Retention of Recent Women Engineering, Mathematics, and Science Graduates in the Workplace

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1 Introduction

This study was initiated in response to several conversations the first author, Dr. Parker, had with women who were either nearing graduation from the Civil and Environmental Engineering (CEE) program at the University of Wisconsin-Platteville (UWP) or had recently begun working in the engineering workplace. These particular women were above average students, had had summer engineering internships, had above-average communication skills, and had excellent personalities. However, they were either quite apprehensive about entering the engineering profession or were dissatisfied with their current jobs.

These women cited various reasons, including lack of interaction with co-workers, dislike of the cubicle syndrome, work that was too structured, etc. Certainly, the same complaints are heard from male students and recent male graduates, but due to the fact that these conversations occurred within the space of a few weeks and that they were so similar, Dr. Parker was curious whether these were merely interesting anecdotes or were indicative of a larger trend.

To investigate this potential trend, we have created and administered a survey to 303 recent women engineering, mathematics, and science graduates from UWP. This paper introduces the survey we created and analyzes and assesses the results.

2 Creation of the Survey

The primary intent of the survey was to determine the fraction of women graduates from the College of Engineering, Mathematics, and Science (EMS) at UWP who were retained in the SMET (Science, Mathematics, Engineering, and Technology) workplace. A variety of questions using a variety of formats were used to help determine which factors impacted the decision of women to be retained in the SMET workplace.

We investigated two groups of factors which might impact a woman's decision to remain in a SMET workplace. The first group of factors dealt with determining the reasons that survey respondents pursued a SMET degree in the first place. These factors were adapted directly from the work of Seymour and Hewitt (1997), who identified the most common

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factors influencing a student's decision to pursue a SMET degree. Seymour and Hewitt noted that the second most commonly cited reason for students to switch from SMET disciplines was choosing that major "for the wrong reasons." Inappropriate reasons suggested by Seymour and Hewitt's study include proficiency in math and science in high school and pressure from parents. We were curious whether the factors that influenced a woman's choice to pursue a SMET major might influence the retention of women in the workplace. In other words, perhaps women who were not retained in the SMET workplace were more likely to have chosen a SMET major in the first place for the "wrong" reasons.

The second group of factors dealt directly with influences from the SMET workplace that might impact a woman's decision to remain working in a SMET field. This set of factors included the availability of child care, whether the respondent had a mentor, the ratio of female:male professionals in their office, whether they felt their job was rewarding, whether they felt their work was valued, etc.

Respondents were allowed to provide their names or to remain anonymous. If they were willing, they could share their e-mail address which allowed them to take part in analyzing the survey results.

We relied on the book "Your Opinion, Please" by Cox (1996) to construct the survey, and had the survey validated by women co-workers. A copy of the survey is included in the Appendix.

3 Survey Distribution

The survey was distributed to 303 women who graduated from the College of EMS between 1991 and 2001. A letter of introduction was included, which is also provided in the Appendix. A business-reply envelope was included.

4 Results and Discussion

119 surveys were returned, which represents a return rate of 39%. This is considered to be a very high return rate, which we feel indicates a strong interest in the subject matter by the respondents. In this section, we highlight various aspects of the collected data. A summary of the data collected is contained in the Appendix.

A breakdown of the return rate with respect to major is provided in Figure 1.

FIGURE 1

Surveys Returned - Majors
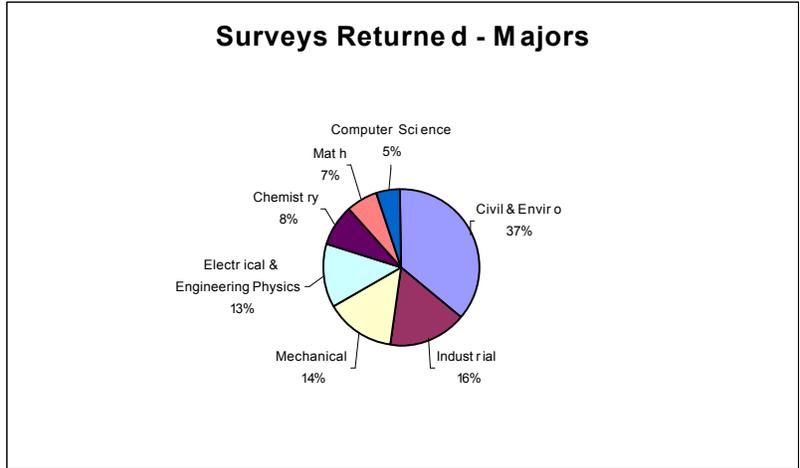
The primary goal of this survey was to estimate the retention rate of recent women graduates in the SMET workplace. Only 23 of our respondents (19.3%) "were not working in a job directly related to their major." We felt that this was an encouraging number, although we do not have any numbers for comparison to male graduates from UWP or for men or women graduates from other institutions.

