# AC 2009-88: UNIVERSITY AND PERSONAL FACTORS THAT HINDER OR ASSIST WOMEN IN COMPLETING A DEGREE IN ENGINEERING

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# University and Personal Factors that Hinder and Assist Women When Completing a Degree in Engineering


## Abstract

Research on women in engineering confirms the presence of gender barriers that affect their recruitment and retention. These barriers stop some women from choosing engineering as a field of study, and impede some women from completing a degree in engineering. However, there are some young female students who complete their engineering education despite the presence of obstacles throughout their college years. This study addressed the university and personal factors that have hindered, motivated, and assisted women who were graduating with a degree in engineering. By studying and understanding the barriers that hinder women in completing a degree in engineering, as well as the factors that assist and encourage them, we can learn how to break down the barriers and how to facilitate the educational journey of female engineering students.


## Introduction

In the U.S. Technical occupations increase almost 5 percent per year, whereas the rest of the labor force is growing at just over 1 percent per year (National Science Foundation, 2004). The 2004 Science and Engineering Indicators report from the National Science Foundation (NSF) indicates that there is a "troubling decline in the number of U.S. citizens who are training to become scientists and engineers, whereas the number of jobs requiring science and engineering (S&E) training continues to grow" (p.1). "If trends continue the United States will lose its ability to fill the growing demand for science and engineering jobs, yielding [its] global standing to nations such as China and India who are training thousands more engineers and scientists than is the U.S." (O'Brien, 2004, p. 1). Furthermore, it was noted that in 2004 the U.S. graduated approximately 70,000 undergraduate engineers, while China graduated 600,000 and India 350,000 (U.S. Department of Education, 2006).

The U.S. Bureau of Labor Statistics (2005) projects that by 2010, 50 percent of all U.S. workers will be women. This projection, plus the growth in the science and engineering labor force, and the shortage of technically skilled workers show the importance and need of having women training to become scientists and engineers. Unfortunately, women have been and continue to be a minority in engineering related fields. In 1971, only 0.8% of the bachelor's degrees earned in engineering were obtained by female students. In 2006, the number went up to 19% (U.S. Census Bureau, 2005-2006). Despite the increase in the number of women obtaining degrees in engineering, women are still underrepresented in engineering, with only 8.5 percent of the U.S. engineers being female (U.S. Department of Labor, 2006).

In 1970, of the 7.4 million students who enrolled in college, 4.4 million were men, and 3.0 million women. By 1980, out of 11.4 million students enrolled in college, more than half of the students were women (U.S. Census Bureau, 2005-2006). This coincides with the fact that in the 1980s people started working towards admitting more women to colleges (Anderson, 2002). Since the 1980s, overall, the number of women enrolled in college has always been higher than

the number of men (U.S. Census Bureau, 2005-2006). Conversely, the number of female students enrolled in engineering programs has always been much lower than the number of male students. Women now account for approximately 17 percent of students enrolled in undergraduate engineering programs, compared with 58 percent of the total undergraduate population, which is expect to reach 60 percent by 2016 (Gibbons, 2008, Loftus, 2007; Peter & Horn, 2005).

Furthermore, only 2 to 3% of women in high school say they want to study engineering, whereas 16.4% of men state they want to pursue an engineering degree (Blaisdell, 2002). On average, women are both less likely to choose an engineering major and more likely to switch out of one than are men (Goodman, 2002). Girls now are just as likely as boys to take AP calculus and more likely to take advanced biology and chemistry. Although the pool of female students is stronger and they now have easier access to most engineering schools, there is a lingering reluctance for women to choose education in engineering and technology related fields (Loftus, 2007). Recruiting women into engineering is a crucial issue if we want to increase the numbers of women in technical fields. However, the story does not end with recruitment. Nationwide retention rates show that out of the very few women who enroll in engineering programs in college, 22.7% dropout after completing only threshold courses in engineering; and 35.4% withdraw after taking engineering courses beyond threshold, but before getting a degree. Only 41.9 percent of women who enroll in engineering programs complete their bachelor's degree (Bell, Spencer, Iserman, & Logel, 2003; Seymour, 2001). These numbers indicate that women are encountering barriers that stop them from completing their engineering education.

