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AIP REPORT
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Physics Bachelors with Master's Degrees

Highlights

- Five to eight years after graduating, about 25% of physics bachelors have master's degrees and are in the workforce. Almost 40% of these have master's degrees in physics or astronomy, about 40% have master's degrees in other sciences and engineering, and 20% have master's degrees in non-science fields **(Table 1)**.

- Some master's degree recipients went to graduate school because they were concerned about a lack of job opportunities after receiving a physics bachelor's degree **(Figure 1)**. These individuals were more likely to earn master's degrees in engineering and other sciences rather than in physics and non-sciences.

- Those who earned master's degrees in engineering and other sciences rated their undergraduate physics, math, and problem-solving preparation higher than those who earned master's degrees in physics **(Figure 2)**.

Table 1. Field of Master's Degree

	Percent
Physics & Astronomy	39
Engineering	28
Math & Other Science	10
Humanities, Social Science, Other	8
Business	7
Computer Science	4
Education	4

Based on physics bachelors with master's degrees.
AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study

- Physics bachelors who went on to earn physics masters are most commonly employed either in software or in science or lab jobs. Less than one-half of physics bachelors who earned master's degrees in engineering are employed in engineering **(Figure 3)**.

- Those with master's degrees in physics, engineering, and other sciences earn significantly higher salaries than those with physics bachelor's degrees. This effect applies even when controlling for field of employment, time in a career-path job, sex, and several career activities **(Table 2)**.

- Physics masters use more computer programming and physics on the job than physics bachelors, even when working in the same field of employment for the same amount of time **(Figure 5)**.

- Those with master's degrees are more positive about some aspects of their undergraduate education than those with physics bachelor's degrees **(Figure 7)**. There is evidence that those from supportive undergraduate physics programs are more likely to earn graduate degrees than those from less supportive undergraduate programs.

- As with physics bachelors, a majority of masters would get an undergraduate degree in physics if they had to do it all over again.

A physics bachelor's degree can be the gateway to a wide variety of career and educational opportunities. People with physics bachelor's degrees often go on to graduate school. The PhD is stereotypically seen as the desired outcome of graduate education for physics bachelors, but many physics bachelors opt for master's degrees for a variety of reasons. These master's degrees are largely in science and engineering, especially physics. Master's degrees earned after a physics bachelor's degree have real workplace value in terms of job opportunities and in terms of salaries. In addition, graduates from supportive undergraduate programs are more likely to go on to complete master's degrees, so quality undergraduate education has lasting value for physics bachelors.

This is the second report based on data collected from physics bachelors who earned their degrees between 1990-93. In 1998-99, the Statistical Research Center contacted all bachelor's degree recipients from a randomly selected sample of 150 physics departments. The departments supplied us with the names of their physics bachelors, and we are grateful to them for their assistance. We were able to find potentially good addresses for 2400 of these graduates (that is, our mail to them was not returned by the post office). Of these, about 1200 completed a sixteen-page questionnaire about their career and educational histories. This study marks the first time that AIP attempted to study physics bachelors five to eight years after they earned their degrees. Data collection was complete in the spring of 1999, and was supported by a grant from the National Science Foundation.

This report covers physics bachelors who went on to earn master's degrees and were employed at the time of the survey (that is, they were not primarily students at the time of the survey). Other physics bachelors who responded to the survey had not earned any graduate degrees and were working at the time of the survey. These physics bachelors were discussed in our first report (Ivie and Stowe, 2002). Still other physics bachelors had earned PhDs by the time of the survey (12% of our respondents) or were primarily students at the time of the survey (24%) and may have earned master's degrees en route to a PhD. However, this report covers those respondents who earned physics bachelors between 1990-93, earned a master's degree, and were working at the time of the survey in 1998-99.

Although the sample of physics bachelors that we drew was a random, representative sample, it should be noted that these bachelors graduated during a severe international recession and that this context probably affected their career and educational choices. Nevertheless, physics bachelors usually have the skills they need to adapt to changing economic and technological situations. We surveyed these respondents at the boom time for the IT industry, and many were able to obtain employment in software-related jobs, with or without master's degrees.

Field of Master's Degree

About 25% of respondents had a master's degree at the time of the survey and were not primarily students, although a few (21) were working on PhDs while working full-time. Among master's degree holders, about 40% earned master's degrees in physics, about 40% earned master's degrees in math, other sciences and engineering (most of these were engineering), and about 20% earned master's degrees in non-science fields **(Table 1)**. The non-science fields include humanities, social science, business, education, and health-related fields (other than MDs). The largest category among non-science masters was business, but there were only 19 people who earned MBAs.

