physicists in the Private Sector: Government Contractors

### Employers

This profile is based on the responses of 68 mid-career physicists who were employed by companies that provided products and services to the US government. The Department of Defense and the Department of Energy are large federal agencies that employ contractors to build specialized equipment, to develop technologies used in STEM research and provide expertise and support in achieving policy objectives. Among the employers of these physicists were several of the best known government contractors including Raytheon, Northrop Grumman, SAIC, and Lockheed Martin.

### Job titles

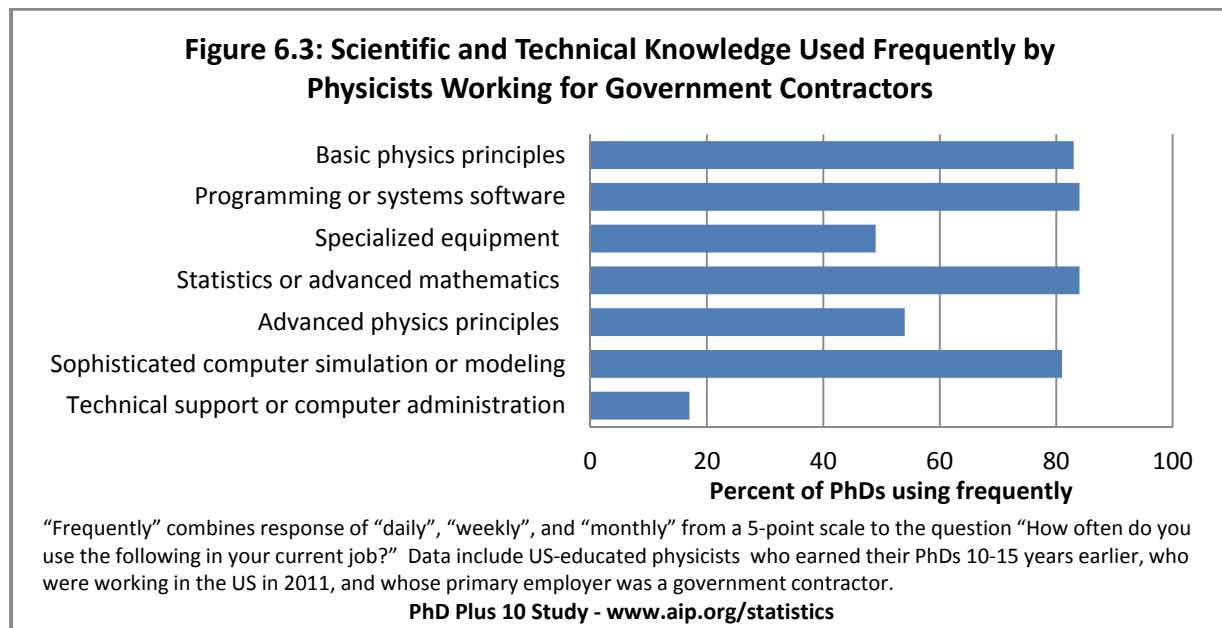
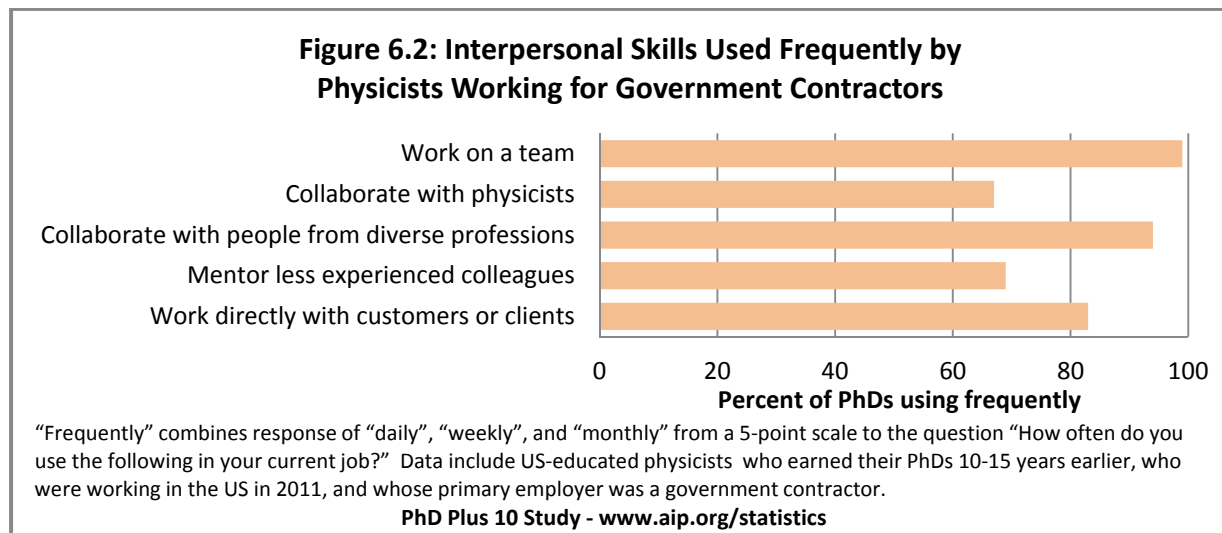
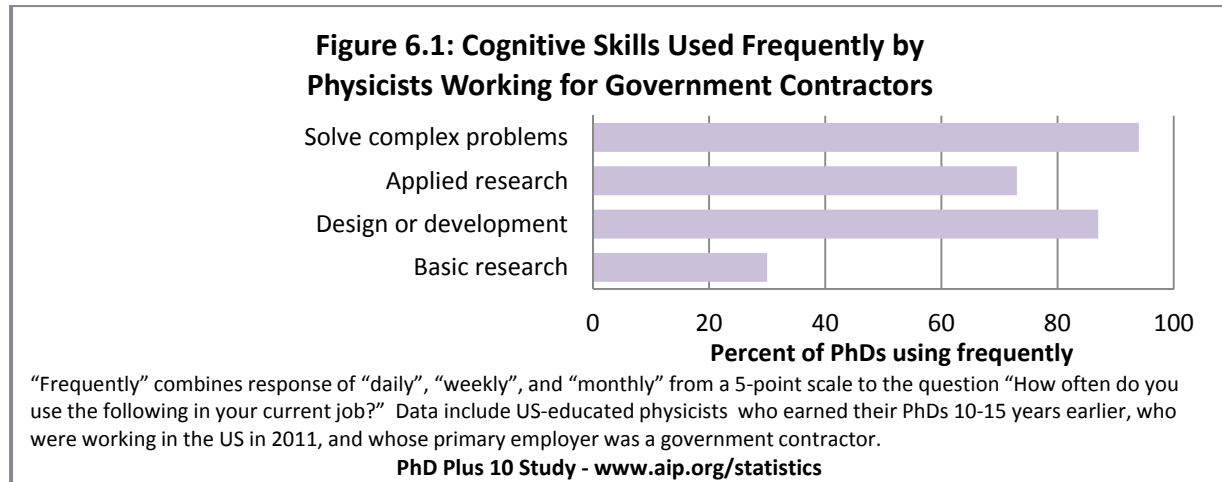
Table 6.1 lists common job titles of mid-career physicists who were working for government contractors 10 to 15 years after earning their PhDs. Job titles were often preceded by words like “senior”, “principal” and “staff” to indicate levels of experience and responsibility.

<b>Table 6.1: Common Job Titles of Physicists in the Private Sector for Gov’t Contractors, 2011</b>
Engineer
Scientist
Systems Engineer
Physicist
Director
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

### Job duties

Mid-career physicists described a variety of job duties. Some mid-career physicists were in engineering roles for government contractors developing radar and radio frequency sensors, semiconductors, and lasers. Many helped develop software to enhance the functionality of high-tech equipment, like electronics in military vehicles or satellites. Some were researching environmental factors that would affect the utility of existing equipment like, for instance, the effect of atmosphere on radar detection. These physicists were also responsible for helping to develop models to account for those factors and were attempting to mitigate their effects.

Most of the mid-career physicists working for government contractors were involved in research and development, but a few were primarily responsible for personnel management and business operations.



**Knowledge and skills used on the job**

The knowledge and skills frequently used by mid-career physicists who worked for government contractors were consistent with their job descriptions. Interpersonal skills are used frequently by physicists who work for government contractors (Figure 6.2). Nearly all of these physics PhDs reported working on teams. Over 90% reported that they frequently collaborated with people from various professions rather than with other physicists. More than 80% worked directly with customers or clients. Quite a few regularly mentored less experienced colleagues and collaborated with other physicists.

Physicists who were working for government contractors frequently solved complex problems and were engaged in design and development (Figure 6.1). Mid-career physicists who pursued this type of career regularly used a variety of scientific and technical knowledge, especially statistics or advanced mathematics, programming or systems software, basic physics principles, and sophisticated computer simulations or modelling (Figure 6.3).

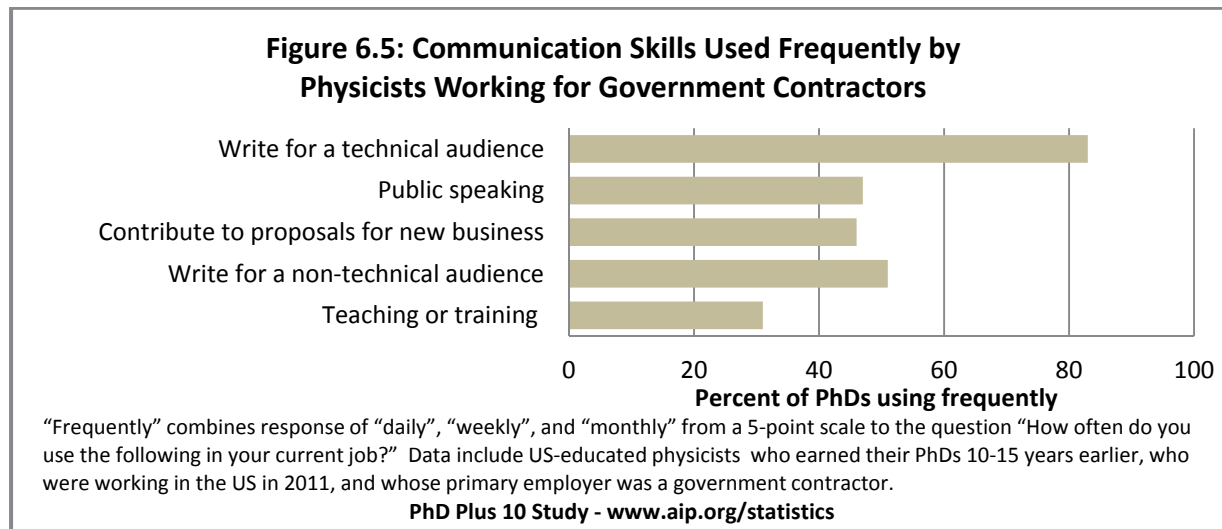
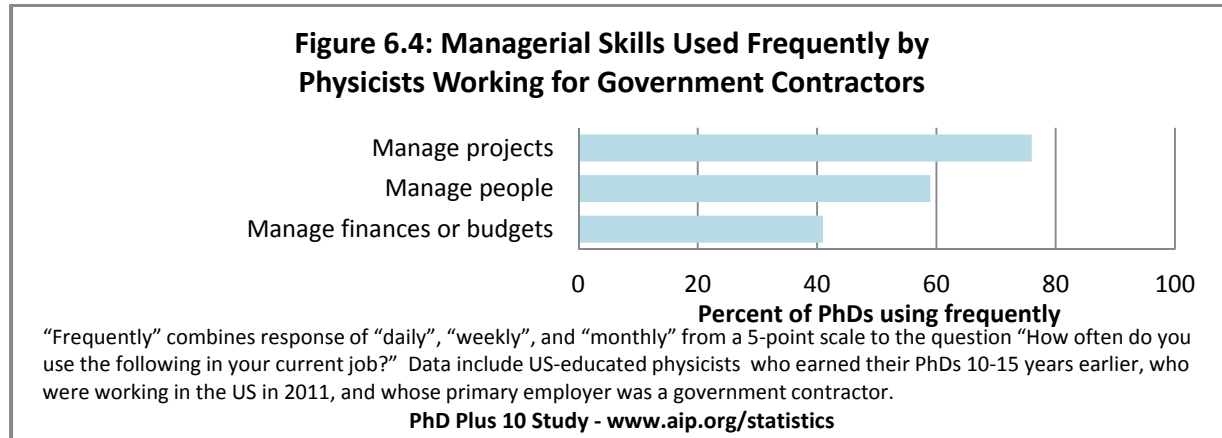
Over 80% of these physicists reported that they frequently wrote for a technical audience (Figure 6.5). Technical writing was a critical skill for many physicists working for government contractors in order to communicate effectively with government liaisons and project officers.