Despite several decades of research on and interventions to benefit women in science, technology, engineering, and mathematics (STEM) fields, there is still major concerns about the drop of young women entering engineering programs, the low retention rates of women in engineering departments, and a drop in the participation of women in these occupations (Bystydzienski & Bird, 2006; Camp, 1997; National Research Council, 2006). A number of programs have been launched over the past decade to recruit more women into the engineering field, and while women now represent 19 percent of all undergraduate engineering students, women remain more likely than men to switch out of the field, particularly in the first two years of college (Goodman, 2002; National Research Council, 2006). A number of universities and research studies have concentrated on determining and creating effective ways to recruit women into engineering throughout the educational pipeline from elementary school to graduate school (Anderson-Rowland, 2000; Anwar, Acar, & Rung, 2002; Cohoon, 2006; Goodman, 2002; National Research Council, 2006; Thom, Pickering, & Thompson, 2002). Goodman (2002), found that the reason women drop out of engineering majors is not a lack of academic ability, but a discouraging academic climate and women not feeling part of a larger engineering community. Researchers have concluded that women need to be provided supports such as mentors, role models, networks, career counseling, and social opportunities in order to attract and retain them to technical fields (Amenkhienan & Kogan, 2004; Cohoon, 2006; National Academy of Science, 2007; National Research Council, 2006; Seymour & Hewitt, 1997; Wentling & Thomas, 2007)

Many studies that have concentrated on the recruitment and retention of women in engineering have studied the factors that affect the educational journey of students at the pre-college, beginning, and/or in the middle of their college years (Bennet, 1996; Cannon & Lupart, 2001;

Martinez, 1992; Tobias, 2000). With the exception of Goodman's (2002) study on the Women's Experiences in College of Engineering, there is very little systemic empirical research that focuses on students who have graduated from an engineering program. Goodman (2002) expressed that research studies that focus exclusively on experiences in colleges of engineering are scarce; since much of the research focuses on women in science or women in science and engineering. Experiences unique to female students of engineering needs further examination. Therefore, it is important to study the experiences of students who have just completed and obtained an engineering degree because, since they have recently gone through situations that female students experience by being a minority in engineering, they can give an accurate inside scope; and because they have successfully overcome any obstacles that were presented in their way towards obtaining an engineering degree. Therefore, this study seeks to add to the women in engineering literature by examining the university factors that have hindered, encouraged and assisted graduating female students, in completing a degree in engineering.

The low numbers of students who are obtaining engineering degrees is an important topic of concern given that an increasing number of women are in the workforce, and that the number of jobs requiring science and engineering training continues to grow. By studying and understanding the university and personal factors that assist and encourage women in completing a degree in engineering, as well as, the barriers that they encounter, we can learn how to break down the barriers and how to facilitate the educational journey of female engineering students. These barriers stop and/or impede some women from completing a degree in engineering. However, there are some young female students who complete their engineering education despite the presence of obstacles throughout their college years. More systematic research that studies the experiences of these women is needed. Moskal (2000) expressed that research concerning the experiences of female scientists and engineers is needed because it is likely to suggest methods for improving the engineering environment in a manner that will attract further female participation.

**Research Questions**

The two major research questions that guided this study are the following:

1. What university and personal factors have hindered women while completing a degree in engineering?
2. What university and personal factors have assisted women in completing a degree in engineering?

**Methodology**

This study utilized a mixed methods design to advance our understanding of the experiences that female students go through in completing an engineering degree. Two major data collection methods were used. First, for the quantitative design, a survey was developed, and was used to obtain insightful information to determine the factors that have hindered and assisted graduating female engineering students at a university in the Midwest in completing a degree in Engineering. The survey data collection method was used because it was cost effective and allowed for a rapid turn-around in data collection from a large group of individuals who are typically busy and difficult to locate (Creswell, 2003). Second, for the qualitative design, focus

groups were conducted with a random sample of the graduating female engineering students at the university in the Midwest to obtain detailed information on their experiences in completing a degree in Engineering. Focus groups were utilized because they produce qualitative data that provide insights into the attitudes, perceptions, and opinions of participants. The focus group presents a more natural environment than that of an individual interview because participants are influencing and influenced by others, just as they are in real life (Krueger, 1994). Focus groups enable the researchers to increase the sample size without dramatic increases in the time required of the interviewer. In addition, focus group techniques are both useful and valid for assessing student problems within an undergraduate curriculum (Diamond & Gagnon, 1985). Quantitative data was analyzed using descriptive statistics and the qualitative data was analyzed using a multi-step content analysis methodology.

The population for this study involved all the senior female engineering students who were graduating from a university in the Midwest at the end of the semester. These women were selected to complete the survey because they were graduating with an engineering degree, thus they were best able to provide the information needed to better understand the factors that hindered and assisted them in completing a degree in engineering. A master list of all the female engineering students who were graduating at the end of the semester was obtained from the Women in Engineering Office at the university in the Midwest. The master list consisted of 127 female engineering students from eleven departments within the College of Engineering. From the Department of Electrical and Computer Engineering there were 34 (27%) female students; General Engineering, 21 (17%); Computer Science, 19 (15%); Civil and Environmental Engineering, 17 (13%); Mechanical and Industrial Engineering, 16 (12%); Materials Science and Engineering, 10 (8%); Aerospace Engineering, 5 (4%); Nuclear, Plasma, and Radiological Engineering, 2 (2%); Agricultural and Biological Engineering, 1 (1%); Engineering Physics, 1 (1%); and Theoretical and Applied Mechanics, 1 (1%).