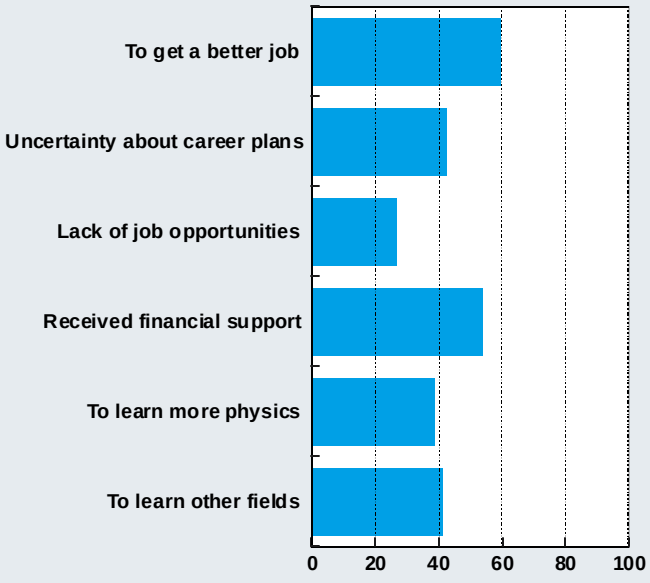
We looked at those who completed master's degrees in physics or astronomy to ascertain whether they had originally had a PhD or a master's degree as their goal. Unfortunately, the questionnaire does not have this question on it, so for many master's degree recipients we do not know if a master's degree was their original goal. However, we did ask if any of their career decisions had been influenced by family considerations. We found fourteen people who said they had dropped out of physics PhD programs because of family considerations, including needing

to work to support children and moving to a different location to be with a significant other. Twelve out of these fourteen were men. There was no other dominant reason respondents dropped out.

Reasons for Attending Graduate School

There are a variety of reasons for attending graduate school, ranging from lack of job opportunities to wanting to learn more about a specific field. We asked respondents to indicate on a checklist which factors influenced them to attend graduate school. Since people usually have more than one reason for attending graduate school, respondents could check more than one. We asked our respondents if attending graduate school was related to job or career concerns. Almost 60% of the master's degree recipients said that they attended graduate school in order to get a better job than they could have with a bachelor's degree alone **(Figure 1)**. About two out of five said that they attended graduate school because they were uncertain about career plans. More than one fourth said they were influenced to attend graduate school because of lack of job opportunities. Altogether, three-fourths of master's degree recipients said that there was at least one job-related reason that they attended graduate school. This is not surprising, since the respondents in this survey graduated during a severe international recession. Master's degree recipients who perceived that they had few job opportunities after their bachelor's degrees were more likely to get master's degrees in engineering and other sciences than in physics or in non-sciences. At least for this group, master's degrees in engineering and other sciences were seen as more job-related than master's degrees in physics and in non-sciences.

Figure 1. Factors that Influenced Physics Bachelors Who Have Master's Degrees to Attend Graduate School



Respondents could choose more than one reason.

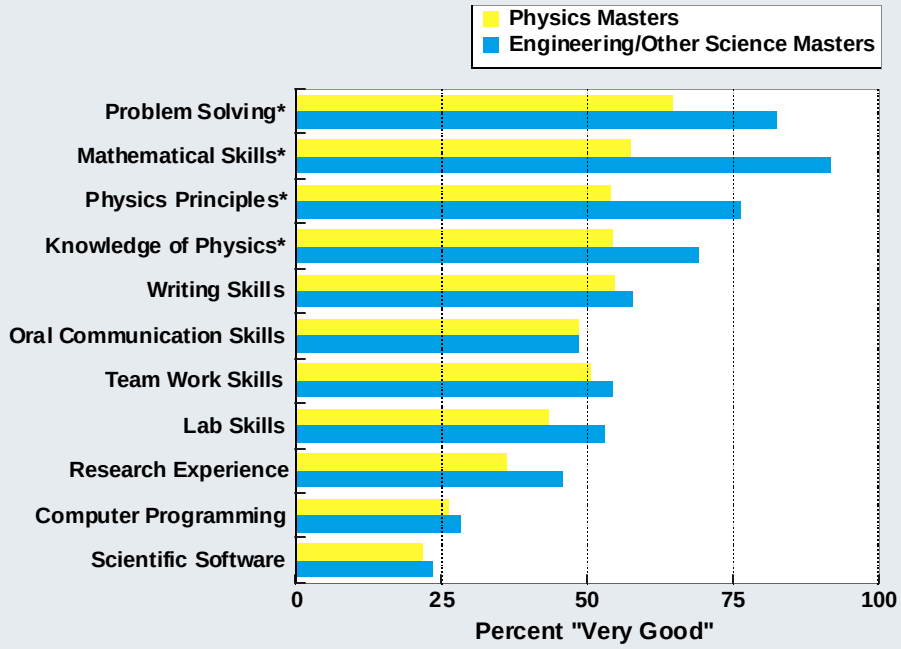
AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study.