The ability to manage projects was very important for physicists who worked for government contractors (Figure 6.4)

**Most rewarding aspects of their jobs**

Mid-career physicists who were working for government contractors described the most rewarding aspects of their jobs. Several common themes emerged and are summarized below:

- Physicists thrived on the intellectual challenge of their work. Based on their comments, many PhDs working for government contractors found their work to be interesting, challenging, and relevant to real-world problems.
- Many wrote about their appreciation for the variety of projects they encountered. A few noted the privilege of working on projects that were sensitive or classified.
- It was important to many physics PhDs who worked for government contractors that their work served a larger goal and would have a real-world impact, in some instances directly supporting national security.
- Physicists wrote that they enjoyed working with smart colleagues and working on teams was also often cited as a rewarding aspect of their work as government contractors.



<b>Table 6.2: What Are the Most Rewarding Aspects of Your Job?</b>
Selected verbatim comments from PhD physicists working for government contractors, 2011
<i>I love my job because I get to learn about new technologies all the time, talk to people from all backgrounds and diverse work experiences both within and outside my company. I also work with an amazingly smart, dedicated and fun group of people.</i>
<i>I support diverse research projects and carry them from proof of concept to testable prototype detectors. Seeing the results of long labor to bring increased detection capability is very satisfying.</i>
<i>Seeing our design and development efforts lead to a working system. Working in the cutting edge of our field. Mentoring younger colleagues.</i>
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

## Chapter 7 - Industrially Employed Physicists: Primarily in Engineering

### Employers

This chapter is based on the responses of 179 mid-career physicists who were employed in industry and were working primarily in engineering. Many were employed by companies making sophisticated technological products with a wide range of industrial or consumer applications, enhancements for existing technologies, or novel solutions to problems. Some companies that employed PhD physicists specialized in computing technology like the manufacturing of semiconductor devices, computer hardware, or hard drives. Other companies developed software to harness computing power for specific purposes, commonly for internet applications but also to make use of real-time information to enhance the functionality of a product. Other companies specialized in measurement instrumentation utilizing a variety of technologies including optics, radio frequency, electromagnetism and biosensors. Mid-career physicists working primarily in engineering were employed by many well-known corporations including Intel, IBM, General Electric, Seagate Technology, Agilent Technologies, and Boeing.

### Job titles

Technical job titles were often preceded by words like “senior”, “principal” and “chief” to indicate levels of experience and responsibility.

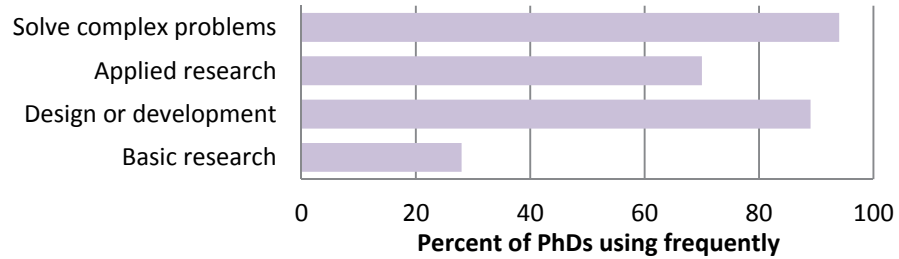
<b>Table 7.1: Common Job Titles of Industrially Employed Physicists in Engineering, 2011</b>	
<i>Technical Titles</i>	<i>Management Titles</i>
Engineer Design Engineer Scientist; Physicist R&D Engineer; Systems Engineer	Manager; Engineering Manager Director President; Vice President Chief Technology Officer
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>	

### Job duties

The field of engineering attracted the largest group of industrially employed physicists who utilized their background of basic physics principles and a range of other skills to solve complex problems in various subfields of engineering. For instance, physicists described working on processes to develop new and improved materials, often related to growing, doping, and etching silicon crystals used in electronics; developing computer chips and accompanying software; enhancing magnetic recording devices; utilizing radio frequency, wireless technology, and optics in communication systems; and devising algorithms for measurement devices. Some PhDs were responsible for optimizing the process from design through production, testing the quality of final products, and sometimes training the end-user. Others directed their companies' intellectual property initiatives and managed patent portfolios.



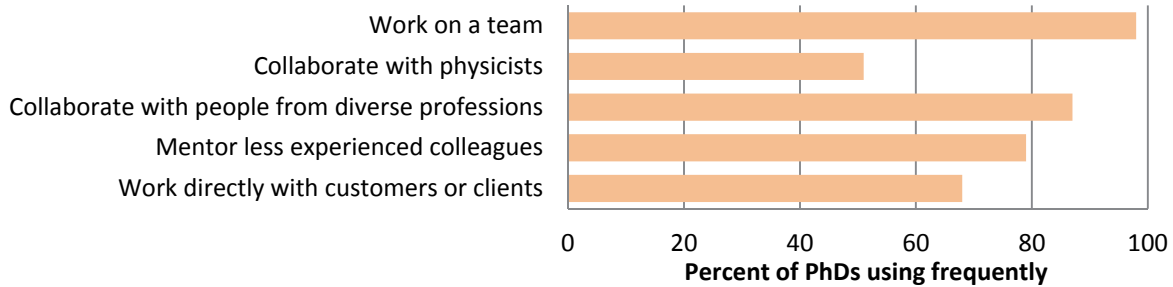
**Figure 7.1: Cognitive Skills Used Frequently by Industrially Employed Physicists Working Primarily in Engineering**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was engineering.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

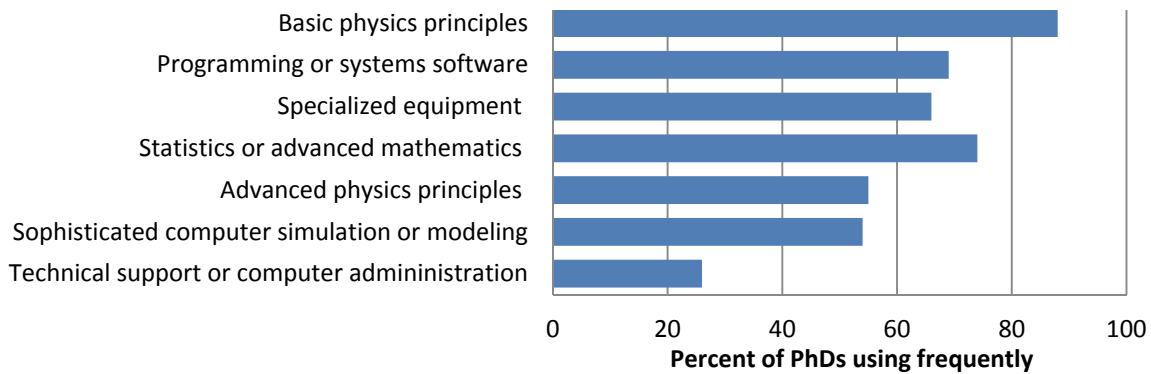
**Figure 7.2: Interpersonal Skills Used Frequently by Industrially Employed Physicists Working Primarily in Engineering**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you do the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was engineering.

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**Figure 7.3: Scientific and Technical Knowledge Used Frequently by Industrially Employed Physicists Working Primarily in Engineering**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was engineering.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

**Knowledge and skills used on the job**

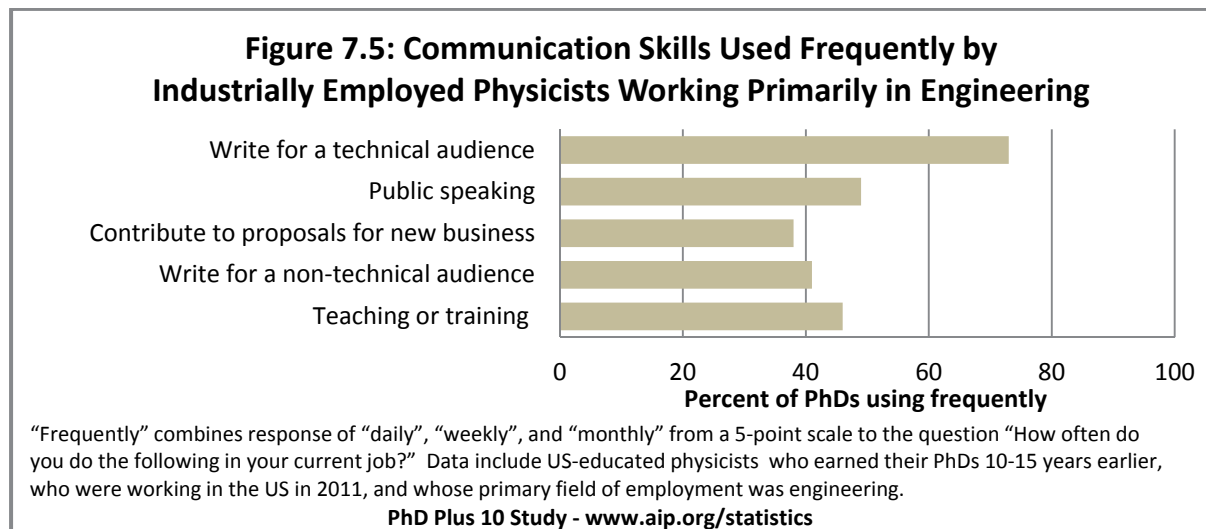
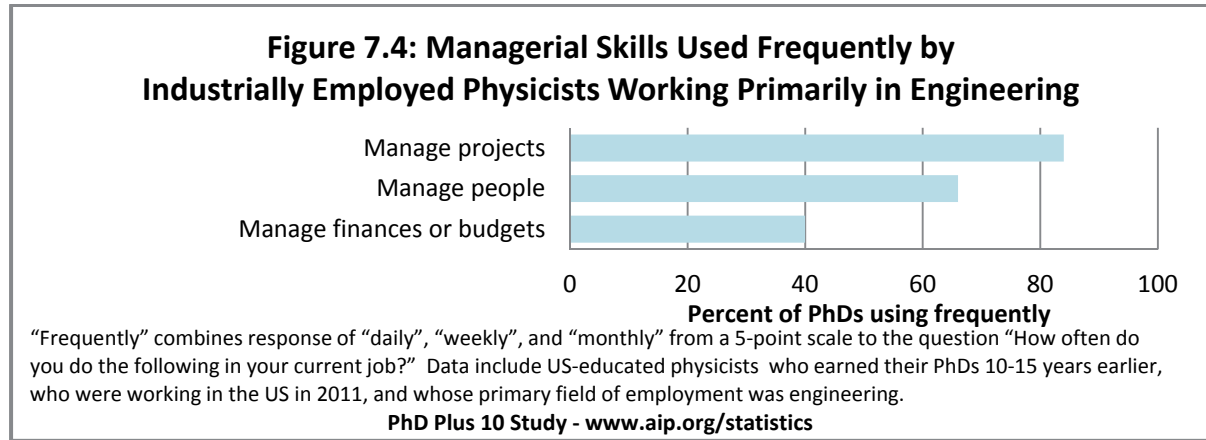
The mid-career physicists who worked in engineering frequently worked on teams, collaborated with colleagues from diverse professional backgrounds and mentored less experienced colleagues (Figure 7.2). These physicists frequently solved complex problems. Many worked on design and development, and many were engaged in applied research (Figure 7.1). More than 80% of the physicists who worked in engineering reported that they frequently used their knowledge of basic physics, and many regularly used advanced mathematics (Figure 7.3).