4.1 Impact of reasons for pursuing a SMET degree

We first investigated whether the respondent's decision to leave a SMET career may have been influenced by choosing a SMET degree for the "wrong" reasons in the first place. Results are shown in Table 1. The values in the 3 middle columns represent the percentage of respondents who either selected "agree" or "strongly agree" corresponding to each statement. The 'p' value in the last column represents the results of a z-test on those who are retained and those who are not retained.

TABLE 1
Reasons for pursuing a SMET degree

Statement	All Respondents	Retained	Not Retained	p
I have always been interested in how things work.	85.7%	84.4%	91.3%	0.394
I have always enjoyed "tinkering" and building things.	71.4%	71.9%	69.6%	0.826
Family or friends actively encouraged me.	73.1%	74.0%	69.6%	0.670
Starting salaries in these fields are relatively high.	63.9%	63.5%	65.2%	0.881
I felt pressure to pursue a technical degree.	17.6%	12.5%	39.1%	0.003
The job market in these fields is generally healthy.	75.6%	75.0%	78.3%	0.744
I excelled in math and science in high school.	91.6%	93.8%	82.6%	0.084
I wanted to make a difference in people's lives.	63.2%	63.5%	56.5%	0.533

The only statistically significant result was that the non-retained women were more than three times likely to have felt pressured to pursue a technical degree than retained women.

Although in retrospect, the word "pressure" may be too vague, this result suggests that placing pressure on women may be instrumental in causing them to choose a SMET discipline and may even cause them to be retained in that major; however, eventually their lack of interest in the field "catches up" with them and they leave the SMET profession. The survey was not designed to determine whether these hypotheses are true.

The data also suggest that the non-retained respondents may have been slightly less proficient in math and science in high school. This is noteworthy, because we certainly don't want young people enrolling in engineering solely because they excelled in math and science, yet we must remember that proficiency in these subjects is often a necessary condition for success in SMET fields.

Some of the written responses were directed at reasons for choosing a SMET career in the first place. One especially enlightening response was this: "When I chose to go into the engineering field, I looked at my strengths, but I did not consider my personality." Another non-retained woman wrote, "People also told me to become an engineer, so I did even though I had no idea what an engineer did."

4.2 Impact of job-related factors

We analyzed various fill-in-the-blank questions and Likert-scale statements to determine which aspects of the engineering workplace might influence the decision to leave or to stay.

Results from the fill-in-the-blank statements are shown in Table 2.

TABLE 2
Workplace characteristics for retained and non-retained respondents

Statement	All Respondents	Retained	Not Retained	p
Child care is/was provided by respondent's employer	4.8%	3.3%	15.4%	0.023
Number of hours worked per week	43.1 hours	42.8 hours	45.2 hours	0.048
Number of hours per day spent working alone	5.2 hours	5.2 hours	5.3 hours	0.407
Fraction of engineers or scientists who were women	16.4%	16.7%	12.1%	0.583
Respondent had/has a mentor	29.2%	29.0%	30.8%	0.870

The responses to the first question in Table 2 are especially interesting since they disagree with our "gut feeling." In effect, those who were not retained in the engineering workplace did so despite having significantly more access to on-site child care.

Table 2 shows that on average, the non-retained respondents had significantly longer workweeks (p = 0.048) than retained respondents. Also, respondents spent

approximately 2/3 of their day working alone with no significant difference between the retained and non-retained women. Two respondents (both retained) reported spending 10 hours per day working alone in their 50 hour workweeks. One respondent reported the following.

> It's been a blessing having the job I do right now. It has, however, steered me away from what I thought would be a suitable job for me. I find it terribly difficult to work alone in a cubicle and not consistently interacting with others. I do not enjoy working primarily at a computer. I am sincerely considering either a career change (become a rancher, an adventure - seeker, something outside!!) or further study (partly to go back to school b/c I enjoy learning or take my deep knowledge in the mission field.)