A little more than half of master's degree recipients said they attended graduate school because they received financial support. Those who received master's degrees in physics were more likely than those in other fields to say that they went to graduate school because they received financial support.

About 40% said that they went to graduate school to learn more physics. This is about the same percentage as those who actually earned physics master's degrees. Two out of five said that they wanted to learn more about a field other than physics.

Respondents who earned master's degrees in sciences and engineering tended to start graduate school within a short time after completing their physics bachelor's degree. However, those who earned master's degrees in non-sciences delayed going to graduate school longer than those who earned master's degrees in physics, engineering, and other sciences. Non-science masters had a median of 2.2 years between earning a physics bachelor's degree and starting graduate school, while science and engineering masters had a median of four months. Seventy percent of science and engineering masters started graduate school within a year of earning their physics bachelor's degree. However, just one out of five non-science masters started graduate school within one year of completing their physics bachelor's degree.

Figure 2. Rating of Physics Bachelors Education as Preparation for Graduate School



Percentage who chose 4 or 5 on a 5-point scale where 1 = terrible and 5 = excellent.

*Differences between the two master's degree fields are significant at $\alpha \# .05$.

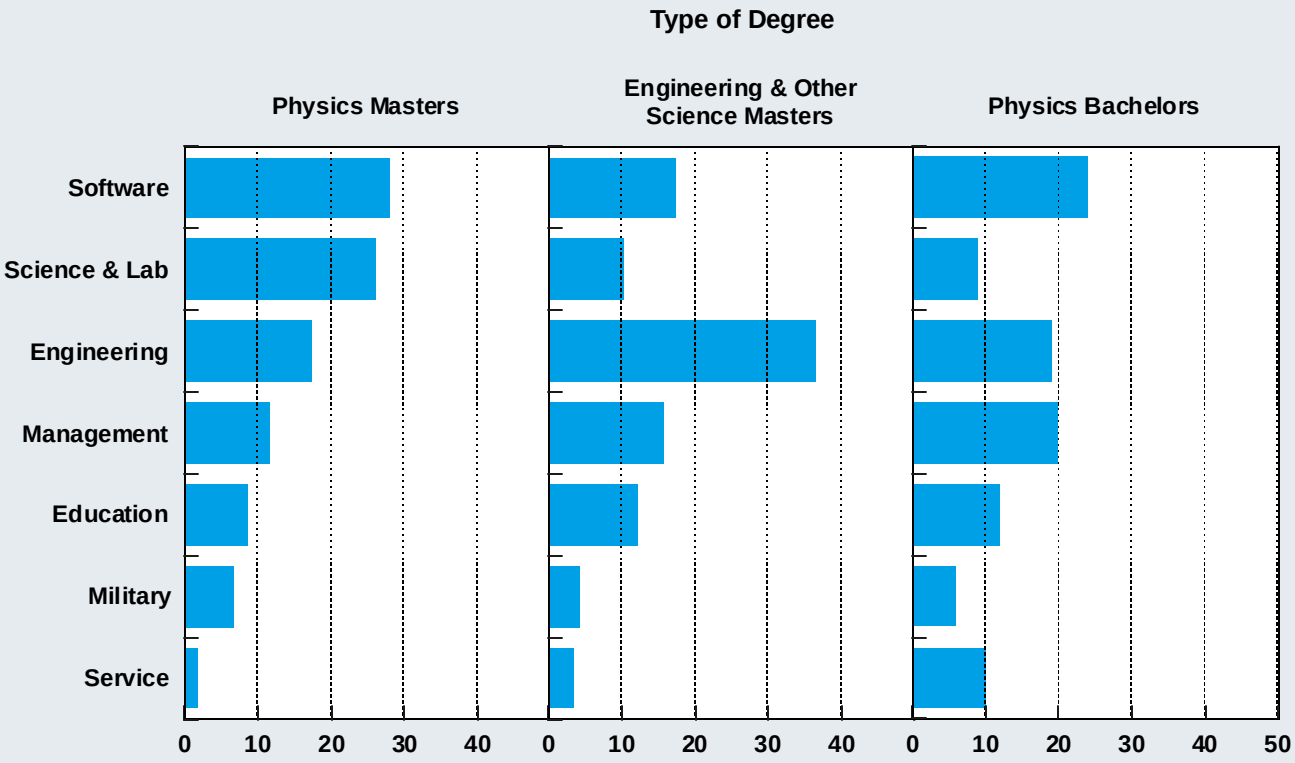
AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study.