More than 80% of these mid-career physicists reported that they frequently managed projects (Figure 7.4), and many of them were regularly required to write for a technical audience (Figure 7.5).

**Most rewarding aspect of their jobs**

Physicists who were working in engineering were asked to describe the aspects of their work that were most rewarding. The verbatim comments written by these physicists were consistent with the knowledge and skills data in Figures 7.1 through 7.5. The following were the most common stated themes:

- Physicists working in engineering wrote that they enjoyed their work because it was intellectually stimulating. They enjoyed that problems were complex and tested their ingenuity. They also appreciated how often they got to work on new problems, which could vary greatly in terms of content and scope. They used phrases like “working at the leading edge” and “intellectual stimulation.”
- Mid-career physicists appreciated that the problems they were helping to solve had a real-world impact. It was important to many physicists that their work be “useful to the world”. A few physics PhDs even described the joy of seeing innovations “come to life.”
- It was also common for physicists to describe the benefit of working with smart people as rewarding. Physicists used words like “talented”, “stellar”, “competent”, and “diverse” to describe other team members with whom they worked. One PhD listed “camaraderie” among the rewards of his job.
- A few physicists working in engineering described the satisfaction of contributing to the success of their company. Many led research teams and some helped direct their companies’ technology and research agendas.



<b>Table 7.2: What Are the Most Rewarding Aspects of Your Job?</b>
Selected verbatim comments from PhD physicists working primarily in engineering, 2011
<p><i>Challenging projects which require real scientific detective work to solve and bring about real world products. Excellent community of scientists and facilities to work with. Great teams to work on with a broad spectrum of different backgrounds and abilities.</i></p> <p><i>Working with motivated people to develop products with a wide range of applications. Recognizing the impact of the products we manufacture on other products and services such as cell phones, LCD TVs, computers, medical devices, research, photovoltaic devices, etc.</i></p> <p><i>I work with some extremely talented physicists, engineers, chemical engineers, and software engineers. However, the most rewarding aspect is seeing the incredibly diverse applications developed with instrumentation that I designed.</i></p>
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

## Chapter 8 - Industrially Employed Physicists: Primarily in Computer Science

### Employers

This profile is based on the responses of 64 mid-career physicists employed in industry and working primarily in the field of computer science. Many physics PhDs working primarily in computer science were employed by renowned computing companies like Google, Apple, Microsoft, IBM, Oracle, Cisco, Yahoo, and Dell. Physicists working primarily in computer science were not distributed equally across respondent cohorts, with 73% from the PhD classes of 1996 & 1997 and only 27% from the classes of 2000 & 2001. This difference is likely due to fluctuations in the computer science job market in line with the dot-com explosion around 1996 and the subsequent bust in the early 2000s.

### Job titles

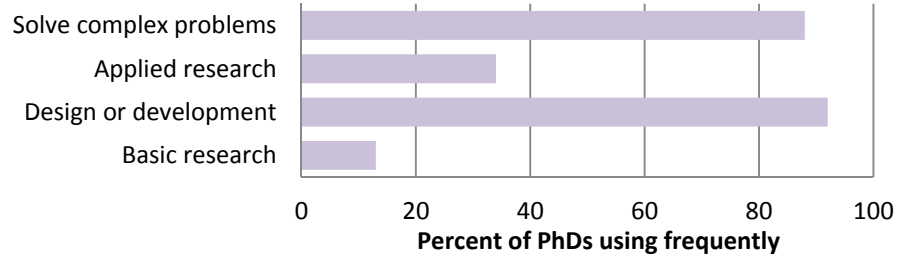
Table 8.1 lists common job titles of mid-career physicists who were working primarily in computer science 10 to 15 years after earning their PhDs. Most of the PhDs working in computer science had software engineering positions. Many physicists in this part of the economy had titles that were preceded by words like “senior”, “principal”, or “lead” reflecting a higher level of responsibility.

<b>Table 8.1: Common Job Titles of Industrially Employed Physicists in Computer Science, 2011</b>
Software Engineer Manager; Product Manager Chief Technology Officer Director Consultant Scientist Systems Engineer
<b>PhD Plus 10 - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

### Job duties

Physicists employed in industry and primarily engaged in computer science described working on software design, development, testing, debugging, optimization, programming including database development and maintenance, product implementation, and software maintenance. A few Chief Technology Officers (CTOs) described researching and choosing new technologies to align their companies’ or customers’ technological futures with their business needs. CTOs, directors, and managers led teams in the design and development of software and related

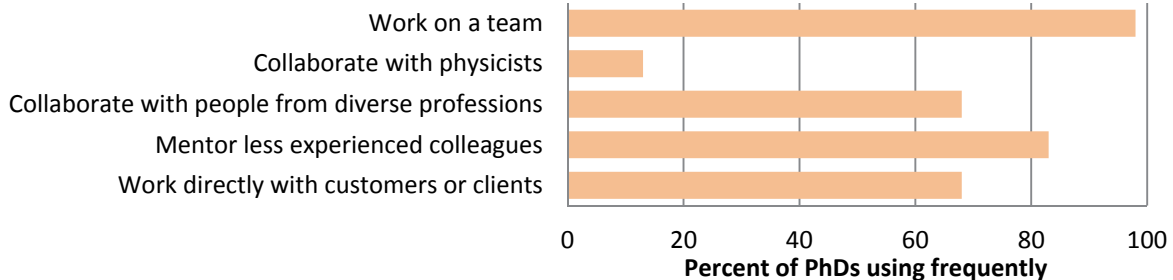
**Figure 8.1: Cognitive Skills Used Frequently by Industrially Employed Physicists Working Primarily in Computer Science**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was computer science.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

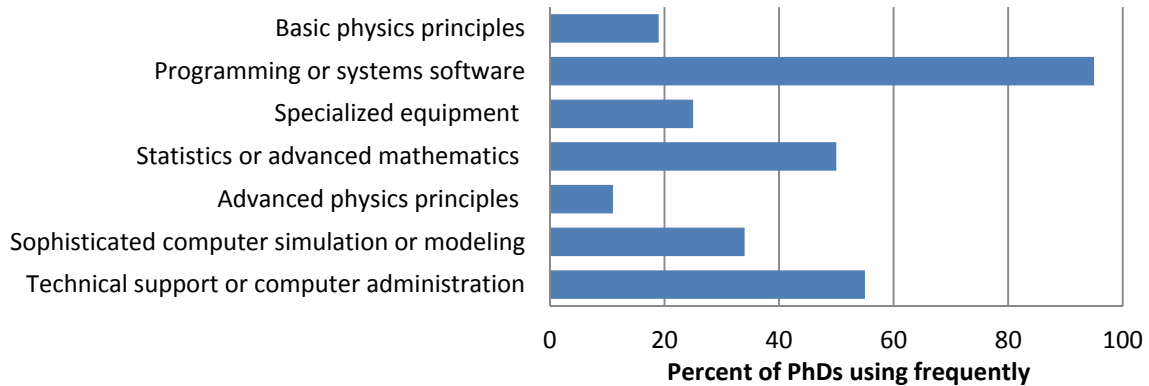
**Figure 8.2: Interpersonal Skills Used Frequently by Industrially Employed Physicists Working Primarily in Computer Science**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was computer science.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

**Figure 8.3: Scientific and Technical Knowledge Used Frequently by Industrially Employed Physicists Working Primarily in Computer Science**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was computer science.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

**(Job duties - cont.)**

technologies. Computer science professionals also provided information technology consulting services, managed data servers and networks, trained or collaborated with clients on the use of unique software, designed and administered networked systems, and marketed and sold their products and services.

**Knowledge and skills used on the job**

Nearly all mid-career physicists working in computer science reported that they were frequently engaged in programming or in systems software (Figure 8.3). About 90% reported that they were frequently involved in design and development, and solved complex problems (Figure 8.1).

