What do women do with engineering degrees?

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Abstract—This descriptive paper makes use of national-level data from the National Survey of College Graduates, 2003. These data, collected by the U.S. Census Bureau for the National Science Foundation, provide insights into the current and previous work experiences and career outcomes for people who work in science and engineering fields or who possess science or engineering masters or bachelors degrees. These are ideal data to examine the extent to which women with engineering degrees stay in the field, go to graduate school, or leave from the field and to what extent their experiences differ from those of their male peers. This paper analyzes outcomes for respondents who earned a first bachelors degree in engineering between 1980-2002. The analyses here represent a potential starting point for more detailed research about the career outcomes for women engineers.

Introduction

Past research has described attrition of women from college engineering programs (Seymour and Hewitt 1996 and Frehill 1993) but to date there has been little systematic research on career outcomes for women in engineering after they earn their bachelors degrees. McIlwee and Robinson's 1992 volume included data from a survey and interviews with women working in engineering jobs in California and concluded that most women experienced sexism. A national survey by the Society of Women Engineers (SWE) in 1991-1992 revealed that women were more likely than men to indicate that they felt that women had been overlooked for promotional opportunities (Eng 1993 and Frehill 1997). Eng noted that the pay of engineers reported in the SWE survey was near parity until about age 30, at which time, a gap between women and men grew and widened with age, a finding that she posited might disappear as more women entered engineering. Morgan's (1997) analysis of these data suggested that cohort effects were responsible for the gap in earnings.

The larger labor market in which engineers find themselves after completing a bachelors degree has been undergoing rapid and accelerating changes. On the one hand, a technical education in science and engineering (S/E) has become even more important (National Academies 2006a). On the other hand, many young people are concerned about the "outsourcing" of S/E jobs and employers are increasingly concerned about the quality of the labor force (National Academies 2006a) and whether the U.S. labor force will be able to remain competitive in a global environment.

Regets' (2006) recent NSF InfoBrief provides some findings from NSF's full SESTAT[1] database system to show:

- Just under half (49%) of those who had earned bachelors degrees in S/E fields by 1994 had gone on to earn a higher degree by 2003.
- Only 8.4% earned masters and 4.2% doctoral degrees in the same field in which they had earned a bachelors degree.

[1] SESTAT is the Scientists and Engineers Statistical Data System.

- Another 5.9% earned a masters or doctoral degree in another S/E field.
- Among engineers, the percentage who earned a subsequent degree was lower (42.1%) than in all other S/E fields except mathematics and computer science (39%).
- Even among those who pursued a non-S/E advanced degree, a majority indicated that their S/E knowledge was critical for their subsequent jobs.
- About 90% of bachelors-degreed engineers within nine years of graduation reported that their job was related to their degree.
- Engineers were more likely than those in other S/E fields to indicate that their job was related to their degree throughout their careers.
- Less than one-third of S/E bachelors degree recipients were working in jobs formally defined as S/E yet two-thirds of these indicated that their S/E degree was related to their current job in 2003.

While these are interesting general findings, in this paper, I drill down into the same data Regets used to provide similar descriptive analyses of engineers and, in particular, women engineers. In this paper I present some preliminary analyses of national-representative data on engineers in the U.S. labor force. The data are from the National Science Foundation's biannual data collection called the National Survey of College Graduates (NSCG). These data will show that there are some important similarities between women and men engineers once they are in the labor market. Significantly, though, these data provide some evidence for what many have known anecdotally all along: that women are more likely to leave engineering post-graduation than are men.

Data and Methods

The NSCG has been conducted since 1993. The survey provides important data about the career outcomes of those who receive either a bachelors or masters degree in an S/E discipline (or a related field) living in the United States. In addition, the sample for these surveys has included people employed in S/E regardless of their bachelors degree field of study. The survey uses a stratified sampling plan with eight demographic groups that capture disability status, race/ethnicity, and citizenship status. In addition, the sample is also stratified by highest degree (bachelors, masters or doctoral degree), occupation (30 levels) and sex. The 2003 170,797 sample size reflects a 85% response rate. Data collection was completed by the U.S. Census Bureau between October 2003 and August 2004 using the week of October 1, 2003 as a reference week. Full details concerning the sampling and imputation issues are available from the National Science Foundation (Kang 2007).