The study participants were given a survey that included a list of possible factors that could have hindered and assisted them while completing a degree in engineering. Participants were asked to check all the factors they had experienced, and to specify if there were any other factors that hindered and assisted them, but were not mentioned on the survey. The list of factors on the survey was developed from an extensive literature review on the recruitment and retention of women in engineering and technology (e.g., Anderson, 2002; Anderson-Rowland, 2000; Cohoon, 2006; Cohoon & Aspray, 2006; Cuny & Aspray, 2002; Goodman, 2002; McDill, Mills, & Henderson, 2000; Seymour & Hewitt, 1997; Thom, 2002, Thom et al., 2002; Wentling & Thomas, 2007).

A study advisory committee made up of three professors from the College of Engineering reviewed the survey and study procedures. A pilot study was also conducted with six female engineering students from six different engineering departments in order to determine content validity, clarity, and appropriateness of the survey. There was agreement by the study's advisory committee and the pilot test participants that the survey and the data being collected were appropriate for meeting the objectives of the study. Minor revisions were made to the survey based on the results of the pilot test.

Furthermore, from the master list of 127 female engineering students, five were randomly selected from each of the six engineering departments with the largest number of female students and student population in general to participate in focus groups. A total of 30 female engineering students were randomly selected from the following departments: Electrical and Computer Engineering 5 (17%); General Engineering, 5 (17%); Computer Science, 5 (17%); Civil and Environmental Engineering, 5 (17%); Mechanical and Industrial Engineering, 5 (17%); and Aerospace Engineering, 5 (17%).

An interview guide was developed to use for the focus groups. The interview guide consisted of three sections. The first section of the guide consisted of opening questions, such as the participants' names, majors, and what they plan to do after they graduate with their degree in engineering. The second section of the guide focused on questions that provided the participants the opportunity to reflect on their past experiences that hindered and assisted them in completing a degree in engineering. The fourth section of the interview guide asked questions that brought closure to the discussion and enabled participants to reflect back on previous comments, such as actions that universities could take to make female engineering students' experiences better and more rewarding.

Before starting the focus group sessions, the participants were asked for approval to audio-tape record the session. All of the participants gave their approval, so the focus group sessions were audio-tape recorded and extensive notes were also taken by the moderator and assistant moderator during each session. Each of the six focus group sessions lasted one hour. After each focus group session a debriefing was conducted between the moderator and assistant moderator to discuss important themes and ideas that were expressed by the participants, whether there were any unexpected findings or actions that should be taken to improve subsequent focus groups. The audio-tape recordings for each focus group session were transcribed verbatim.

The transcribed account of each focus group session was reviewed several times, with themes and patterns emerging after the first few sessions. Based on these themes and the two major objectives of the study a startlist of codes (Miles & Huberman, 1994) was developed. Phrases on each of the transcripts were then identified, coded, and categorized. Phrases were deemed more appropriate than sentences for coding as sentences often contained more than one conceptual idea. To increase the validity of findings, the researchers utilized the peer examination strategy suggested by Merriam (1988) by which a panel of three colleagues was asked for comments as items were coded, categories were delineated, and findings were developed. This panel independently reviewed the overarching content themes in addition to the statements taken from the focus group transcripts to determine the appropriate categorical placement for each. The analyses and ratings from all the researchers matched principally well.

Out of the 127 female students who were graduating, 89 students filled out the survey, resulting in a return rate of 70.08%. Each of the six focus group sessions was originally composed of five female engineering students who were graduating with the same major. However, for three of the focus group sessions two of the female students did not attend, therefore there were a total of 24 participants.

**Profiles of the Study Participants**

***Survey Participants***. The study participants for this study included 89 senior female engineering students who graduated from a university in the Midwest. The study participants' majors included: General Engineering, 15 (17%); Electrical Engineering, 14 (16%); Computer Science, 14 (16%); Civil and Environmental Engineering, 12 (13%); Materials Science and Engineering, 10 (11%); Computer Engineering, 5 (6%); Mechanical Engineering, 5 (6%); Industrial Engineering, 5 (6%); Aerospace Engineering, 5 (6%); Agricultural Engineering, 1 (1%); Engineering Physics, 1 (1%); Nuclear Engineering, 1 (1%); and Engineering Mechanics, 1 (1%).