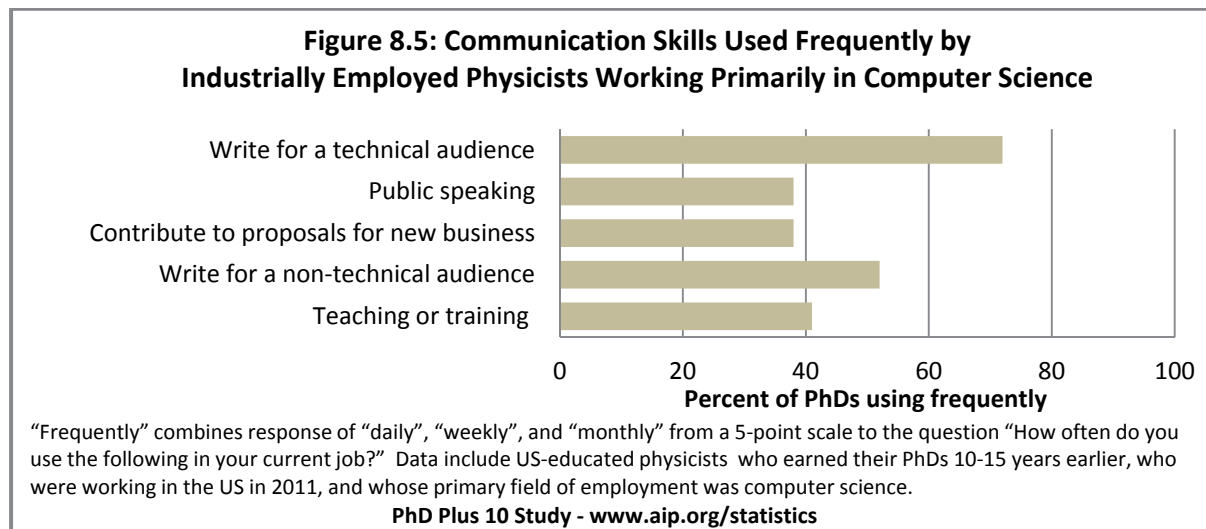
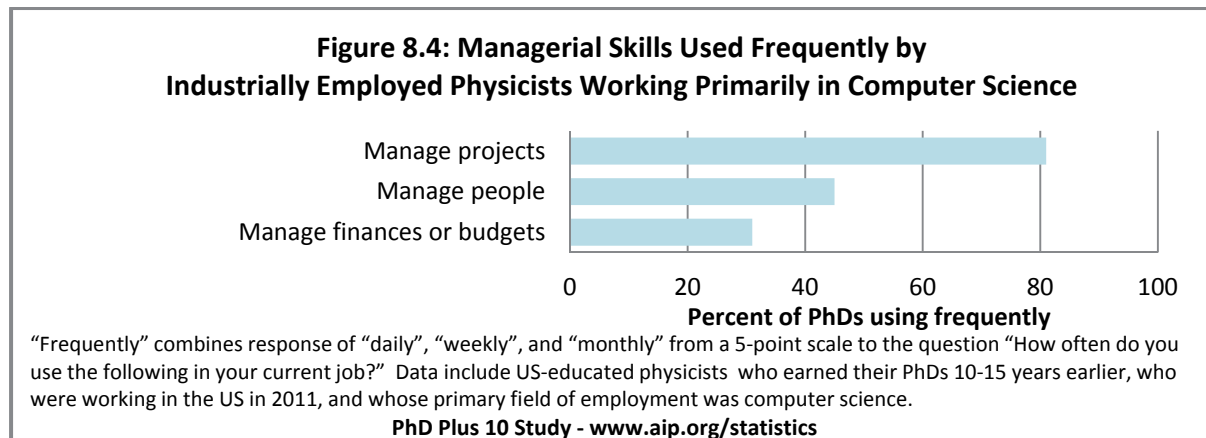
Interpersonal skills were very important for physicists who worked in computer science. Physicists who worked in industry and were primarily involved in computer science worked on teams, and many were frequently involved with mentoring less experienced colleagues. A significant percent indicated that they regularly collaborated with colleagues from diverse professional backgrounds and regularly worked directly with customers or clients (Figure 8.2).

Managing projects (Figure 8.4) and writing for a technical audience (Figure 8.5) were essential skills for physicists who worked primarily in computer science.

**Most rewarding aspects of working primarily in computer science**

Mid-career physicists working in computer science described various aspects of their work that they found rewarding. They typically cited one or more of the following:

- The intellectual challenge was the rewarding aspect of work that was cited most frequently by physics PhDs who worked in computer science. A few commented that they enjoyed that their work involved multiple disciplines - computer science, business, and psychology, for instance - to achieve their objectives.
- Many mid-career physicists appreciated that their work would have a real-world impact and that their applications would be used by people.
- Many physics PhDs working in computer science enjoyed the opportunities they had to work with smart people, often collaborating on teams.
- A fair number described satisfaction in serving their clients' needs in a timely and effective manner, which also contributed to their companies' success.



<b>Table 8.2: What Are the Most Rewarding Aspects of Your Job?</b>
Selected verbatim comments from PhD physicists working primarily in computer science, 2011
<i>Working with smart people and solving complex problems. While my job is not related at all to my background in physics, I find that rigorous training in problem solving and deep understanding of underlying physical processes has helped me enjoy and advance in every position I have held.</i>
<i>Knowing that my work directly impacts tens of thousands of people.</i>
<i>Challenging work, engaging with multiple teams and companies, design and implement practical solutions.</i>
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

## Chapter 9 - Industrially Employed Physicists: Primarily in Physics

### Employers

This chapter is based on the responses from 55 mid-career physicists employed in industry and engaged primarily in physics. They worked for a variety of companies that relied on research and development in the physical sciences to create or improve upon their products or services. Many of these companies produced specialized cutting-edge materials or devices, e.g. semiconductors or lasers, which were often then integrated into a wide array of useful products, e.g. consumer electronics or medical imaging instrumentation. Employers of physicists in the private sector working in physics included IBM, General Electric, Intel, Siemens, Schlumberger, and Northrop Grumman among many other large corporations.

### Job titles

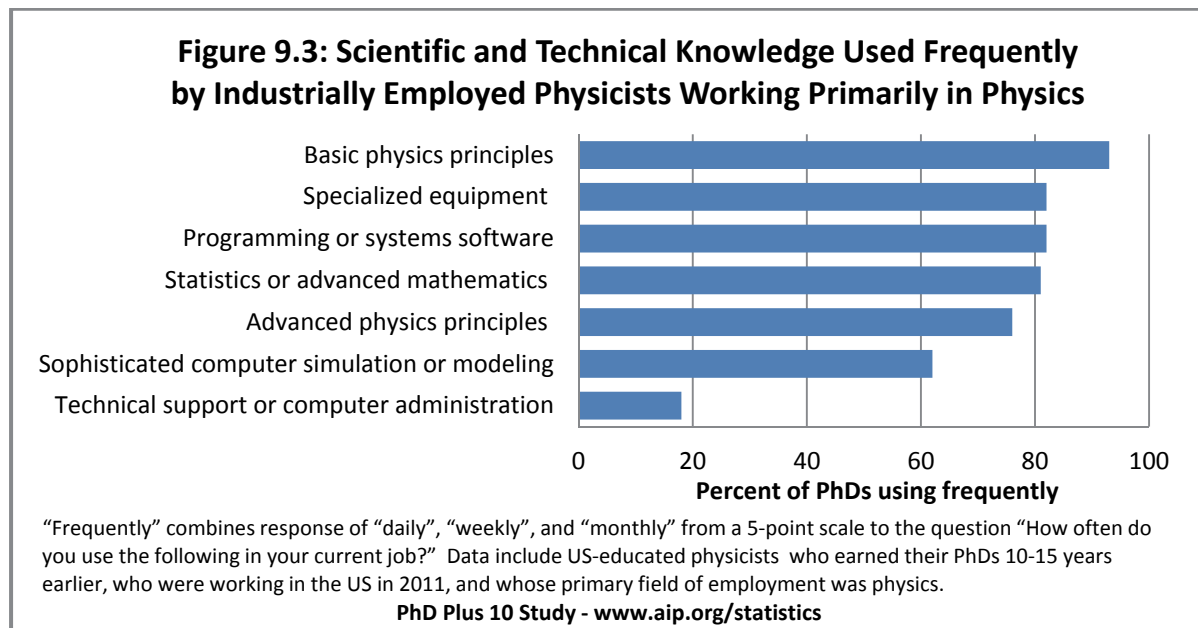
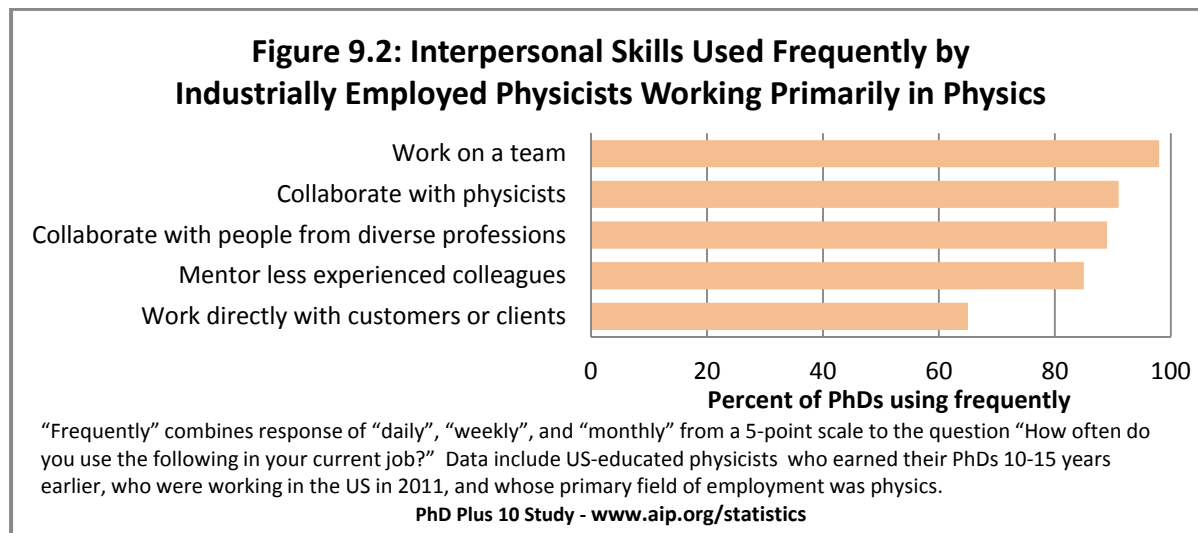
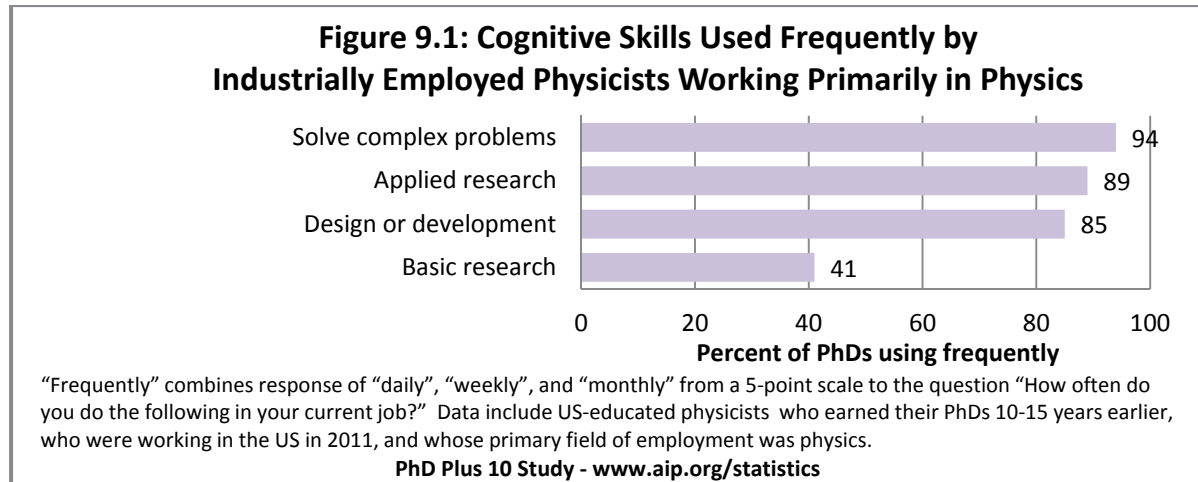
Table 9.1 lists common job titles of mid-career physicists who were industrially employed working primarily in physics 10 to 15 years after earning their PhDs. Job titles were often preceded by words like “senior”, “principal” and “staff” to indicate levels of experience and responsibility.