In this paper, since I am interested in understanding the career outcomes only of engineers, I chose the 22,748 cases for which individuals reported a first bachelors degree in engineering[2] (with engineering as either the major, n = 22,274 or as a second major or minor, n = 274). The analyses in this paper will be generally descriptive, with no attempt to infer causality. Figure 1 shows the percentage of engineering bachelors degree recipients who reported that they were in an engineering job in 2003 plotted against the years since their bachelors degree.

[2] "Engineering technology" is not included in this paper. NSF places "engineering technology" in the "S/E related" category.

As shown in Figure 1 (which plots the data from Table 1), women are slightly less likely than men upon receipt of their degrees to be employed in engineering but there is a very narrow gap up until about five years after they receive their degrees. Both men and women leave engineering within the first ten years of earning a degree, but women do so at a more rapid rate than do men. But as the percentage of men who no longer report working in engineering levels out, women continue to leave the field. It is important to note that this is a cross-sectional analysis of the data, therefore, as shown in an earlier piece by Morgan (1998) there could be cohort effects accounting for these differences.

Figure 1. Engineering Bachelors Degree Holders Reporting an Engineering Job in 2003

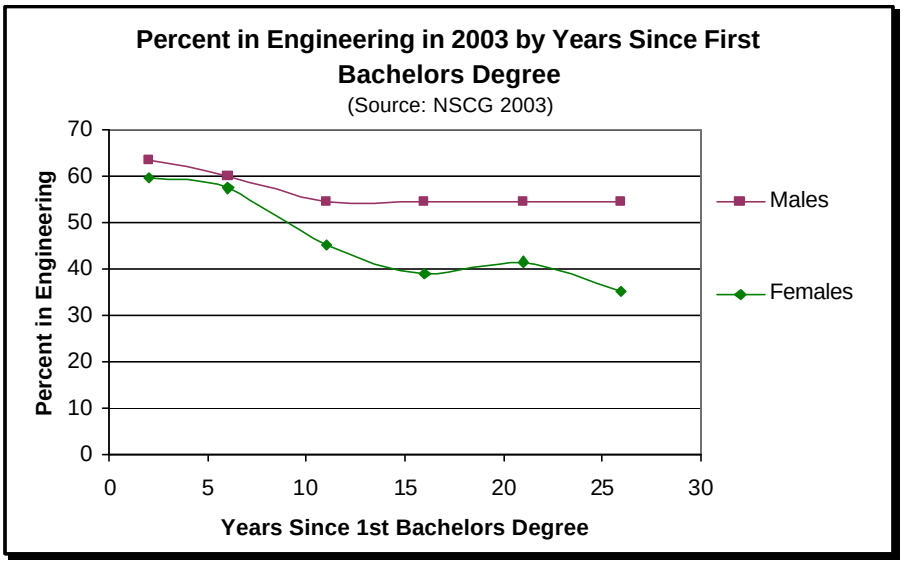


Table 1. Percent of Respondents by Degree Cohort Who Indicated "Engineer" as Their Current Job in 2003

	Female	Male	Total
1975-1979	35.2	54.3	52.8
1980-1984	41.4	54.4	52.6
1985-1989	38.9	54.3	51.6
1990-1994	45.3	54.3	52.5
1995-1999	57.5	60.0	59.4
2000 and later	59.6	63.5	62.3

Because there could be some important cohort effects impacting, especially, women who had earned their degrees prior to the 1980s, subsequent analyses in this paper are limited to those in the latter two cohorts shown in Table 2. This limitation omitted 294 females and 7,231 males who had reported earning a first bachelors degree in engineering subsequent analyses.

Table 2. Degree Cohorts by Sex, First Bachelors Degree

	Females		Males		Total	
Pre-1980	294	8.5%	7231	37.5%	7525	33.1%
1980-1994	1632	47.3%	7890	40.9%	9522	41.9%
1995-2002	1525	44.2%	4176	21.6%	5701	25.1%

Results

Table 3 shows the demographic characteristics of the restricted set of engineers used in these analyses (3,157 women and 12,066 men who earned their first degree in engineering in 1980 or later). Women were less likely than men to be employed and more likely to be "not in the labor force" (10.2% vs. 1.9%). Women were three years younger on average than men, were less likely to have children and if they did have children had fewer children on average than did men. Finally, women and men were distributed across the six engineering disciplines in slightly different proportions.