The study participants ranged in age from 21 to 30 years, with an average of 22.1 years. The ethnic origin of the study participants included: White, 51 (57%); Asian/Asian American, 32 (36%); Hispanic, 4 (4%); and African-American, 2 (2%).

The study participants' college grade point averages (GPA) ranged from 2.5 to 4.0, with an average 3.39 GPA. The educational level of the study participants' fathers included: Master, 36 (40%); Bachelor, 28 (31%); High school, 13 (15%); Doctorate, 9 (10%); Associate, 1 (1%), and Less than high school, 1 (1%). The educational level of their mothers included: Bachelor, 41 (46%); High school, 22 (25%); Master, 21 (24%); Doctorate, 3 (3%); and Less than high school, 2 (2%).

Of the 89 study participants, 67 (75%) indicated that they would choose engineering as a major, if they could choose their major again; 18 (20%) indicated that they would not choose engineering as a major, if they could choose their major again; and 4 (5%) indicated they were unsure. Of the 89 study participants, 18 (20%) were very satisfied with their overall experience in their undergraduate engineering program; 58 (65%) were satisfied; 10 (11%) were neither satisfied nor dissatisfied; 3 (3%) were dissatisfied, and none were very dissatisfied. The study participants' plans after graduation included: Having accepted a job and were going to be working in a job related to engineering, 36 (40%); Attending graduate school, 29 (33%) (Engineering (59%), Law (21%), Science (10%), other (10%)); Searching for a job related to engineering, 8 (9%); Having accepted a job and were going to be working in a job not related to engineering, 2 (2%); and Being a stay-at-home mom for a while, 1 (1%).

***Focus Group Participants***. The study participants for the focus groups included 24 senior female engineering students who graduated from the university in the Midwest at the end of the semester. The study participants' majors included: Aerospace Engineering (3 students); Electrical and Computer Engineering (3 students); Mechanical and Industrial Engineering (5 students); Computer Science (5 students); General Engineering (3 students); and Civil and Environmental Engineering (5 students).

## Results

The results of this study are summarized in two sections that parallel the two major research questions of the study: (1) University and personal factors that have hindered the study participants while completing a degree in engineering, and (2) University and personal factors that have assisted the study participants in completing a degree in engineering. Please note that when the focus group results are presented the word **majority** is used to indicate 12 to 24

participants, **many** indicates 8 to 11, **several** indicates 4 to 7, and **some** indicates 1 to 3 participants.

**Research Question One: University and Personal Factors that Hindered the Study Participants While Completing a Degree in Engineering**

Research question one addressed the factors that had hindered the graduating female engineering students while completing a degree in engineering. This section begins with a review of the university factors that hindered the participants while completing a degree in engineering. Then, reviews of the personal factors that hindered the participants while completing a degree in engineering are presented.

**University Factors**

The ten most frequent university factors identified by the survey study participants as hindering them while completing a degree in engineering included: Ineffective professors, 49 (55%); Professors who did not motivate me, 44 (49%); Low grades in engineering classes, 39 (44%); Poor teaching quality, 32 (36%); Too much homework, 32 (36%); Excessively competitive environment, 31 (35%); Curriculum too demanding, 26 (29%); Class material too difficult, 25 (28%); Lack of female professors, 22 (25%); and Lack of female classmates, 22 (25%).

Many of the focus group participates supported the survey results by stating that ineffective professors and professors who did not provide a positive climate/environment in the engineering classroom and/or department hindered them when completing their degree in engineering. Some of the words that were used to describe their professors were: unfriendly, rude, condescending, unavailable, self-righteous, uncaring, impersonal, and unkind. In most cases these words were used to describe their professors creating an unfriendly climate/environment in the engineering classroom and/or department. Several of the focus group participants reported having professors who were not interested in being good teachers and were unavailable when it came to the classroom. Several of the participants indicated that having ineffective and unfriendly professors caused them to frequently question whether they should stay in their department or leave engineering altogether. This is what one participant had to say about her professors:

> "Many of my professors integrated the impression into the classroom when they were teaching of unfriendliness and unwillingness to help you by being condescending and telling you that you should know these kinds of things. I have heard comments such as, 'you should know how to do this', and 'my third grade daughter knows how to do this', several times. I felt like I was always behind everybody and I was the only one not getting it. But I felt if I went to talk to my professor he would just laugh at me or be really rude and condescending. This may not have happened, but it was enough to keep me from going and asking for help."