The average workweek lasted 43.1 hrs. The maximum number of hours worked per week was 65 and the median workweek was 40 hours. When asked "what do you like least about your job," seven women mentioned the long hours required, and one specifically mentioned the uncertainty of the number of hours that might be required on any given day. One woman stated the following:

> My company encourages involvement in civic organizations as well as professional ones. Often times there are city/town/county board meetings related to our projects we must attend during the evenings. Engineering is not simply a 9 to 5 job. This, in combination with the stress of the position, makes it very difficult to juggle work and home life. My company does have a few female engineers who work part time so that they can stay home with their children a couple of days a week. However, this is frowned upon by several of our male counterparts because they get frustrated when situations arise and they need something from these part timers on their day off.

The fourth question in Table 2 was asked to determine the number of instances where women might be viewed as a "token" female. Kanter (1977a, 1977b) appears to have coined the term "tokenism," and defined token members in terms of a numeric imbalance: a token member is a member of a subgroup that represents less than 15% of the whole group. (An interesting analysis by Yoder (1991) looked at three factors in addition to numeric imbalance, including gender status, occupational inappropriateness, and intrusiveness.) Results from our study showed that 47% of the retained women and 67% of the non-retained could be considered "token" women in their workplace. There was not any significant difference in the fraction of those who were retained and those who were not retained.

The statements tested in Table 3 were phrased as statements to which the respondents were to rank on a Likert scale. The statements are phrased in the present tense in Table 3, but were phrased in the past tense in the portion of the survey directed at non-retained women. The following statistical analyses are limited by the fact that only 13 out of the 23 non-retained respondents filled out the corresponding set of follow-up questions. (93 of the 96 who reported to be still working in a SMET field properly filled out the additional questions.)

TABLE 3
Factors influencing workplace retention – percent agreeing with each statement

Statement	All Respondents	Retained	Not Retained	p
My salary is too low	46.2%	49.5%	23.1%	0.074
The social interactions in my workplace are rewarding.	75.5%	74.2%	84.6%	0.413
My job is challenging.	89.6%	89.2%	92.3%	0.735
My employer allows flexible work hours	77.4%	81.7%	46.2%	0.004
My job is not rewarding.	13.2%	12.9%	15.4%	0.805
I make valuable contributions to my workplace.	89.6%	91.4%	76.9%	0.109
My work is not valued by my superiors.	10.4%	8.6%	23.1%	0.109
Balancing family & work is the most challenging aspect of my job.	42.3%	44.0%	30.8%	0.367

We found it interesting that women who were no longer working in the SMET workplace did not reinforce several popular stereotypes. For example, Table 3 suggests that salary, balancing work and family, and rewards and challenges in the workplace were not significantly different for those who were not retained than for those who were retained. However, the lack of flexible work hours was noted by significantly more of the non-retained than of the retained, although whether this was a *cause* for their leaving cannot be verified due to the structure of the survey.

The results from this portion of the survey showed that nearly 90% of the respondents agreed with the statement "my job is challenging." This statement was also often repeated in response to the question, "what do you enjoy most about your job?"

Table 3 shows that approximately ¾ of the respondents agreed that the social interactions in their workplace were rewarding. This ratio was slightly higher for those not retained but not significantly so. However, one of the most common responses to the question "What do you enjoy least about your job?" was the lack of interaction with other people, and several specifically cited "time spent in front of a computer." One respondent said, "I wish there were more 'humanity' in my work; everything is hard facts & you have to be able to defend every decision. I don't work with people much, I don't feel like I help anyone and I wonder if what I'm doing is very significant." On the other hand, the most popular response to the question "What do you like most about your job?" could be categorized as "interactions with co-workers and clients." Clearly, the respondents value social interactions, and appear quite dissatisfied when it is missing.

Women in the workplace often cite the difficulty in balancing work and family. In response to the statement that this balancing was the *most* challenging aspect of their jobs, only 42.3% of the respondents agreed. Interestingly, 31% of the non-retained respondents agreed with this, but this was not significantly lower than the responses from the retained respondents. One woman wrote the following:

> My biggest struggle has been with finding balance between work and being a mom. People love to tell me what I should do and there is a lot of guilt that women put on themselves b/c of this. I've even tried staying home but I have found that not only am I good at what I do, I've never imagined my life w/o it (work). My husband is extremely supportive which is especially helpful. We always run into the problem of late hours and who can pick up at day care. It's a balancing act but it usually works for us. The greatest challenge for me is the balance.