Table 3. Demographic Characteristics of Respondents Who Earned a First Bachelors Degree in Engineering in 1980 or Later

	Females	Males	Total
Age - Mean and (std. dev.)	33.0 (7.2)	36.1 (7.5)	35.5 (7.6)
Labor force status			
Employed	84.8%	95.0%	92.9%
Unemployed	4.9%	3.1%	3.5%
Not in labor force	10.3%	1.9%	3.6%
Race/Ethnicity			
American Indian	1.4%	1.1%	1.2%
Asian	22.9%	22.7%	22.7%
Black/African American	9.4%	5.2%	6.1%
Hispanic/Latino/a	11.0%	8.6%	9.1%
White	68.0%	72.0%	71.2%
Marital status			
Married*	64.8%	73.7%	71.9%
Widowed	0.5%	0.2%	0.3%
Divorced or separated	5.3%	3.5%	3.9%
Never married	29.4%	22.6%	24.0%
Number of children			
No children aged 18 and under	56.8%	46.8%	48.9%
Average children 18 and under among those with children	1.8	2.0	1.9
Engineering field of bachelors degree			
Aerospace, aeronautical, and astronautical	4.8%	4.6%	4.7%
Chemical	16.1%	8.6%	10.1%
Civil and architectural	15.1%	12.8%	13.2%
Electrical and computer	27.1%	35.3%	33.6%
Industrial	9.1%	4.7%	5.6%
Mechanical	14.0%	22.5%	20.7%
Other	13.8%	11.6%	12.0%
Sample size (n)	3,157	12,066	15,223

Notes: * or living in a marriage-like relationship

There were several variables of interest in describing career outcomes for the women and men engineers. The variables discussed here are by no means an exhaustive list of career outcomes measures included in the NSCG. Following Regets' (2006) approach, I first examined the subsequent education that engineers reported, shown in Table 4. Female and male engineering graduates were equally likely to pursue subsequent education beyond the bachelors degree. Among those who did earn a post-bachelors degree, a majority of those did so in engineering with 70.1% of women and 72.0% of men earning either a masters or Ph.D. in engineering. Men

were more likely to report a doctoral degree than were women, while women more likely to report earning a masters degree than men.

Another 10.1% of women and 12% of men reported earning an MBA as their highest degree among those who had reported pursuing post-bachelors training. An additional 17.1% of women and 12.7% of men who went beyond the BSE indicated that they earned a higher degree in another S/E area. Finally, while anecdotal evidence has long emphasized that engineering graduates pursue other professional fields like medicine, law and education, the NSCG data indicate that these are not very common among BSE recipients of either sex.

Table 4. Educational Outcomes

	Females	Males	Total
Bachelors in Engineering w/no higher degree	55.8%	56.1%	56.1%
Education beyond the BSE			
Masters, Engineering	42.5%	37.6%	38.6%
Ph.D., Engineering	27.6%	34.4%	33.0%
Masters, other S/E or related	10.0%	7.6%	8.1%
Ph.D., other S/E or related	7.1%	5.1%	5.5%
Business (Master's or 1st professional)	10.1%	12.0%	11.6%
All other	2.7%	3.4%	3.2%
Medicine	0.5%	0.7%	0.7%
Law	0.6%	0.7%	0.7%
Education (Masters and doctoral degrees)	0.4%	0.2%	0.3%
N (with post-bachelors degree)	1,394	5,296	6,690

Another set of variables of interest consisted of features of the work that people reported. In addition to reporting a particular job field, respondents reported whether or not they engaged in 14 different work activities for at least 10% of their time on the job. The survey then asked individuals to name the top two such activities. Table 5 and Figure 2 show the responses to this item by gender and by job (i.e., engineer versus non-engineer) for the respondents who reported earning a first bachelors degree in engineering after 1980. "Administrative activities" included "Accounting, finance and contracts," "Employee relations," and "Management or supervision of people/projects." I included in the "Engineering" category the following activities: "Applied research," "Basic research," "Development," Design," "Quality or productivity management," "Computer applications," "Production, operations, and maintenance." The other three activities are as reported in the original data.

Women and men who indicated that they were engineers were similarly likely to report a range of engineering activities (see Figure 3) as their primary work activity. It is important to note, however, that another 22.2% of females and 22.9% of males who reported various administrative activities as their primary work activity had also identified themselves as holding an "engineering" job. Likewise the remaining 8.3% of female engineers and 7.2% of male engineers reported primary work activities that were not specific engineering tasks. Among those who reported that they were no longer in engineering, it is notable that almost half of women and more than half of the men reported primary work activities that could be seen as engineering tasks. Women appear to be a little less likely than men to report administrative tasks as non-engineers but the most noteworthy gap is in the percentage of females that report teaching (8.5%) versus males (3.9%).