Still another participant had this say about her professors:

> "I was literally the only girl in most of my classes. I had two classes and there were three other girls in them. It was kind of frustrating and it was more than just being a girl thing, it was that I couldn't really connect with the people in my classes. Especially the professors didn't really make an effort to really talk to me like I was a normal person. The professors were used to a male class and they didn't know how to respond to me. For example, if I would go and ask them a question during their office hours they were not willing to explain things to me in a different way."

Although the survey participants did not identify this factor, many of the focus group participants reported that poor and ineffective advisors hindered them when completing their degree in engineering. One participant had this to say about her advisor:

> "My advisor was rude and used a tough approach in his advising. Nothing I did was ever good enough for him. My freshmen year I walked out of his office in tears every time because he would yell at me about my grades or whatever else I didn't do right. I really didn't need this because I was already stressed out and had enough internal pressures to deal with. I would just feel so awful after meeting with my advisor."

Several of the focus group participants emphasized the survey results by indicating that low grades in their engineering classes hindered them while completing their degree. One participant had this to say:

> "One thing that hindered me was the classes that I took at the beginning that were weed out classes. I was getting C's on my tests and I had never gotten a C before and I was really upset and it was really discouraging. I didn't realize it at the time, but the average on the tests were way below 50% and that the professors curve the grade at the end of the semester, but they don't necessarily tell you that on the syllabus. At the time these bad grades were causing me to reevaluated my major. I just think some of the weed out classes can really hinder people and there should be a better way to teach these classes."

Several of the focus group participants strengthened the survey results by indicating that courses that were extremely difficult made them lose some of their self-confidence and made them question the reason for being there. One participant had this to say:

> "I definitely had some extremely difficult classes and there were times when I didn't do well on the tests, and it was so devastating and discouraging. I actually thought of giving up and leaving because I didn't know why I was doing this to myself. But I remember talking to my Mom and she would encourage me to stay and tell me not to give up and that I would eventually get it and do well. She was right, it took me a while, but I did very well and made it through."

Several of the focus group participants reinforced the survey results by reporting that seeing so few females in engineering classes concerned them. One participant had this to say:

> "One of the things that was really hard to see was that a lot of girls left, every year you saw less and less girls in engineering. And sometimes I would get comments like: 'oh are you still in engineering'? It's like they expected me to switch out of engineering for some reason. It was almost like there was a pressure to get me out of engineering, like what are you doing here? It was so hard and I knew I could have it so much easier, so sometimes it was hard to convince myself to continue to do what I was doing."

Several of the focus group participants felt that because engineering is a male dominated field many girls enter feeling intimidated and with a fear of failing. These participants felt that professors in engineering courses should provide a class structure that includes more opportunities for girls to have positive and successful experiences. One participant had this to say:

> "Male and females come from a different mindset, therefore there should be a different course structure so that women feel a little more at home when they are pursuing a degree in engineering. The minute females feel failure they are more likely than males to think of withdrawing, and if the feeling of failure continues they are more likely than males to actually withdraw. Males seem to be more comfortable with the feeling of failure than females or maybe males cope better with failure than females. Therefore, females need to be given opportunities in their classes to feel successful, so when they encounter failure, they can cope with it in a more positive way than just withdrawing."

**Personal Factors**

The five most frequent personal factors encountered by the survey study participants that hindered them while completing a degree in engineering included: Lack of free time, 59 (66%); Doubts about career goals, 50 (56%); Low self-confidence, 28 (31%); Lack of motivation, 22 (25%); and Lack of self-discipline, 17 (19%).

Many of the focus group participants reinforced the survey results by indicating that they came into their engineering programs with self-doubt and a low self-confidence level. Sometimes the low self-confidence carried throughout their degree program. Several participants indicated that academically they did really well in high school, but in some of their engineering courses their performance was average. This created a lot of pressure for some of the participants. This is what one participant had to say:

> "This is a really good school, so when I came here I felt like I wasn't good enough. It seemed like everyone else in my classes already had some background knowledge and were so much smarter than me. It was hard to find other people in my classes that I felt I could talk with, because there were only a few girls and I wasn't going to go up to some boy and start talking. At first it was hard for me to meet people, so I felt lonely. Later I realized that most people come in feeling

that way, so some of it just has to do with being in a new environment and not necessarily being a girl."

One participant had this to say about her performance:

> "I was always so use to doing really well in my classes in high school and then coming here and being average was the hardest transition I have ever had to make in my life. I was always so upset and mad at myself about it. This is really hard because you feel like for your career you should be doing something that you are good at and especially in an engineering profession that requires so much competency. I just put so much unnecessary pressure on myself. Personally, I think this hindered me throughout my four years."

