

## **Careers of Women who Study Physics: Findings from a Survey of Sigma Pi Sigma Members**

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**Overview.** In the summer of 1994, we surveyed members of the Sigma Pi Sigma national physics honor society by mail, with the goal of obtaining information about the kinds of careers former physics students pursue. Because women have historically been, and continue to be, severely underrepresented in physics, they were oversampled at a rate of five women for every two men. Their responses provide a glimpse of the range of careers which women who have studied physics pursue. The data also provide a basis for comparison with men of like abilities and educational backgrounds. In addition, since engineering is one of the most common fields of employment for physics degree recipients at the bachelor's and master's level, it is possible to examine the responses of engineers in some detail.

**General findings.** A total of 454 women and 1125 men participated in the survey. Of this total, 330 women and 913 men majored in physics as undergraduates. Although the majority of women who had earned bachelor's degrees in physics went on to earn advanced degrees, a significantly smaller proportion of women (59%) than men (73%) did so ( $p < .001$ ). Only 18% of women went on to earn PhDs (11% in physics). Among men, 36% obtained PhDs (27% in physics). Women who earned PhDs in physics took about 8.4 years after their physics bachelor's on average to complete their degrees, while men took significantly less time, 6.7 years ( $p < .001$ ). The difference was slightly smaller for the subset who had been in the workforce for less than ten years: 8.2 years for women and 7.0 years for men.

Among respondents who were eligible for employment (i.e., were employed at least part-time or unemployed but were not students and were not retired), women experienced significantly greater rates of both unemployment and part-time employment. Ten percent of women were unemployed, compared to about 4% of the men ( $p < .001$ ). An additional 10% of women and 3% of men were employed part-time ( $p < .001$ ). The remainder of this paper will focus on respondents who were employed at least part-time when they completed the survey.

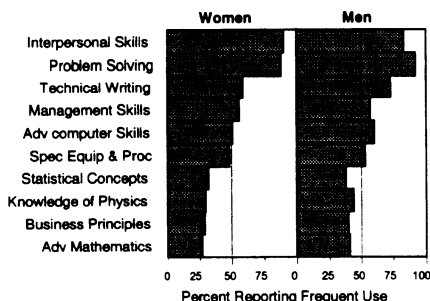
For employed respondents who majored in physics as undergraduates (186 women and 684 men), the distribution by employment sector was similar, but not identical, for women and men. Private industry was the largest employer of both groups. Large companies employed 29% of the women and 35% of the men in the sample. The next largest employment sector was education, where about 30% of women and 23% of men were employed. Government, including the military, government contractors, and federally

funded research centers, employed another fifth, approximately. Small businesses and professional firms accounted for an additional 16% for both men and women. A small percentage of respondents worked in nonprofit organizations.

Engineering was the most common field of employment for women who participated in the survey. Over a fifth of the respondents—both women and men—were employed as engineers. Management was the most common field of employment for men, and the second most common field for women. A quarter of men and one-sixth of women held management positions. About 12% of women and 18% of men held positions as research scientists, primarily in universities and government labs. Roughly equal proportions of women (10%) and men (12%) worked in higher education as teachers. In contrast, 14% of women, but only 4% of men, identified themselves as high school teachers ( $p < .001$ ). Another 10% of the respondents held computer science-related positions as software developers, programmers, systems analysts, and so on. Of the remainder, about 5% held other scientific/technical positions, and the rest worked in nontechnical fields.

When asked to rate how often they relied on various skills that may be relevant in the workplace (listed in Figure 1), women overall reported less frequent use of these skills than men did, with one notable exception: interpersonal skills. Although the vast majority of both women and men used interpersonal skills frequently, a significantly greater proportion of women (90%) than men (83%) did so ( $p < .025$ ). Admittedly, this difference is not large. Other differences, though significant, were modest also, as in the case of advanced computer skills and business principles. The most striking differences between women and men were seen in their reported use of physics knowledge, advanced mathematics and technical writing in their work ( $p < .001$  in each case). Although only a minority of men used their knowledge of physics and advanced mathematics regularly on the job, even fewer women did. About three-quarters of men and three-fifths of women used technical writing regularly. Women and men did not differ significantly in the frequency with which they used problem solving, statistics concepts, management skills, or specialized equipment in their work.

**Figure 1. Skills Used Frequently  
In the Workplace, by Gender.**



Less than half of the respondents felt that their careers had “gone pretty much in the direction” they intended. Forty-seven percent of men and 39% of women agreed with this statement. Nevertheless, relatively few would get a degree in a different field if given the chance to do it over again. However, women were more likely to say they would do so than men were: 26% of women and 16% of men would get a degree in a different field ( $p < .002$ ). And, while the majority agreed that their undergraduate physics education provided a solid background for their careers, a significantly smaller proportion of women (60%) than men (75%) felt this way ( $p < .001$ ). In light of these differences, it should not be surprising that a greater percentage of women (54%) than men (38%) wished that they had gotten more useful career counseling as undergraduates ( $p < .001$ ).

**Focus on engineers.** Fifty-six women identified themselves as engineers. Of these, 57% had majored in physics as undergraduates. Another 30% had majored in engineering. The breakdown for the 180 men engineers was similar. As in the larger sample, significant gender differences in degree attainment were found. Fifty-three percent of women engineers stopped at the bachelor's level, compared to 35% of men ( $p < .02$ ). About two-thirds of women with advanced degrees (virtually all at the masters level) earned them in engineering. This was true for just under half of the men in this group.

Over 95% of the engineers in the sample (both women and men) who were employed held full-time positions. No data were available on the number of unemployed engineers who participated in the survey. For both groups, computer systems/software engineering and electrical/electronics engineering dominated. Together, they accounted for about half of the engineering specialty areas cited. Aeronautical/astronautical engineering ranked third among women, followed by mechanical, nuclear and industrial. Men cited aeronautical/astronautical, mechanical, and nuclear engineering with equal frequency. Industrial engineering was mentioned by less than 5% of men.

Not surprisingly, three-quarters of the engineers worked in private industry. Virtually everyone else worked in government. Nearly half of the engineers worked in the manufacturing sector (including computer hardware and software manufacturing). Another fifth worked for employers whose primary function was research and development. About 10% of women engineers and 15% of men were employed in service-producing industries, including transportation, utilities, and communications. Another 15% of women and 10% of men worked in or owned companies that provided direct services in the form of engineering consulting, equipment repair, health care, and business support.

Interestingly, three-quarters of women engineers reported that they were working in the field of their highest degree, despite the fact that less than 40% had earned their highest degree in engineering. Significantly fewer men, about half, said they were working in their highest degree field ( $p < .01$ ). This seeming contradiction on the part of women in particular may be a function of the types of courses, internships, and research opportunities individuals had as students. Indeed, there is evidence to suggest that women's and men's educational experiences had differential impacts on their careers. For example, while three-fifths of both groups reported that they had participated in internships as students, 88% of women and 75% of men who had had such experiences found them helpful in obtaining their first positions ( $p < .125$ ). More strikingly, Two-thirds of women and half of men reported that they had participated in extracurricular activities, and of these 57% of women but only 33% of men had found them useful ( $p < .02$ ). Exactly what the extracurricular activities entailed is not known.

Just as we saw in the full sample, a greater proportion of women than men engineers relied on interpersonal skills frequently as part of their job (91% of women, 80% of men,  $p < .055$ ). Men and women did not differ markedly in their use of the other skills, with the exception of statistical concepts. Half of women and a third of men reported using statistical concepts frequently ( $p < .065$ ). These findings for women engineers, while suggestive, are inconclusive and warrant further research.