<b>Table 9.1: Common Job Titles of Industrially Employed Physicists in Physics, 2011</b>
Scientist
Physicist
Director
Manager
Engineer
Member Technical Staff
Vice President
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

### Job duties

Many of the physicists working in the private sector doing physics were engaged in hands-on applied research in a variety of areas including optics and photonics, radiation sensors, electronics, and x-ray imaging with medical as well as security applications. Many were responsible for managing research teams and those in senior-level positions were responsible for directing their companies’ technology development and intellectual property agendas.





**Knowledge and skills used on the job**

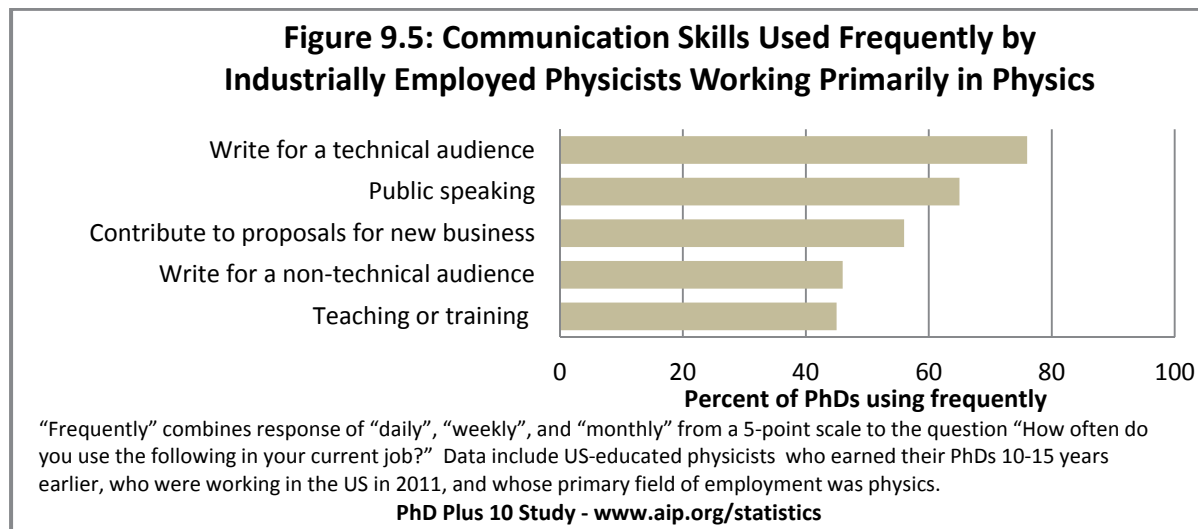
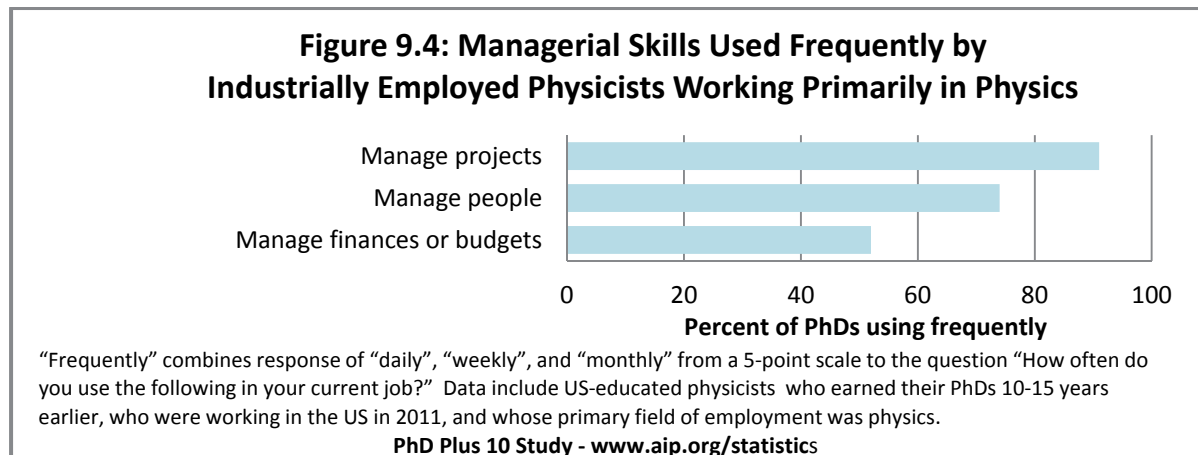
Mid-career physicists who worked in industry primarily in physics used a variety of different kinds of scientific knowledge. Virtually all of them used basic physics principles frequently and three-quarters reported using advanced physics principles regularly (Figure 9.3). In addition, over 80% of them also frequently used specialized equipment, systems software, and statistics or advanced mathematics. Virtually all report that they frequently solved complex problems (Figure 9.1) and frequently managed projects (Figure 9.4).

Interpersonal skills were very important for mid-career physicists who worked in industry and were engaged primarily in physics. A significant percentage of them reported that they regularly worked in teams, collaborated with other physicists, collaborated with people from diverse professions, and mentored less experienced colleagues (Figure 9.2). Such a reliance on interpersonal skills inevitably increases the importance of communication as well. These physicists reported that they regularly wrote for technical audiences and their jobs often included public speaking (Figure 9.5). More than half regularly contributed to proposals intended to develop new business.

**Most rewarding aspects of their jobs**

Industrially employed physicists who worked in physics were asked to describe the most rewarding aspects of their work. The following themes were cited most often:

- Nearly half of the mid-career physicists described the intellectual stimulation of their work as very rewarding. Some used phrases like “solving challenging problems” while others enjoyed the variety of problems they encountered. A few physics PhDs highly valued that they could pursue topics that were of interest to them. Several physicists used the word “freedom”.
- The rewarding aspect that was cited the next most often by physicists was real-world impact. The application of knowledge in design and development was very rewarding. A few physicists wrote about the appeal of “advancing the state-of-the-art.”
- A few of these physicists also valued their working conditions, including working with smart colleagues and clients, and a good work-life balance.



<b>Table 9.2 What Are the Most Rewarding Aspects of Your Job?</b>
Selected verbatim comments from PhD physicists working primarily in physics, 2011
<p><i>Bringing a vision on paper to life with the help of incredibly talented people.</i></p> <p><i>It is intellectually stimulating. I work with very intelligent people on interesting technical problems, and I get to apply science in a business setting with the promise of realizing products which are deployed to solve real-world needs.</i></p> <p><i>The intellectual pursuit of new knowledge, technology, and understanding. I love the “Aha!” moments of physics just like I did the first time I picked up a book on physics.</i></p>
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

## Chapter 10 - Industrially Employed Physicists: Primarily in Other STEM Fields

### Employers

This profile is based on the responses of 30 mid-career physicists employed in industry and working primarily in STEM fields other than physics, computer science or engineering. These physicists worked for an assortment of large corporations and medium-size companies that provided highly sophisticated products and services. These companies had diverse specializations including applied mathematics, bio-tech and gene sequencing, audio recording equipment, and laser surgery.

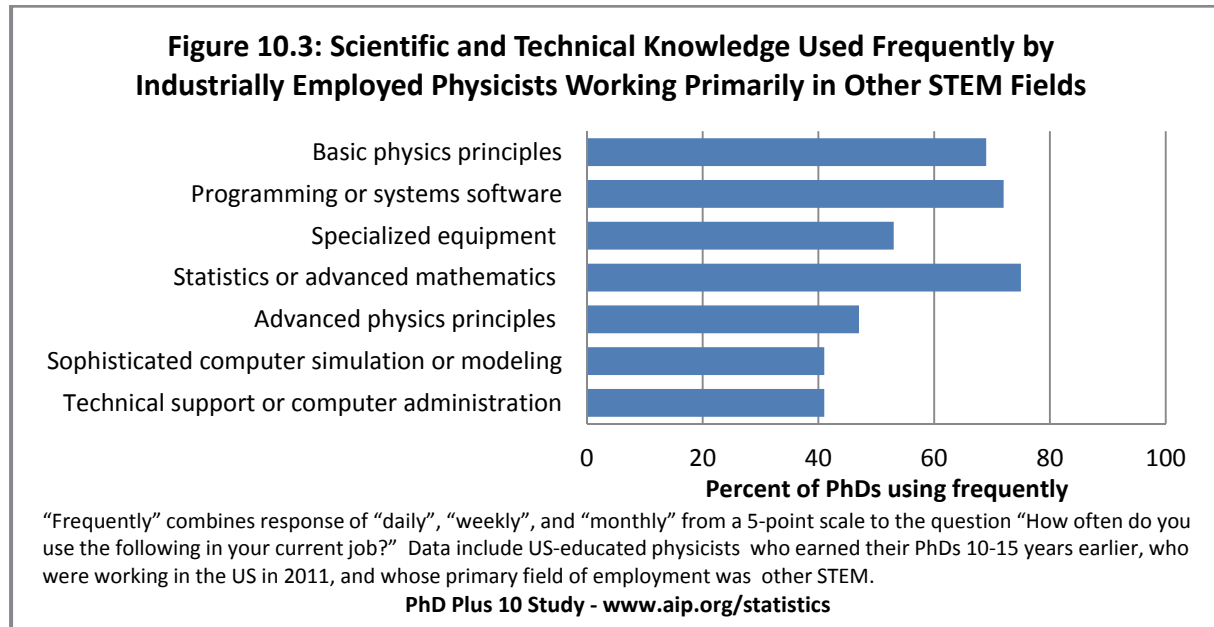
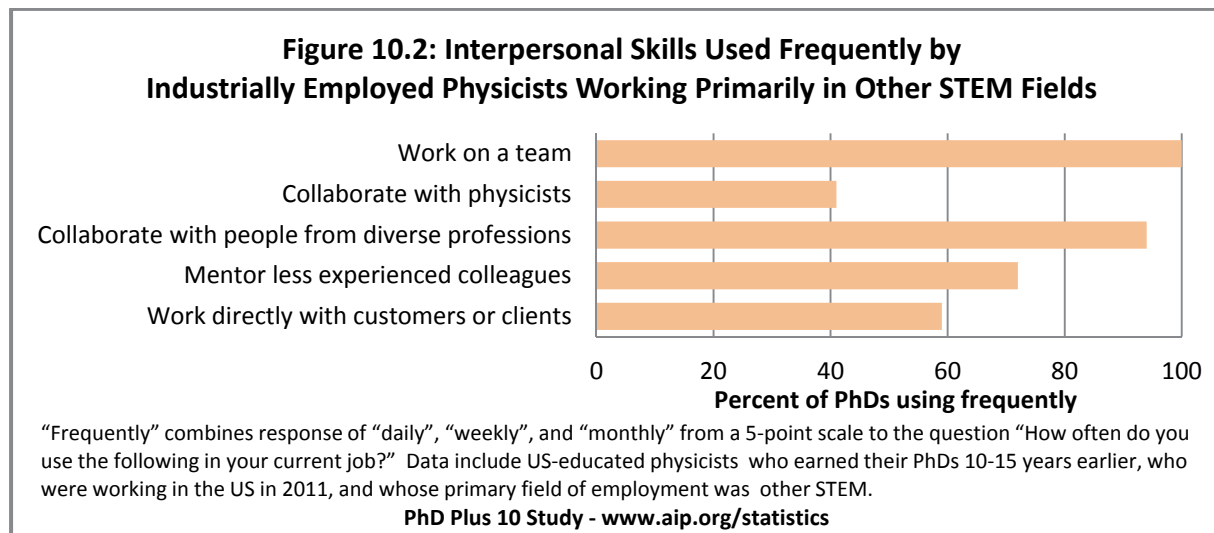
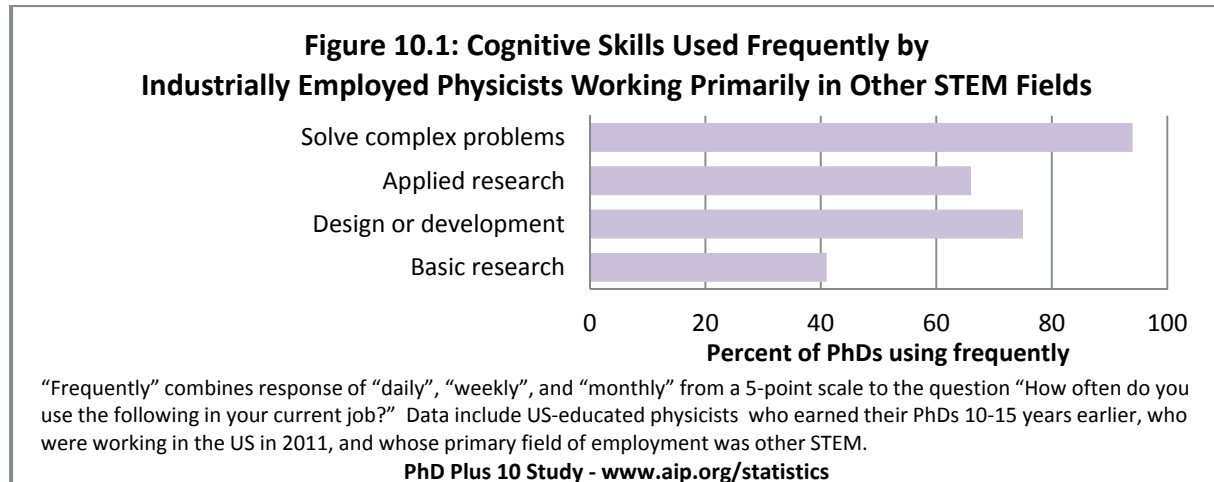
### Job titles