Many of the focus group participants supported the survey results by mentioning lack of free time as an issue they encountered throughout their engineering programs. Several of the participants wanted to get involved in extra-curricular activities (e.g., sports, student organizations, student government), but they did not have time. They also mentioned that their friends that were not in engineering tended to have more time to do activities that were non-school related (e.g., exercise, parties, movies, sleep).

Many of the focus group participants reported having doubts about their career goals during their engineering degree programs. One participant had this to say:

> "I think that a lot of my friends who were questioning staying in engineering really couldn't picture themselves as an engineer. It wasn't like they weren't interested or weren't capable, they just had no image of themselves as an engineer. There is no real good reason just that it's really hard to picture a girl being an engineer. Maybe it's because in society you rarely see pictures of female engineers, but you do see pictures of guys who are engineers. So it's like a fundamental thought and you question if you belong in engineering."

Some of the focus group participants felt that because there were so few females in their classes they had to prove their competence far and beyond. One participant stated:

> "When the students in your classes are mostly male, I think in general it is so hard to not let the intimidation get to you because it is so prevalent. It is something I still struggle with today and even when I am in the workplace. When I did my internship it was hard not to let the smart male engineers intimidate me because you know they are seemingly all knowing and some of them can talk down to you because they think that they know everything. So we tend to work harder and be more determined because we are females in the engineering field."

**Research Question Two: University and Personal Factors that Assisted the Study Participants in Completing a Degree in Engineering**

Research question two addressed the factors that had assisted the study participants in completing a degree in engineering. This section begins with a review of the university factors that assisted the participants in completing a degree in engineering. Then, reviews of the personal factors that assisted the participants in completing a degree in engineering are presented.

## University Factors

The ten most frequent university factors identified by the survey study participants as assisting them when completing their degree in engineering included: Involvement in campus student organizations, 48 (54%); Teaching quality/excellent professors, 41 (46%); Good performance in engineering classes, 38 (43%); Internships, 35 (39%); Supportive/encouraging/motivational professors, 33 (37%); Enjoyed engineering classes, 33 (37%); Good guidance by advisors/counselors, 31 (35%); Received scholarship/fellowship, 30 (34%); Good relationships with professors, 27 (30%); and Research experiences, 24 (27%).

Many of the of the focus group participants reinforced the survey results by indicating that being involved in campus student organizations (e.g., Women in Engineering, Society for Women in Engineering, Women in Math, Science and Engineering) assisted them when completing their degree in engineering. A participant had this to say:

> "I made a lot of really good friends through my association with the Society for Women in Engineering [SWE]. I think there are a lot of people who join SWE and who stay in engineering because they don't want to give up their friends. The amount of time you put into SWE comes to mean so much to you that I think leaving engineering becomes like a much bigger decision. So for me, my classes were interesting and I got good grades, but it has been what I have been able to do through extracurricular activities, such as my involvement in SWE that became my self-identity, and so that's what really anchored me into being committed to my engineering program."

Another participant stated:

> "My first three years here I lived in one of the dorms that had a living-learning community for women, it was called women in math, science, and engineering [WIMSE]. I lived there multiple years, but it was most beneficial my freshmen year because that year they paired up roommates by major. My freshman year roommate was a woman in Aerospace Engineering, and we had almost all of our classes together ever since. It was really good to meet people in your major right away, so you can establish a support network immediately. This was probably the most beneficial thing for me."

Many of the focus group participants helped explain the survey results by reporting that having excellent professors and teaching assistants assisted them while completing their degree in engineering. Some of the words that were used to describe their professors were: motivational,

encouraging, helpful, and supportive. This is what one participant had to say about her professor:

> "I had a great opportunity last year to work with a professor on a research project. I learned a lot about research from him. He also gave me some really good advice about graduate schools and jobs. He gave me a lot of moral support and motivated me to do well in school and encouraged me to apply for graduate school. He also wrote several reference letters for me when I applied to graduate school."

Several of the focus group participants indicated that taking part in an internship helped them to stay focused in their engineering courses and to determine their different career options. One participant stated:

> "I started looking more seriously at job options after I participated in an internship. I think everyone should be required to have an internship in engineering, and I don't think that it's encouraged enough. My internship gave me some great experience and it exposed me to the type of work that I liked and I didn't like. It also helped me to understand why we study chemistry, physics, and all this math stuff. It helped me realize the reason and importance of my courses."

Several of the focus group participants supported the survey results by stating that advisors that were helpful and supportive assisted them while completing their degree. These advisors provided then with moral and emotional support, as well as the advise they needed to plan their course schedules. Also, several of the focus group participants stated that taking part in the women in engineering retreat after they had been accepted into the College of Engineering was helpful and motivating to them. They felt it was helpful and inspiring because they were able to meet other female freshman and upper-class engineering students. This made them realize that there were other women who were going to go into or were already in the engineering field.