Preparedness for Graduate School

Undergraduate physics education generally gives people a solid foundation for graduate school. Physics education emphasizes math skills, problem-solving skills, and of course, physics principles. We asked respondents to rate how well physics undergraduate education prepared them for graduate school in various areas. There are differences in these ratings according to the field of master's degree **(Figure 2)**. Respondents who earned master's degrees in engineering and other sciences were generally more positive about their undergraduate education in the areas of physics, math, and problem solving than respondents who earned master's degrees in physics. About four out of five of those who earned master's degrees in engineering and scientific fields other than physics rated their undergraduate preparation in terms of physics principles, scientific problem solving, and math skills as very good. People who got master's degrees in physics, though, were less enthusiastic about their preparation in these areas. There are similar differences for "knowledge of physics," where only a little more than half of physics masters rated their preparation as very good, but 70% of other science and engineering graduates rated their preparation as very good.

In other areas, there were no differences between physics masters and masters in other sciences and engineering. Only about one-fourth of respondents rated their programming preparation as very good, and they were similarly disappointed with their preparation in scientific software. When we examined the areas in which respondents wished they had better preparation, many mentioned computer programming, but most did not say what sort of programming experience that they wish they had obtained.

Figure 3. Field of Employment 5 to 8 Years After Receiving Physics Bachelor's Degree



AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study.

In areas such as lab skills, research experience, writing skills, oral communication skills, and teamwork skills, about 40-50% of respondents rated their undergraduate preparation as very good. However, almost one-third of respondents rated their undergraduate research experience as poor.

In summary, respondents were least happy with their programming and scientific software experience and were happier with the other aspects of their undergraduate preparation. However, those who earned master's degrees in engineering and other sciences were more pleased with their physics, math, and problem solving preparation than were those who earned master's degrees in physics.

Field of Employment

Physics bachelors work in a variety of fields, and many use their physics training in those fields (Ivie and Stowe, 2002). But how does earning a master's degree affect the job prospects of physics bachelors? For masters, field of employment varies by field of master's degree **(Figure 3)**. More than one-fourth of physics masters are employed in software jobs, and another one-fourth are employed in science or lab jobs. The third most common field of employment for physics masters is engineering. Having a physics master's degree rather than a bachelor's degree changes job prospects for these respondents. For example, less than ten percent of physics bachelors work in science or lab jobs, but these jobs are much more common for physics masters. Compared to physics masters, a higher

percentage of physics bachelors work in management. This is probably due to the fact that, at the time of the survey, bachelors had more work experience than masters.

People with master's degrees in other sciences and engineering are most commonly employed in engineering jobs. However, less than half of engineering masters are employed in engineering. Somewhat less than one-fifth of other science and engineering masters are employed in software, but most of these are *not* computer science masters. Although almost twenty percent of respondents with master's degrees work in software jobs, only eleven respondents have master's degrees in computer science. These respondents received bachelor's degrees at the beginning of the Internet boom and were able to use their flexible physics backgrounds to obtain jobs in this fast-paced industry without the formal credentials of a master's degree in computer science. The third most common field of employment for other science and engineering masters is management.

For people who earned master's degrees in non-sciences, almost one-third work in management (most of these have MBAs), almost one-fifth work in education (most of these have master's degrees in education), and about one-fifth work in service and professional jobs. These jobs include ministers, librarians, and a journalist.

Salary

Those with physics backgrounds typically earn good salaries. In 1999, the middle 50% of physics bachelors with master's degrees earned between $37,500 and $60,000. Salary is influenced by many factors, including time on the job. One major difference between physics bachelors and those who earned master's degrees is that bachelors had been employed in career-path jobs slightly longer (about 14 months) than the masters. We defined a career-path job as "a job that will help you in your future career or a job in the field in which you want to make your career" and asked respondents when they started their first career-path job. As of April 1, 1999, masters had been in career-path jobs an average of 4.6 years, and bachelors had been in career-path jobs an average of 5.8 years. In spite of this difference in experience, those respondents with master's degrees in physics, other sciences, and engineering had higher salaries than those with only physics bachelor's degrees.