Finally, we considered whether those who remained employed in a SMET position were merely "sticking it out" or were truly enjoying their job. 83% either "agreed" or "strongly agreed" with the statement "Overall, I am satisfied with my job." Moreover, Table 3 shows that nearly 90% of those retained in the SMET workplace found their jobs challenging, and only 13% did not find their jobs rewarding. This is somewhat in disagreement with the fact that 12 respondents listed repetitive tasks/boredom/lack of creativity as being the portion of their job that they disliked the most. (This represented the second most popular response to this question; the most popular response dealt with office politics/upper management/red tape).

4.3 Drawing Conclusions from Written Responses

The last questions on the survey invited respondents to share any comments they might have and to list the least enjoyable and most enjoyable aspects of their jobs. Many of these responses have been incorporated into the above assessment, but many of them addressed issues that were not otherwise mentioned in the survey. These latter comments are analyzed in this section.

Although we did not directly ask a question about sexual harassment (primarily because we were unsure of how to define sexual harassment), there were some points raised in the individual responses that addressed this issue. "As far as being a woman in a male-dominated field, I haven't faced any discrimination because of it." Only two respondents listed a related response (lack of respect/harassment) as being the aspect of their SMET job that they liked the least. One CEE graduate wrote this:

> People often ask how men treat me at work. I am a project manager for road construction and our company employs approximately 200 people. We also have numerous subcontractors on the jobs. The majority of the men treat me great. They do not look down on me because I am female. They even ask me for guidance occasionally. I really enjoy the construction atmosphere.

Another question that we did not ask, but which was raised often was the lack of self-confidence felt by many women. One retained woman said "I'm not sure anyone can prepare college students for that struggle. Giving women the confidence to not be disheartened by the egotistical "male" in the engineering organization may be something they could be prepared for." One non-retained respondent wrote the following:

> Recently I have been debating about going back to engineering since I have realized that I left engineering for three main reasons. I didn't have any confidence in myself and I worked for a company that didn't take the time to help promote my development as an engineer. I also didn't

feel comfortable out in the field but part of that may come from lack of self-confidence.

Women also mentioned that in some cases they had to work harder to "prove" themselves or to show what they were capable. One respondent noted the following.

> Although my workplace is pretty progressive and accepting of female engineers, there is still the underlying sense of a less than equal engineering world. I haven't had any real problems, but I do feel the need to prove myself and work harder than my male counterparts. I am the only female engineer in my department; however, I am also one of very few in my department who actually has an engineering degree, so I think this helps me gain some more respect (it certainly helps my paycheck out!)

Seventeen respondents mentioned that the variety and diversity of tasks associated with SMET careers were the aspect of their job that they enjoyed the most. Respondents wrote the following.

> I enjoy a wide variety of projects to work on. I like going to visit jobsites in the field to see what I'm going to design or have designed. I like being able to point to something and tell my husband. 'I designed that'

> I am learning a new system and doing a variety of different tasks each day.

> The different variety of tasks and constant challenge of new problems to solve. I also do more then just electrical based engineering."

5 Final Thoughts

The analysis of this data has helped to subtly re-shape the initial question, such that we no longer ask "how many women leave SMET careers and why?" but rather "why are so many women retained in SMET professions?" despite self-reported low pay, lack of company-provided child care facilities, difficulty in juggling schedules, and a large number of hours spent at work. The data suggests that women are retained because they feel that they are making contributions to the workplace, and simply put, they find their job challenging *and* rewarding. One respondent said, " I love engineering. I get to see what I design and know that I am helping a community." Another replied, "I get to do a lot of cool stuff, like design test plans for huge engines. My work is constantly changing, keeping things exciting." A third woman replied that the aspect of her work that she enjoyed the most was "A sense of accomplishment when the part of the project I direct gets done on schedule or when we find clever ways to solve problems. Work is a big part of my happiness and who I am."

We also found that respondents, when asked "What do you enjoy most about your job," each listed *several* aspects, often completing lists with three or more items. The responses are the same as the ones we hear over and over from all engineers, regardless of gender. The responses were grouped into categories, and the following categories were the most popular, each with the number of responses in parentheses:

> ➢ interactions with people, including co-workers and clients (26);

- ➢ variety and diversity of work (22);
- ➢ opportunity to learn nearly every day (13);
- ➢ challenge of engineering work (13);
- ➢ accomplishment of completing a project (12).

Finally, it may not be a question of what academia or the workplace is doing "wrong," but in many cases the decision to leave is the natural result of young person maturing, or having a strong desire to stay home and raise their children themselves, or finding a career that better suits their interests and abilities. As one non-retained respondent said, "After I received my BS I went on for a graduate degree in music, so my current job relates to my music degree. It wasn't that I didn't enjoy my degree in math - I just wanted to pursue my music career."