## Personal Factors

The ten most frequent personal factors reported by the survey study participants as having assisted them in completing a degree in engineering included: I make sure my assignments are turned in on time, 74 (83%); I am a hard worker, 69 (78%); I study with my classmates/friends, 68 (76%); Perseverance/determination, 64 (72%); I am self-motivated, 61 (69%); Support from classmates/friends, 57 (64%); I am highly disciplined, 53 (60%); I study enough to make sure I do well in my classes, 52 (58%); I am happy I chose to major in engineering, 52 (58%); and I am rarely absent from classes, 51 (57%).

The majority of the focus group participates supported the survey results by stating that participating in study groups with classmates and friends assisted them in completing their degree. One study participant stated:

> "Once you start seeing people over and over again in your classes and you start to talk to them, then you make friends. Once you are friends with people in your classes it makes it easier and more comfortable to study and do homework together. You build a community of support and that helps you do better in your classes."

Another participant had this to say:

> "Study groups were the most important to me. I think without study groups I would have been miserable, it would have been almost impossible to do well. It's a group that forms from people in your classes that then become your friends. I have a group of friends now that are in almost all my classes. We go to classes together and we spend a lot of time outside of class studying and doing fun things together."

Many of the focus group participants reinforced the survey results by indicated that perseverance and determination assisted them in completing their degree in engineering. One participant stated:

> "Being a strong and independent person and having a drive to be persistent has been very helpful to me. A lot of self-motivation is also involved. I mean you really work hard at something and when you finally get it, it is just the best feeling ever. For example, if you have been working on a problem for a really long time and all of the sudden you get the right answer it is such a good feeling, it is kind of like a high and you want to do it again and again."

Many focus group participants supported the survey results by identifying support from classmates and/or friends as a factor that assisted them in completing a degree in engineering. This is what one participant had to say:

> "When I first started it was hard, but once I met other students and made friends that helped a lot because I then had other people to talk to about things. Establishing a network of friends who can help and support you along the way was the most helpful to me. It is so helpful to have friends to talk to about classes, professors, course load, what classes to take, or just about anything."

Many of the focus group participants stated that being involved in extracurricular activities and having a balanced life assisted them in completing their degrees. These participants had other interests outside of engineering and they felt getting away from engineering for a while made them appreciate it more. One participant had this to say:

> "Having friends to talk to and participating in extracurricular activities were really helpful. After a physics exam or any other hard exam I would be so frustrated and stressed out. So I would go to skating practice with my friends after an exam and I would tell them that I totally failed the exam and they would listen to me.

> Then after a night of skating practice and having fun with my friends I would feel so much better."

Several of the focus group participants reported that doing well in their engineering courses motivated them to stay in engineering and complete their degrees. One participant had this to say:

> "One thing that really encouraged me to stay in engineering was doing well in really hard courses like chemistry and physics. These are considers some of the weed out classes and they had people in them that looked like they were so much smarter than me and seemed to study so much harder than me. It was kind of exciting to stay right up there with them. It made me realized that I could really do well in engineering and that made me even more motivated to stay in engineering and continue to do well."

Several of the focus group participants indicated not being afraid of failure and not trying to be perfect helped them in completing their degree in engineering. This is what one participant stated:

> "Don't think you have to get straight A's or be perfect or number one in your educational programs to stay in an engineering degree program. So if you are getting a B or C in one of your classes, don't start to think that you are a failure or that engineering isn't for you or that you aren't smart enough or that maybe you should just withdraw. It's important to take a step back and remind yourself that you don't have to be perfect, but you can still succeed."

**Discussion**

The findings of this study reveal that the major hindrances that female students encountered in the university related to ineffective professors and professors who did not provide a positive climate/environment in the engineering classrooms and/or departments. Similarly, a study conducted by Seymour and Hewitt (1997) found that engineering students "were virtually unanimous in their view that no set of problems in S.M.E. [(Science, math, and engineering)] majors was more in need of urgent, radical improvement than faculty pedagogy" (p.165). In addition, Vogt (2008) noted that large number of students depart from engineering and computer science programs before graduation because of the inaccessible or unapproachable nature of faculty. Goodman (2002) found that the climate in colleges of engineering affects whether women persist. According to Goodman female students whose views of the engineering department and engineering classroom environments were the most positive were most likely to stay in engineering. Furthermore, Cohoon (2006) found that STEM departments retain more female students when faculty members enjoy teaching and share responsibility for success with their students, and express strong appreciation for their female students' abilities and work styles. The importance of having professors who are committed to preparing interesting lectures that motivate their students and providing an encouraging and supportive environment is evident throughout the literature and the findings of this study.