To determine which other factors have effects on salary, we used models with multiple variables in them. We controlled for field of master's degree, field of employment, length of time in a career-path job, sex, and whether they have hired bachelor's level employees, work in a professionally challenging job, or used their physics bachelor's degree to obtain a career-path job. **Table 2** shows how much each factor affects salary, even when the

Table 2. Factors That Influence Salary for Physics Bachelors 5 to 8 Years After Graduation (1999)

	Amount of Increase
Working in a software job[1]	$8900
Job responsibilities include hiring bachelors level employees	$5200
Having a master's degree in engineering or other sciences[2]	$4300
Having a master's degree in physics[2]	$3900
Working in a job that is professionally challenging	$3800
Being male	$2600
Physics bachelors was helpful in getting a first career-path job	$2100
Each year of experience	$800

[1]Compared to mean salary of all respondents with bachelor's and master's degrees.

[2]Compared to having a bachelor's degree in physics.

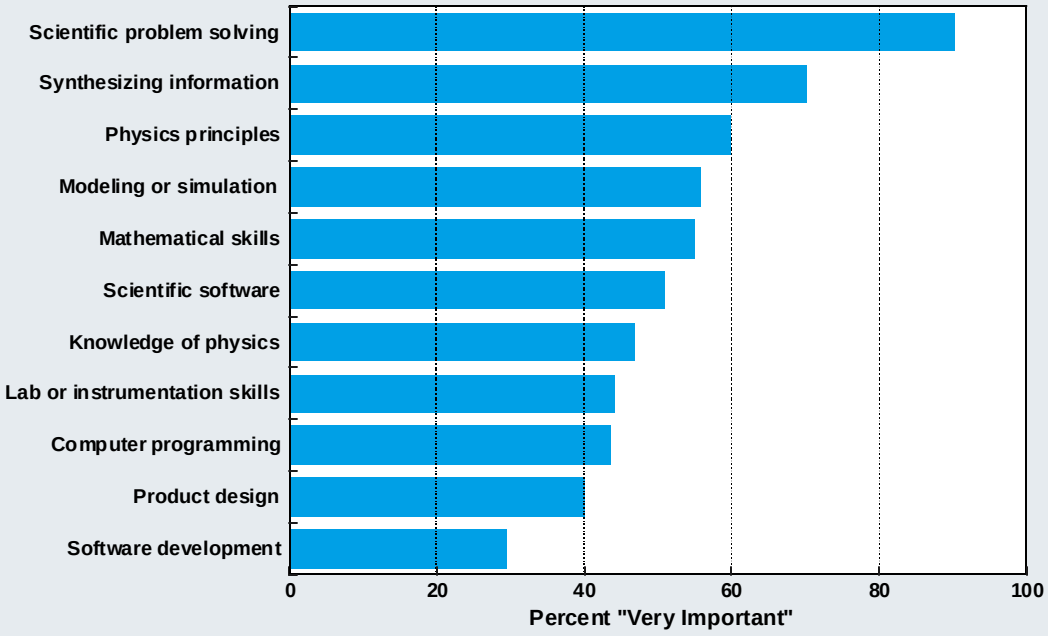
AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study.

other factors are taken into consideration. Again, having a master's degree in engineering, other sciences, or physics has an effect on salary. Specifically, those with master's degrees in physics earned $3900 more on average than those with bachelor's degrees in physics. Those with engineering and other science masters earned $4300 more on average than those with bachelor's degrees in physics. However, engineering and other science masters do not make significantly more than physics masters. These effects apply regardless of time in a career-path job, field of employment, sex, and whether they have hired bachelor's level employees, work in a professionally challenging job, or used their physics bachelor's degree to find a career-path job. In addition, having a master's degree in a non-science field does not significantly increase salary over having only a bachelor's degree in physics.

Length of time in a career-path job has a positive effect on salary, with those employed longer earning $800 more per year of experience, even controlling for the other factors in the model. On average, people working in software make $8900 more than the mean salary of all respondents. Again, this difference applies independent of the other variables in the model.