Table 10.1 lists common job titles of mid-career physicists who were employed in industry and were working in other STEM fields 10 to 15 years after earning their doctorates. Job titles were often preceded by words like “senior” or “principal” to indicate levels of experience and responsibility.

<b>Table 10.1 Common Job Titles of Industrially Employed Physicists in Other STEM Fields, 2011</b>
Scientist
Engineer
Manager
Director
Member Technical Staff
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

### Job duties

Mid-career physicists working in industry and primarily engaged in other STEM fields described various responsibilities and duties many of which were unique to the field in which they worked. Several physics PhDs who were employed by biotech companies described working on analyzing gene sequences and developing diagnostic tools to aid in genomic analysis. Other physicists described using applied mathematics for failure analysis and reliability studies, to develop algorithms for optimal business decision making, or to forecast hospital patient flow. Some physicists described leading teams to improve their companies' products or processes.



**Knowledge and skills used on the job**

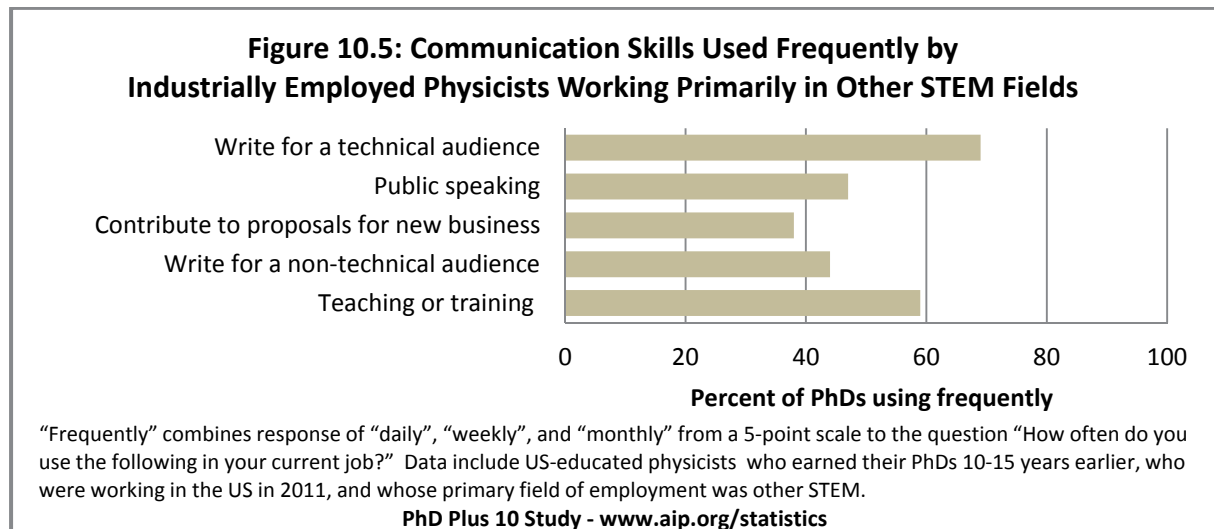
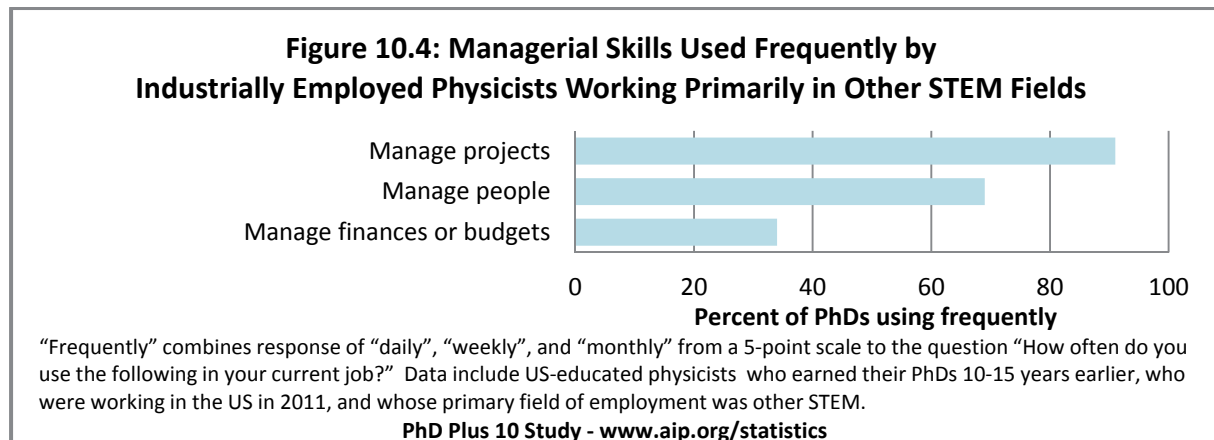
Mid-career physicists who worked in companies primarily engaged in other STEM fields had varied jobs, but there was consistency in several professional skills used frequently by them in their work. All these physicists reported working on a team and nearly all collaborated with people from diverse professions, and quite a few frequently mentored less experienced colleagues (Figure 10.2). Nearly all reported that they frequently solved complex problems (Figure 10.1), and managed projects (Figure 10.4).

These physicists used various types of scientific knowledge depending on their positions. The most frequently cited were statistics or advanced math, use of programming or systems software, and basic physics principles (Figure 10.3). Communication was also very important in this line of work and physicists most commonly cited the need to write for a technical audience and training (Figure 10.5).

**Most rewarding aspects of their jobs**

Physicists who worked in other STEM fields 10 to 15 years after earning their PhDs enjoyed various aspects of their work. The following main themes occurred often among the comments they wrote:

- Physics PhDs enjoyed the intellectual challenge of their work. Several used the term “complex” to describe problems or issues that they worked to resolve.
- Many mid-career physicists also thrived on the real-world impact of their work. Several felt that the problems they were working on were “critical” or “mattered” to society at large. They enjoyed seeing their work “applied in practice”.
- Several of these mid-career physicists noted the joy of working with smart people.



<b>Table 10.2: What Are the Most Rewarding Aspects of Your Job?</b>
Selected verbatim comments from PhD physicists working primarily in other STEM fields, 2011
<i>Seeing my technology applied in the marketplace to help with real-world problems.</i>
<i>Working with customers helping them to solve problems that affect the environment, food safety, and drug development.</i>
<i>See the direct results of my work applied in practice. Collaborate with a diverse team. Work on a changing range of projects over time. Develop novel solutions to complex problems.</i>
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

## Chapter 11 - Industrially Employed Physicists: Primarily in Non-STEM Fields

### Employers

This chapter is based on the responses of 32 mid-career physicists who were employed in the private sector and were working primarily in non-STEM fields. These physicists were often in high-level managerial positions and were managing projects and people for corporations, some of which were part of the science and engineering enterprise. Interestingly, of the physicists who were not working in STEM fields, nearly one-third earned additional degrees that facilitated their transition into a non-STEM field. Half of those who earned additional degrees earned Master's in Business Administration (MBA) degrees and the other half earned Juris Doctors (JD) from law schools and became practicing attorneys.

### Job titles

Table 11.1 lists common job titles of industrially employed physicists who were working in non-STEM fields 10 to 15 years after earning their PhDs. Most of these titles were consistent with positions in upper management and the legal profession.

<b>Table 11.1: Common Job Titles of Industrially Employed Physicists in Non-STEM Fields, 2011</b>
Director President; Vice President Attorney Manager
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

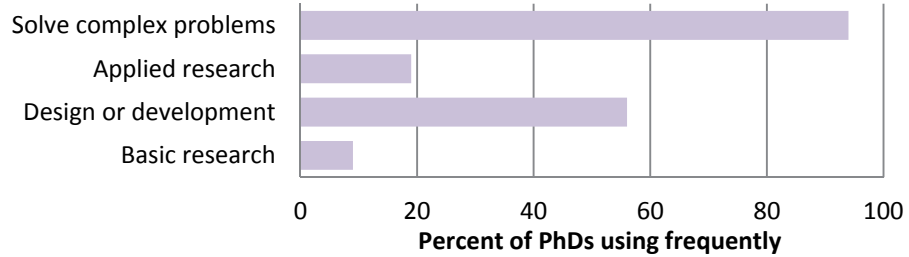
### Job duties

The mid-career physicists in this group, including those with MBAs, utilized problem solving skills in achieving long-term business objectives, and, to a lesser extent, immediate business needs. Physicists described devising corporate and operations strategy, training employees, analyzing manufacturing processes to maximize efficiency, improving processes and limiting expenses, quality assurance, and directing new initiatives. Some of the work these mid-career physicists did focused on assessing future risk, forecasting potential markets based on trends, and fostering long-term profitability.