Table 5. Percent Reporting Each Type of Primary Work Activity as Their "Top" Activity

	Engineers		Non-Engineers	
	Females	Males	Females	Males
Administrative and related	22.2	22.9	29.9	31.4
Engineering	69.4	69.8	49.1	54.5
Sales, purchasing, and marketing	2.1	2.5	9.4	8.0
Teaching	3.4	2.9	8.5	3.9
Other	2.8	1.8	3.1	2.3
n	1628	7808	1176	5282

Figure 2. Primary Work Activity of People Who had Earned a First Bachelors Degree in Engineering in 1980 or Later

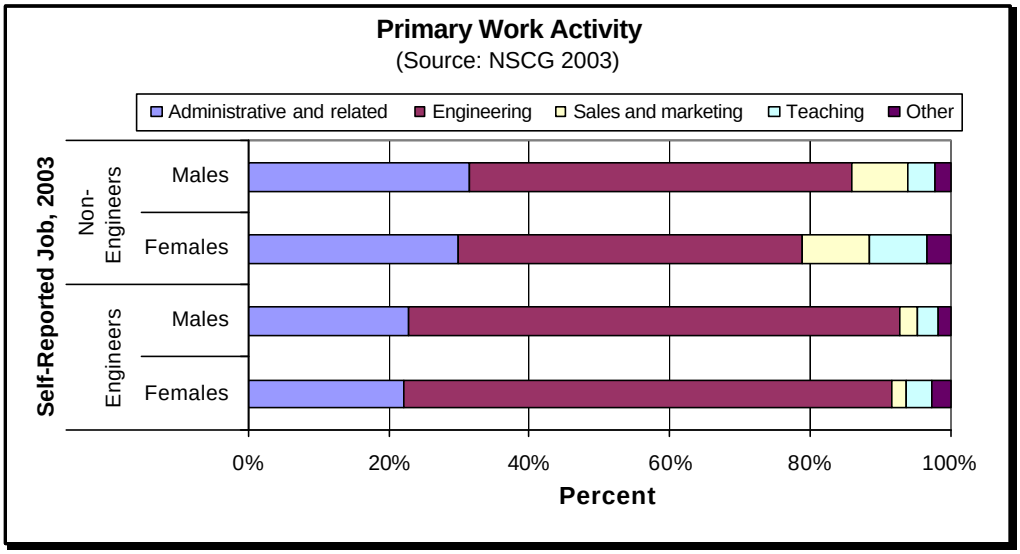
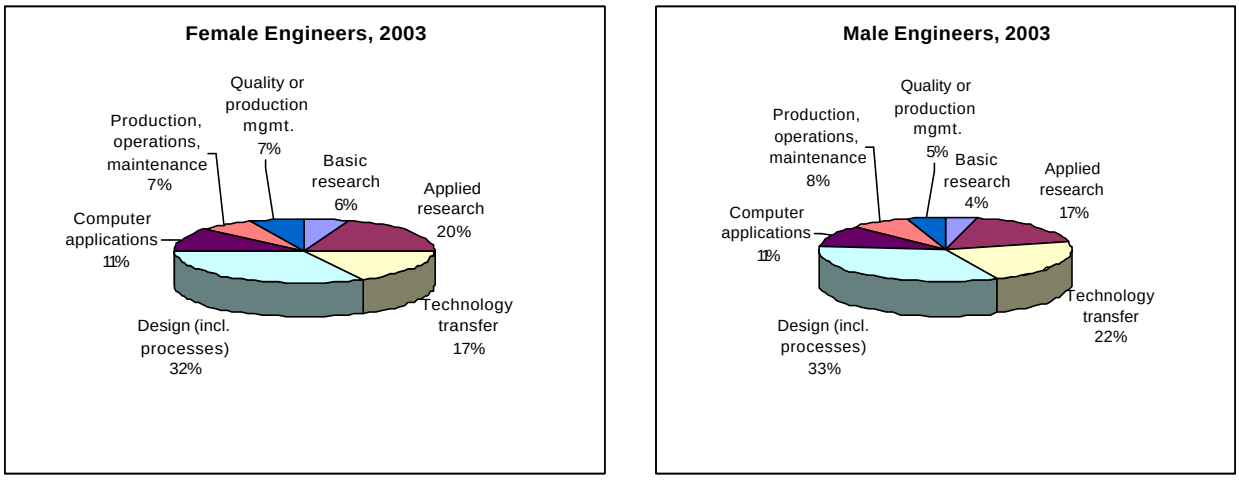