When all the variables in the model are taken into account, having hired bachelors level employees also has an effect on salary, with those who have done so making $5200 more on average than those who have not. People who say that their jobs are professionally challenging make $3800 more on average than those who say their jobs are less professionally challenging, even controlling for degree, field of employment, and the other variables in the model. People who say that having a physics bachelor's degree helped them in their search for a career-path job also make $2100 more on average than those who say it hindered them, independent of the other variables in the model. This is perhaps a reflection of the extent to which their career-path jobs are physics-related. In addition, males make $2600 more on average than females, even

Figure 4. Importance of Knowledge and Skills for Physics Bachelors Who Have Master's Degrees and Work in Science & Engineering Jobs*

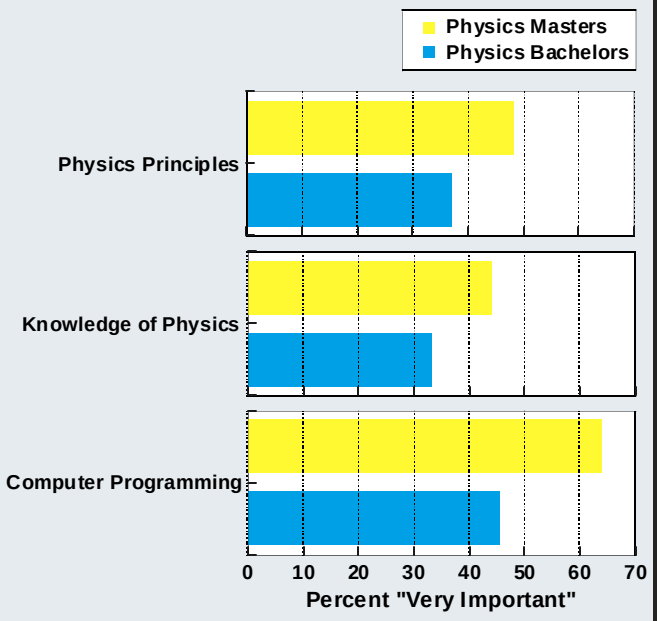


Percentage who chose 4 or 5 on a 5-point scale where 1 = completely unimportant and 5 = essential.

*But not in software jobs.

AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study.

Figure 5. Importance of Knowledge and Skills Used on the Job for Physics Masters and Bachelors



Physics masters are significantly different from physics bachelors when controlling for field of employment and time in career-path job.

AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study.

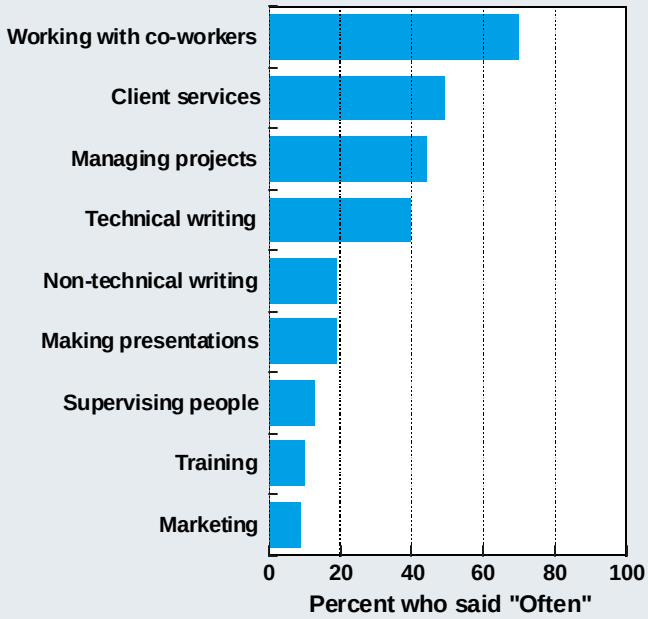
controlling for all the other factors such as field of employment and degree.

Knowledge and Skills Used on the Job

Even after earning a master's degree, physics bachelors are able to take aspects of their undergraduate education and use them on the job. We asked respondents to rate how important various items are for their principal jobs. This list of items was intended to represent skills that are directly related to physics education, such as math, problem-solving, and programming skills. As for physics bachelors (Ivie and Stowe, 2002), field of employment makes a difference in what respondents say is important. **Figure 4** shows the percentages of masters who work in science and engineering (but not software) who rated each item as very important. Among the respondents in this group, almost all indicated that scientific problem solving is important in their jobs. Synthesizing information, using physics principles, engaging in modeling or simulation, and using mathematical and scientific software skills also rated highly. This group does not do much software development, although a sizeable minority indicated that computer programming is important in their jobs.

Our analysis shows that even controlling for experience and field of employment, physics masters rate three items higher than physics bachelors **(Figure 5)**. These are physics principles, knowledge of physics, and computer programming. That is, even in the same field and having worked for the same amount of time, those with physics master's degrees say that physics is more important than those with physics bachelor's degrees. Physics masters use computer programming more than physics bachelors, and this is true even when working in the same field of employment for the same amount of time.