Physicists working in non-STEM also oversaw daily business operations, project management, database management and programming, design and manufacturing, and sales and marketing.



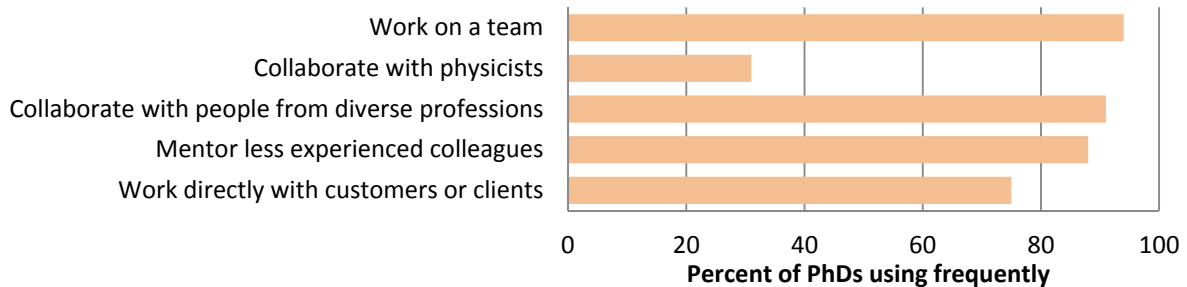
**Figure 11.1: Cognitive Skills Used Frequently by Industrially Employed Physicists Working Primarily in Non-STEM Fields**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was a non-STEM field.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

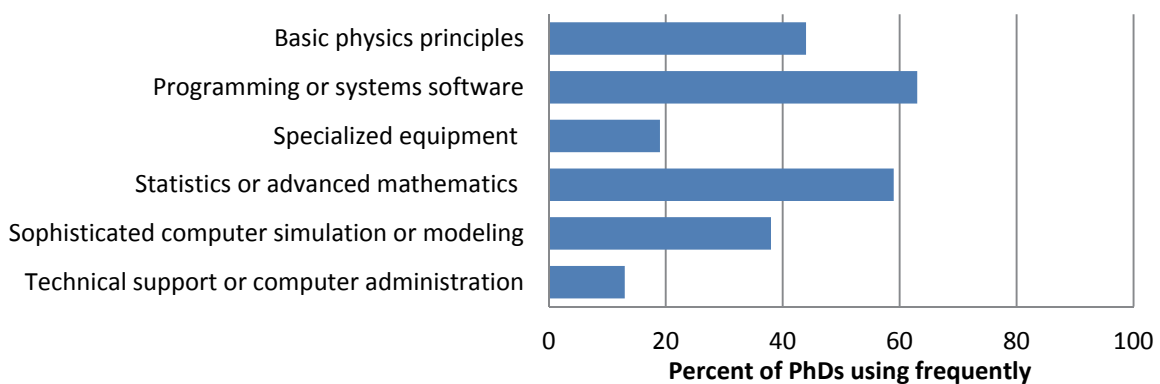
**Figure 11.2: Interpersonal Skills Used Frequently by Industrially Employed Physicists Working Primarily in Non-STEM Fields**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was a non-STEM field.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

**Figure 11.3: Scientific and Technical Knowledge Used Frequently by Industrially Employed Physicists Working Primarily in Non-STEM Fields**



“Frequently” combines response of “daily”, “weekly”, and “monthly” from a 5-point scale to the question “How often do you use the following in your current job?” Data include US-educated physicists who earned their PhDs 10-15 years earlier, who were working in the US in 2011, and whose primary field of employment was a non-STEM field.

PhD Plus 10 Study - [www.aip.org/statistics](http://www.aip.org/statistics)

**(Job duties cont.)**

The JDs described working on intellectual property (IP) litigation and prosecution, drafting patent applications, and advising clients about IP strategies, assessing the legal accessibility of incorporating others' patents into new products, and helping clients develop patent portfolios relevant to their business goals. Some physics PhDs who did not earn JDs also worked on intellectual property law in consulting roles for law firms or private practices. IP law, though technically non-STEM, is obviously and inextricably linked to the STEM community.

Mid-career physicists opted out of STEM careers due to factors that push them out of STEM careers as well as factors that attract them to non-STEM fields. Physicists described being concerned about competing for academic positions and being limited by academic bureaucracy, limited funding for physics, and losing interest in a narrow subfield of research as contributing factors to their leaving STEM fields. They also described being attracted to new fields by opportunities for advancement, utilizing a broader range of abilities than would have been required for physics research, and the intellectual excitement of experiencing a new field.

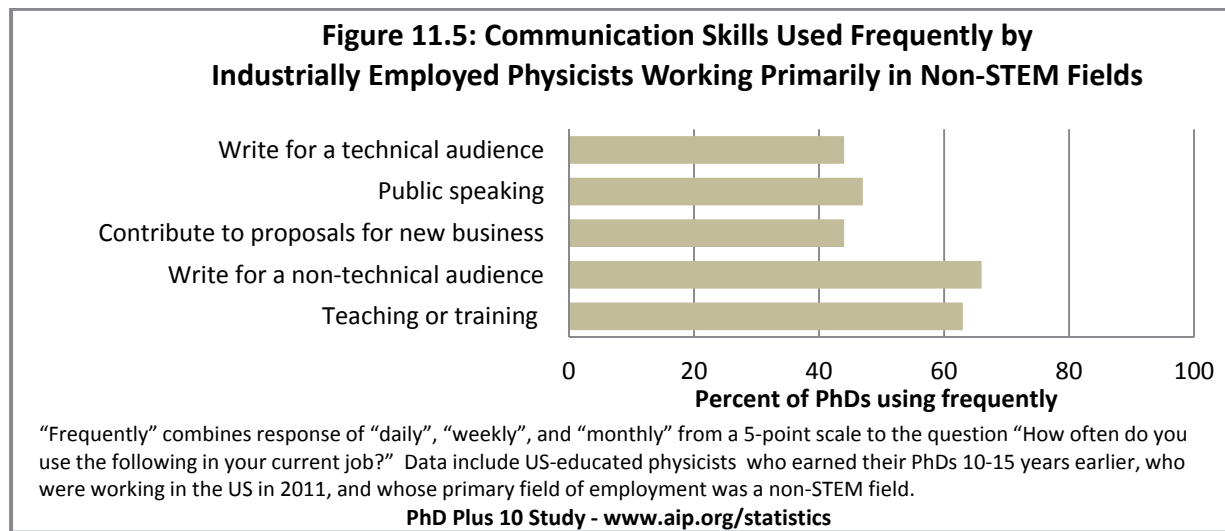
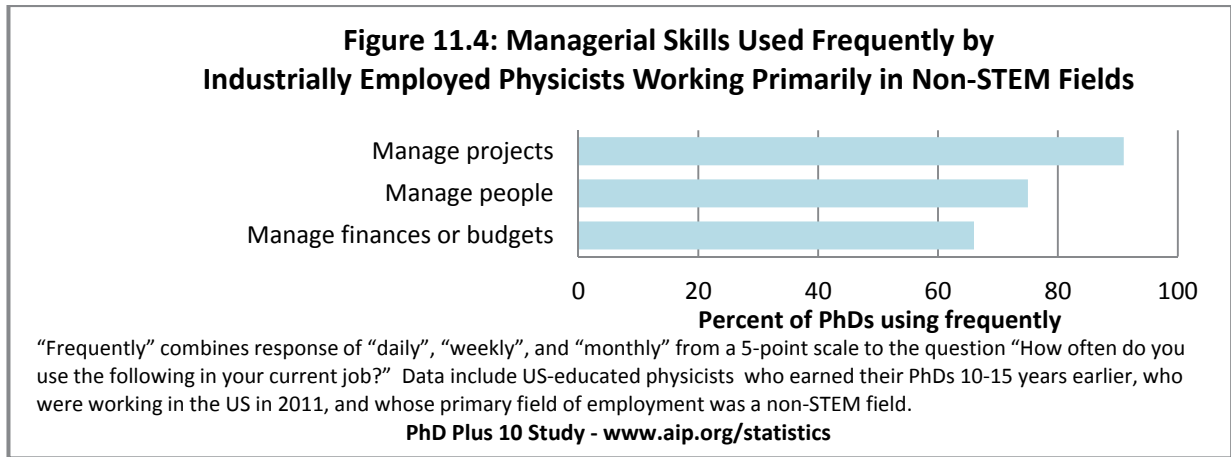
**Knowledge and skills used on the job**

Mid-career physicists in this type of career frequently solved complex problems (Figure 11.1), many of which involved managing projects (Figure 11.4). Interpersonal skills were essential in this type of career and about 90% of them reported that they worked on a team with professionals from diverse backgrounds (Figure 11.2). Nearly 90% reported that they frequently mentored less experienced colleagues. Use of systems software and advanced math or statistics were important in these lines of work (Figure 11.3). These mid-career physicists reported that communication with non-technical audiences was very important and that they were often involved in training, especially of other employees (Figure 11.5).

**Most rewarding aspects of their jobs**

Physics PhDs who were working in non-STEM fields 10-15 years after earning their doctorates described what it was about their jobs they found most rewarding.

- The most often cited rewarding aspect of work reported by this group was the intellectual challenge of working on difficult and diverse problems.
- Many physicists in this group enjoyed working with smart people, often from diverse professional backgrounds.
- It was common for mid-career physicists to derive satisfaction from helping their clients and companies succeed.



<b>Table 11.2: What Are the Most Rewarding Aspects of Your Job?</b>
Selected verbatim comments from PhD physicists working primarily in non-STEM fields, 2011
<i>Ability to influence a large organization and see the results of one’s work, varied challenging business and organizational problems to resolve, a great management team, a great group to manage, and working with great technical people.</i>
<i>Being able to bring both my problem solving and science skills together with my business skills.</i>
<i>Getting to learn about new technology and solving clients’ problems.</i>
<b>PhD Plus 10 Study - <a href="http://www.aip.org/statistics">www.aip.org/statistics</a></b>

## Appendix

### Finding PhD Physicists in the Private Sector

There are three primary reasons why there is little reliable data on mid-career PhD physicists in the private sector in the US. First, it is comparatively easy to identify and locate people while they are students, but it is far more difficult and expensive to locate people ten or more years after they have left the university system. Second, PhD physicists in the private sector pursue a wide variety of types of careers, and comparatively few of them work primarily in physics. Consequently, they are the least likely of all physics PhDs to be affiliated with physics-related professional societies.<sup>5</sup> Third, industry is far more proprietary about the contact information of their employees than academe or many government research facilities. In several instances, we knew physicists were employed by particular companies, but in trying to contact them were told by corporate staff members that their policy did not permit them to disclose contact information.