Figure 3 shows the different types of work activities that had been aggregated, above, as "engineering" by sex for respondents who self-defined their occupation as "engineering" in 2003. As shown in these pie charts, there are few meaningful differences in the kind of primary work activity reported by female and male engineers. Women were slightly more likely to indicate that they did applied research (20%) versus men (17%) but men were more likely to report that they were involved in what I have labeled as "technology transfer[3]" (22%) versus women (17%). Men and women were fairly equally likely to report that their primary work activity was computer applications, design, production, operations or maintenance, quality or production management, or basic research.

[3] The NSCG codebook indicates this as "Development – using knowledge gained from research for the production of materials, devices."

Figure 3. Engineering Work Activities of Engineers, 2003



For what kinds of employers did men and women engineers work? Women engineers were slightly more likely to work in the government, 4-year colleges, and non-profits than were men and men were slightly more likely than women to be employed in private, for-profit companies. The sex gap in the type of employer is more pronounced among non-engineers than among those who reported that they worked as engineers. Only half of women non-engineers worked for for-profit companies versus 62% of male non-engineers. Female non-engineers, like female engineers, were more likely than men to work for government organization, colleges, and non-profits. All but a few of those respondents who indicated that they were working in pre-K-12 education (85 of the 89) indicated that they were "non-engineers." Non-engineers of both sexes were also more likely than engineers to report that they were self-employed.

Table 6. Types of Employers of Engineers, NSCG 2003

	Engineers			Non-Engineers		
	Females	Males	Total	Female	Male	Total
Self Employed	8.3%	8.5%	8.5%	11.2%	12.0%	11.8%
Private, for-profit	56.4%	60.8%	60.0%	50.0%	62.0%	59.6%
Government, including military	19.1%	17.7%	17.9%	16.8%	13.0%	13.8%
Pre-K - 12 education	0.1%	0.0%	0.0%	3.5%	0.8%	1.3%
2-Year colleges	0.2%	0.2%	0.2%	0.9%	0.3%	0.4%
4-Year colleges, medical schools, and university-affiliated research institutes	10.6%	8.1%	8.6%	10.2%	7.2%	7.8%
Non-profit, other	5.3%	4.6%	4.7%	7.5%	4.7%	5.2%
N	1,768	7,597	9,365	1,288	5,014	6,302

Conclusions

The results here indicated that women are less likely than their male peers with bachelors degrees in engineering to be working in engineering after receiving their bachelors degree and that the sex gap increases with older cohorts. Male and female engineers were quite similar in the types of work activities and workplaces in which they worked, with women a little more likely to be employed in government and educational settings than men. Bachelors degree holders of both sexes who were employed in Pre-K-12 education were likely to indicate that they

were in non-engineering occupations. Interestingly, however, even among the respondents who did not say that they were in an engineering occupation, about half of the women and just over half of the men reported a primary work activity not entirely outside the kind of work performed by engineers (i.e., the seven work activities available in the NSCG dataset, shown in Figure 3).

While male and female engineering bachelors degree recipients were equally likely to pursue post-graduate studies, males were more likely than females to earn doctoral degrees in engineering while females were more likely to earn masters degrees. Males and females were equally likely to report earning graduate credentials in engineering. Among those who indicated that they had earned graduate degrees, men were slightly more likely to pursue business (12%) than women (10%) but women were more likely than men to move into other S/E fields for either masters or doctoral degrees (17.1% of women versus 12.7% of men). A small percentage of engineers (2.7% of women and 3.4% of men) pursued graduate studies in fields outside of S/E or business, in the professional fields of law, medicine or education.

In short, while there are some key differences in the career outcomes shown here for women and men with bachelors degrees in engineering, there were quite a few similarities between the sexes. The key divergences lay in the widening gap between women who are no longer engineers versus men who no longer say they are in engineering. These differences need greater attention. The ways in which family formation issues play a role in women's engineering career outcomes also deserves closer attention than that which was given here. The National Survey of College Graduates provides a rich source of data for those interested in understanding what happens after people earn engineering degrees. This paper has merely scratched the surface of these important issues.

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