Figure 6. Time Spent on Job Activities by Physics Bachelors Who Have Master's Degrees and Work in Science & Engineering Jobs*



Percentage who chose 4 or 5 on a 5-point scale where 1 = none and 5 = extensive.

*But not in software jobs.

AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study.

Communication and People Skills

In addition to using math, physics, and problem-solving skills on the job, physics-trained masters also use communication and people skills. We asked respondents to rate how much time they spent using various communication and people skills at work. As with physics bachelors, the degree to which masters use these skills on the job varies with their field of employment (Ivie and Stowe, 2002). **Figure 6** shows the percentage of masters who work in science and engineering jobs (but not in software) who said they spend a good deal of time on each activity. This group makes extensive use of their interpersonal skills, with 70% reporting they spend a great deal of time working with co-workers. Almost half the respondents in this group indicated they spend a great deal of time providing services to clients. Most do not spend much time supervising people, training others, or marketing products.

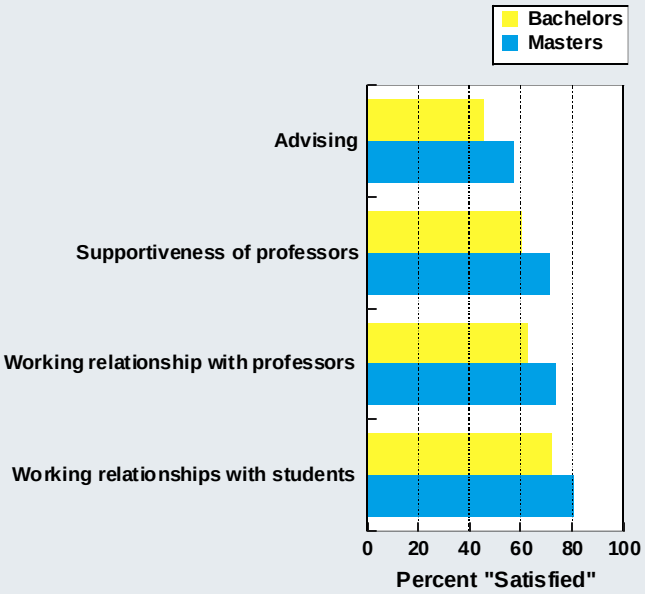
Evaluation of Undergraduate Education

We have seen so far that physics-trained masters use many of the skills they learned as undergraduates while on the job. Do these masters see the value of physics education for their careers? The answer is yes. In fact, physics-trained masters were more positive about some aspects of their undergraduate education than bachelors. Those with master's degrees were more likely to say that they were satisfied with the advising, supportiveness of physics professors, and working relationships with physics professors and other physics students than people who only had bachelor's degrees in physics **(Figure 7)**. It is possible that those with master's degrees thought undergraduate school looked better after attending graduate school, but this is unlikely. Those with only bachelor's degrees who had attended graduate school had similar evaluations of undergraduate education as those bachelors who had never attended graduate school. And both groups of bachelors were less positive than the masters, who had similar evaluations as people who had received PhDs by the time of the study. So it is possible that those with more favorable undergraduate experiences are more likely to complete a graduate degree.

Although master's degree recipients see some aspects of their undergraduate education more positively than bachelors, masters who work in science and engineering rate their physics preparation less favorably than bachelors who work in science and engineering. A larger percentage of physics bachelors than masters working in science and engineering said that their undergraduate knowledge of physics was very good preparation for a career (73% for physics bachelors; 54% for masters).

When asked if they would get another undergraduate degree in physics if they could do it all over again, almost two-thirds of all master's degree recipients said that they almost certainly would. This percentage is similar to the percentage

Figure 7. Evaluation of Undergraduate Program by Physics Bachelors and Physics Bachelors Who Have a Masters



Percentage of respondents who chose 4 or 5 on a 5-point scale where 5 = very satisfied and 1 = very dissatisfied.

Differences between bachelors and masters are significant at $\alpha \# .05$.

AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study.

who would major in physics again among physics bachelors (Ivie and Stowe, 2002). And the percentage is just as high regardless of the field of master's degree. In other words, those who earned masters in any field, even non-sciences, are very likely to say they would major in physics all over again.