Based on surveys that the SRC conducted on PhD physicists one year after they earned their degrees, we conclude that respondents to the PhD Plus 10 Study were somewhat more likely to have taken a postdoc than non-respondents (Appendix Table A3). This is likely due to two related issues: physics PhDs who took postdocs were in the university system longer than those who did not and those who took postdocs were more likely to be employed in academe or government labs (Table 2.2). Combined, these issues made PhDs who took postdocs easier to find 10 years later than PhD physicists who did not take postdocs. These trends further contributed to the difficulty in finding PhDs in the private sector because they were the least likely to have taken postdocs.

### Selection into the Primary Types of Careers

We categorized respondents into one of eight types of careers based on their survey answers to questions about primary field of employment, employment sector, employer name, job title, and job description. Each respondent was assigned to the best fitting group. We recognize that the work activities of physics PhDs are often varied and complex, so their jobs could transition between career types or exist in more than one career type.

Respondents' self-categorizations led to some overlap of job titles between career types. In nearly all cases, we left respondents in the categories they self-selected. For instance, a few respondents with the job title "software engineer" categorized themselves as working in

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<sup>5</sup> An initial tactic to locate PhDs included looking up names against physics-related society membership lists.

engineering instead of computer science. Also, general job titles like “physicist” and “scientist” showed up across several types of careers. Overall, the types of careers proved to be distinct enough for substantive analysis despite their limitations.

## PhD Physicists We Contacted

**Table A1: Survey Population, Sample, and Coverage Rates by Degree Class**

Physicists who Earned their PhDs in the US 10 to 15 Years Earlier					
Class	PhDs earned N	Names Available N	Names in Range* N	PhDs Potentially Contacted (Sample)	Coverage %
1996	1,438	1,405	1264	907	71.7
1997	1,385	1,275	1137	868	76.3
2000	1,214	1,055	906	747	82.4
2001	1,157	1,251	1095	897	81.9
<b>TOTAL</b>	<b>5,194</b>	<b>4,986</b>	<b>4,402</b>	<b>3,419</b>	<b>77.6</b>
Source: AIP Enrollments and Degrees surveys, 1996-2001					

Note: There were more total names for 2001 than number of physics PhDs earned because that year includes graduate students who self-identified that they anticipated earning their PhDs, but who were not on official department-provided lists of degree earners.

\* “Names in Range” excludes those identified to be outside of the US, deceased, not in target degree years, and duplicate names.

There were 5,194 physics PhDs conferred in the classes of 1996, 1997, 2000, and 2001 in the United States. The focus of this study is on the physicists who earned their PhDs in the United States from those four degree cohorts and who lived in the US during 2011.

Extensive efforts were made to match current contact information, both postal and email addresses, to the names of 4,986 physics PhDs. The bulk of the contact information we used resulted primarily from matching to physics-related society directory lists and secondarily through web-searches for each individual.

Physics PhDs who graduated more recently were easier to locate. As we expected, it was progressively more difficult to locate PhDs as we went further back in time, in part because they had more opportunities to change their contact information due to relocation.

## Tapping Existing Networks to Find Fellow Alumni

In conjunction with web-searches, we asked 1,470 respondents via email if they knew the whereabouts of their peers – those who earned physics PhDs from the same university around the time they did and who we had been unable to contact. About 340 respondents (23%) replied with helpful information about 310 of the outstanding PhDs. Of those 310, we garnered new US addresses for 158 PhDs (51%).

That leaves 152 non-respondents for whom we did not receive updated contact information but about whom we learned something helpful. For instance, we learned about last name changes, physicists who had left the US, those who had unusual career trajectories, and sadly that a few had passed away. This effort was costly in terms of the time spent developing useful information about a comparatively small number of mid-career physicists.

The high cost to gather contact information was justified when we examined the critical difference in the types of respondents who we located using extended efforts (see Table A3).

### PhD Physicists Who Responded

The upper estimate of PhDs in our target population who we may have contacted is 3,419. This excludes PhDs for whom we never had useable contact information, those who were determined to be currently outside of the US, physicists who had passed away, and respondents who were not the intended person. It is an upper estimate because it includes everyone for whom we had any contact information even if we had no confirmation that our correspondence actually reached them. There were practically no differences in response rate by degree class, but there were proportionally more or less respondents per class depending on class size and our coverage rates (from Table A1).

**Table A2: Respondents and Response Rates by Degree Class**

Physicists who Earned their PhDs in the US 10 to 15 Years Earlier		
Degree Class	Legitimate Respondents	Response Rate %
1996	389	42.9
1997	390	44.9
2000	343	45.9
2001	422	47.0
<b>Total</b>	<b>1,544</b>	<b>45.2</b>

Legitimate respondents include physics PhDs from these four degree classes who were living in the US in 2011. A portion of the 1,860 total respondents were out-of-range. One-hundred sixty-two were living outside of the US and 93 respondents had the names we were trying to contact, but either they graduated in a different year or did not have a physics PhD. Inevitably, some respondents dropped out at various points throughout the questionnaire. Sixty dropped out before the question about currently residing in the US. Thirteen respondents never entered the workforce. Another 12 reported that they were still in a postdoctoral appointment and were excluded from analysis.

For employment analysis, 25 PhDs were not working. Fourteen PhDs who held multiple part-time jobs were excluded from analysis since their employment situation was more complex than the scope of the survey.

## Why We Extended Data Collection

We used both email and physical mail to contact PhDs. The survey was conducted in sequential contact waves. As we developed additional contact information, we periodically started another wave of surveys. Each wave of data collection included a pre-notice, a request to participate with a unique respondent ID and a link to the online survey, and at least two reminder messages.

Data about the initial employment outcomes of these classes were compared to a few expectations about our sample, specifically about the proportion of new PhDs who took postdocs (less than half). After the first wave, PhDs who took postdocs were overrepresented and PhDs who worked in the private sector were underrepresented. Thus, we decided to extend data collection using additional search strategies.

**Table A3: Differences in Current Employment Sector and Postdoc experience by Contact Wave**

Physicists who Earned their PhDs in the US 10 to 15 Years Earlier				
Wave				
Employment Sector	1 %	2 %	3 %	Total %
Academe	47.7	45.9	6.3	44.8
Government	16.5	13.5	3.2	15.3
Private Sector	30.4	35.1	<b>83.2</b>	34.3
Other	5.5	5.4	7.4	5.6
<b>Took a Postdoc</b>				
Yes	63.5	64.9	33.7	61.7
No	36.5	35.1	<b>66.3</b>	38.3
<b>Total Number</b>	1225	148	95	1468

Note: Wave 1 included the first two electronic waves and first postal wave. Wave 2 was the third electronic contact. Wave 3 was the second postal contact, which included corrected addresses from Wave 1.

The latter two waves used contact information collected from web-searches, alumni leads, and corrected postal addresses. These latter waves increased the number of overall respondents by nearly 20 percent. Further, these respondents were far less likely to have taken a postdoc and were disproportionately working in the private sector, boosting the overall percentage of those working in the private sector to 34.3% and slightly correcting the proportion of those who took postdocs.

That these groups – non-postdocs and private sector employees - were more difficult to locate indicates that they are likely still underrepresented. Thus, we do not draw any conclusions about the population as a whole and instead focused on the characteristics within and between groups.

## Likelihood of Leaving the US

During data collection, 406 PhDs were matched to addresses that were outside of the US. We did not attempt to contact them. In addition, 162 PhDs who responded to the survey indicated that they were abroad. We estimated that these 568 physicists represented about half of those who were in our target groups and who were actually residing outside of the US.

**Table A4: Citizenship at time of PhD**

Physicists who Earned their PhDs in the US 10 to 15 Years Earlier			
Citizenship	All PhDs at Time of Degree %	Respondents to PhD Plus 10 Study %	
US	53.7	66.3	
Non-US	46.3	33.7	
Permanent Resident	-	Permanent Resident	8
Temporary Visa	-	Temporary Visa	25.7
<b>Number</b>	<b>5194</b>	<b>1747</b>	

Source: AIP Initial Employment Surveys, Enrollments and Degrees Surveys 1996-2001 did not distinguish between Permanent Resident and temporary visa status.

Existing data on citizenship shows that non-US citizens made up about 46% of physics PhDs from 1996-2001. Thirty-four percent of PhDs who responded to the PhD Plus 10 Study reported that they were non-US citizens at the time of their degrees. We believe that non-US citizens made up a significant majority of the PhDs with foreign addresses who we did not contact. This is supported by the fact that over 80% of the 162 respondents who were currently out of the US were non-US citizens at the time of their degree. Further, we suspect that those living abroad would be more difficult to locate than those who stayed in the US and would accordingly account for a disproportionately high percentage of the people for whom we never located an address.

Because we cannot infer the whereabouts of the entire population, we cannot quantify the percentage of physics PhDs who left the US. However, we are confident from these indicators that the proportion of our respondents who were non-citizens is low because non-US citizens were more likely to leave the United States than were US citizens.

Nearly all of the physics PhDs who had temporary visas at the time they earned their PhDs and worked in the US at the time of the PhD Plus 10 Study had changed their citizenship status. Half upgraded to permanent resident status and 45% became US citizens. It was extremely rare that people who earned their PhDs in physics while on a temporary visa continued to work in the US on a temporary visa 10 to 15 years later.

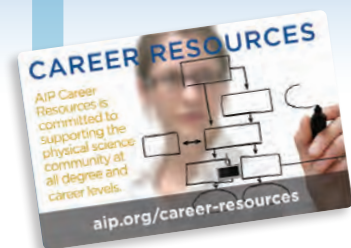






# CAREER RESOURCES

1



[aip.org/career-resources](http://aip.org/career-resources)

2



**Society of Physics Students**  
[spsnational.org](http://spsnational.org)

3



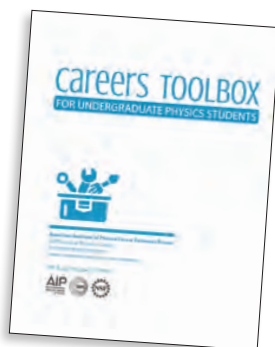
**Internships and summer research positions**  
[jobs.spsnational.org/jobs](http://jobs.spsnational.org/jobs)

4



[GradSchoolShopper.com](http://GradSchoolShopper.com)

5



**Careers Toolbox**  
[spsnational.org/careerstoobox](http://spsnational.org/careerstoobox)

6



**Employment statistics and trends**  
[aip.org/statistics](http://aip.org/statistics)

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**Science policy fellowships**  
[aip.org/policy/fellowships/overview](http://aip.org/policy/fellowships/overview)

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[physicstoday.org/jobs](http://physicstoday.org/jobs)

9



**Industrial outreach**  
[aip.org/industry](http://aip.org/industry)



This PhD Plus 10 Study has  
**two companion reports**  
available at [aip.org/statistics](http://aip.org/statistics)

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These reports contain verbatim comments from two questions:

- What are the most rewarding aspects of your job?
- Briefly describe your job duties and responsibilities