Conclusions

- ➢ We have not identified a single factor that could explain persistence or non-persistence. We feel this is an important conclusion because it reminds us that retention of women in the workplace is an exceeding complex issue and cannot be readily addressed by focusing on only a single factor.

- ➢ Women who were not retained were more likely than retained women to have worked in a position that did not offer flexible work hours.

- ➢ 80% of respondents are employed in careers directly related to their SMET major.

- ➢ Social interactions in the workplace are very important to the respondents, and was the most popular response to the question "What do you like most about your job?"

- ➢ Women remain working in their jobs for the same reasons that all people have traditionally worked in engineering. These reasons include the challenge and variety of the work, the satisfaction of seeing a job completed, the ability to solve problems, among other rewards.

Acknowledgments

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APPENDIX

Copy of Survey

Letter of Introduction

Summary of Data Collected

<u>Summary of Data Collected</u>

- 303 surveys sent to 1992 – 2001 women EMS graduates
- 119 returned (39% return rate)

	Sent %	Returned %	Retention Rate %
Chemistry	8	8	70
Civil & Enviro	33	37	86
Computer Science	9	5	100
Electrical & Engineering Physics	12	13	69
Industrial	15	16	89
Math	10	7	50
Mechanical	14	14	82

Graduation Years

1997 – 14%
1999 – 13%
1996, 2000, 2001 – 11%
1998 – 10%
1992, 1994 – 9%
1993 – 5%
1995 – 4%

- 3.28 Mean, 3.27 Median, 3.2 Mode GPA (Range 2.1 – 3.98)
- Marital Status – Single (35%), Married (62%), Divorced/Separated (3%)
- Children – 0 (72%), 1 (12%), 2 or more (16%)
- Currently in position directly related to major – Yes (81%), No (19%)
- Prior to college, did you have friends/family who were engineers – Yes (42%), No (58%)
- Average work week was 43.1 hours with an average of 5.4 hours alone per day
- On average the work environments have 16% female
- Do/did you have a mentor – Yes (29%), No (71%)
- Is/was childcare provided by your employer – Yes (5%), No (95%)

Q7. I originally decided to pursue a science or engineering degree because...

	SA%	A%	D%	SD%	NC%
a. I have always been interested in how things work.	29	56	12	2	1
b. I have always enjoyed "tinkering" and building things.	18	53	20	7	2
c. Family or friends actively encouraged me.	38	35	17	4	6
d. Starting salaries in these fields are relatively high.	16	48	21	7	8
e. I felt pressure to pursue a technical degree.	3	14	45	35	3
f. The job market in these fields is generally healthy.	12	64	9	2	13
g. I excelled in math and science in high school.	61	30	8	1	0
h. I wanted to make a difference in people's lives.	23	40	21	6	9

Q12. **Below is a set of statements describing possible factors influencing a person's satisfaction with working in an engineering or science field.**

	SA%	A%	D%	SD%	NC%
a. Overall, I am satisfied with my job.	28	56	10	3	3
b. My salary is too low.	11	39	39	8	4
c. The social interactions in my workplace are rewarding.	24	51	14	5	6
d. My job is challenging.	34	55	8	1	2
e. My employer allows flexible work hours.	47	34	12	1	5
f. My job is not rewarding.	3	10	52	31	4
g. I make valuable contributions to my workplace.	26	66	2	1	5
h. My work is not valued by my superiors.	2	6	49	38	4
i. Balancing family and work is the most challenging aspect of my job.	21	23	35	8	13

Q18. **Below is a set of statements describing factors that may have influenced your satisfaction with your previous engineering or science work experience.**

	SA%	A%	D%	SD%	NC%
a. My salary was too low.	8	15	62	15	0
b. The social interactions in my workplace were rewarding.	8	77	8	8	0
c. My job was challenging.	8	85	8	0	0
d. My employer allowed flexible work hours.	23	23	38	15	0
e. My job was not rewarding.	8	8	62	23	0
f. I made valuable contributions to my workplace.	31	46	23	0	0
g. My work was not valued by my superiors.	0	23	46	31	0
h. Balancing family and work was the most challenging aspect of my job.	15	15	38	15	1

Observations
Q13&19: Most Enjoy – people, variety, and challenge
Q14&20: Least Enjoy – politics, stress, and time working alone