Conclusion

Physics bachelors who went on to earn master's degrees generally felt well prepared for graduate school, especially those who earned master's degrees in sciences (other than physics) and engineering. One of the main reasons physics bachelors who earned master's degrees attended graduate school is to obtain a better job than they could with a bachelor's degree alone. For the most part, especially when measured by salary, those who obtained master's degrees in any science or engineering (including physics) did obtain better jobs than physics bachelors.

A higher proportion of physics masters than physics bachelors obtained jobs in science, but significant proportions of both groups were working in software jobs at the time of the survey. On the job, master's degree holders who work in science and engineering reported that they made extensive use of scientific problem-solving skills, the ability to synthesize information, and physics principles.

Furthermore, there is evidence that those with master's degrees (and PhDs) earned them because they had more positive experiences as physics undergraduates than those who did not earn graduate degrees. This perhaps best illustrates the role that a supportive undergraduate physics education can have for these graduates. Quality physics undergraduate education can increase the likelihood of earning a graduate degree, which makes a significant difference in job opportunities.

Reference

Ivie, Rachel and Katie Stowe (2002). *The Early Careers of Physics Bachelors* (College Park, MD: American Institute of Physics, Pub. Number R-433).

STATISTICAL RESEARCH CENTER LIST OF PUBLICATIONS

The Statistical Research Center, formerly the Education and Employment Statistics Division, collects data on the composition and dynamics of the scientific labor force and the education system. Below is a list of the Center's current publications along with a brief description of each. Unless otherwise indicated, single copies can be downloaded for free at *www.aip.org/statistics* or by writing to:

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A detailed analysis of faculty openings and new hires in universities and four-year colleges.

Enrollments and Degrees Report* (July 2002)
An examination of academic enrollments and degrees conferred in physics and astronomy programs nationwide.

Graduate Student Report: First-Year Students in 1999 and 2000** (January 2003)
A summary of the characteristics, subfields of specialization, sources of support, perception of undergraduate preparation, and career goals for first-year physics and astronomy graduate students.

1999 Initial Employment Report: Follow-ups of 1998 Physics and Astronomy Degree Recipients* (June 2001)
A description of the initial employment and continuing education of physics and astronomy degree recipients.

Mastering Physics for Non-Academic Careers (2001)
A detailed analysis of all the master's degree programs in physics departments in the U.S. including those that offer a masters as their highest physics degree and those that have a master's degree program in parallel with physics Ph.D. program in the same department.

Physicists in Government (April 1997)
An examination of the common career paths of Sigma Pi Sigma members with bachelors, masters and PhDs employed in FFR&DCs, federal agencies, state and local government and the active military.

Physics and Astronomy Senior Report: Class of 1999 And 2000* (June 2002) (Formerly Bachelor's Degree Recipients Report)
Looks into the backgrounds, experiences, and future plans of physics and astronomy majors at the point of graduation.

Physics in the High Schools IV (Maintaining Momentum: High School Physics for a New Millennium, 1997) (August 1999)***
An analysis and interpretation of information collected in a nationwide survey of teachers of physics at the secondary level.

Physics in the Two-Year Colleges (October 1998)
First comprehensive study of physics programs and faculty in the two-year colleges.

Roster of Astronomy Departments with Enrollment and Degree Data, 2001* (September 2002)
Detailed data for astronomy degree-granting departments in the U.S.

Roster of Physics Departments with Enrollment and Degree Data, 2001* (September 2002)
Detailed data for physics degree-granting departments in the U.S.

2000 Salaries: Society Membership Survey** (June 2001)
An analysis of the effect of factors such as geographic location, employment sector, gender, years from degree, and degree level on salary levels and salary increases. $15 for a single copy, $10 each for multiple copies. (All orders must be prepaid. Make your check payable to the American Institute of Physics and mail it to the address above.)

2000: Salaries Summary Report** (March 2000)
Only available from the web at www.aip.org/ statistics
A two-page summary that gives overall trends and salaries.

The Early Careers of Physics Bachelors (August 2002)
An examination of the employment patterns of people with no degrees other than physics bachelor's degrees, five to eight years after graduation. The report includes common job activities and skills used on the job. It also describes these physics bachelors' evaluations of how well physics education prepared them for careers.

Women in Physics, 2000 (June 2000)
Data on current and historic trends in the representation of women in physics, including comparative data on women in related fields.

Women Physicists Speak: The 2001 Study of Women in Physics (June 2002)
Findings from an international survey of over 1,000 women physicists from 55 countries. The study was conducted as part of a larger effort carried out by the International Union of Pure and Applied Physics (IUPAP).

* Published annually
** Published biennially
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