Low grades in engineering classes was another factor that hindered the study participants while completing a degree in engineering. The literature supports this finding by specifying that perceived low ability, academic difficulties, performance problems or perception of low grades are major reasons why female students reject or quit particular choice options (Brainard & Carlin, 2001; Cohoon & Aspray, 2006; Goodman, 2002; Lent et al., 2002). A study conducted by Goodman (2002) revealed that a significant number of females who are leaving engineering are academically quite capable of succeeding. Goodman states that, "in the year that they [students] left engineering, almost 45% of leavers had A or B averages in their engineering-related courses, and two-thirds had A or B averages in a previous year" (p. v). According to Goodman (2002) many young females leave not because they can't do the work, but for reasons other than academic ability. These reasons may include their negatively interpreting grades that may actually be quite good and diminished self-confidence. Fortunately, the study participants who identified low grades as a barrier were able to overcome the negative effect that their low grades in engineering classes had on them, and did not drop out of engineering. However, a high percentage of female engineering students let their low grades discourage them to the point that they end up dropping out of engineering (Brainard & Carlin, 2001; Cohoon & Aspray, 2006; Lent et al., 2002). For this reason, it is vital to provide women with a strong support system so that they are able to prevail over barriers that may come along the way to the completion of their engineering education.

Lack of female professors and classmates was also a factor that hindered the study participants while completing a degree in engineering. Female engineering students often found themselves in classes that were predominantly male with few, if any, female professors. Women comprised only a small percentage in their engineering classes. Having fewer female engineering students lead to a greater sense of isolation and fewer resources for networking than those available to the male students. The literature has widely noted the need for female role models and mentors for women students in science and engineering (Cohoon & Aspray, 2006; Loftus, 2007; Margolis, & Fisher, 2002; National Research Council, 2006; Teague, 2002 ). According to Cohoon & Aspray (2006), since same-sex role models are essential to participation and persistence in a discipline, small numbers of available women role models could inhibit women's recruitment, retention, and progression in computer science and engineering. Researchers have noted the vital importance of role models and mentors for women in engineering (Cohoon & Aspray, 2006; Goodman, 2002; Margolis, & Fisher, 2002). The literature shows that women faculty have a positive impact on the retention of female engineering students. Also, the impact of faculty gender has a greater impact on female engineering students when their classes have few female students, as is often the case in engineering (Robst, Keil, Russo, 1998; Widnall, 2000). For women to participate to their full potential in engineering, they must be provided with female faculty and student role models and mentors, so they can see themselves in a career path that allows them to reach their full intellectual potential.

Lack of free time was another factor that the participants mentioned as having hindered them while completing a degree in engineering. The lack of free time encountered by the female engineering students could be a consequence of the university factors of too much homework, curriculum too demanding, class material too difficult, too much lab work, and having a job identified by the female students as also having hindered them while completing a degree in engineering. According to Margolis & Fisher (2002), many women in engineering find their

peers' heavy workload, the lack of time, and single-minded devotion to engineering and computer science frightening and at odds with their desire to maintain a variety of hobbies and interests and live a balanced life. In the same way, other researchers have also noted that women in engineering have been hindered by excessive educational requirements, and difficulty balancing school and personal life while completing a degree in engineering (Brainard & Carlin, 2001; Goodman, 2002; Lent et al., 2002).

Self-doubts and low self-confidence was also a factor that hindered the participants while completing a degree in engineering. Confidence in one's own ability to succeed is a crucial determinant of academic course and career choices (Eccles, 1994). Students who expect to succeed at a particular task are more likely to engage and succeed than are those who anticipate failure (Huff, 2002). It is well documented that women exhibit lower self-confidence than men when it comes to engineering. Studies have found that this loss in women's self-confidence is produced by male peers/professors discrimination and low expectation of females, lack of role models and female peers, and the fact that women attribute poor performance to their own lack of ability (Cohoon & Aspray, 2006; Cuny, & Aspray, 2002; Goodman, 2002; Seymour & Hewittt, 1997; Thom, 2002). Confidence in their engineering-related abilities has been shown to be a crucial variable in determining female students' persistence in engineering. Goodman (2002) found that women in engineering are more susceptible to attrition because of lower levels of self confidence in their abilities. Furthermore, Goodman found that even before they have made the decision to leave engineering, female students' perceptions about their self confidence and surrounding engineering environments differ between those who will continue in the major and those who will leave. In spite of their self-doubts and low self-confidence the participants of this study succeeded in their engineering programs.

Involvement in campus student organizations (e.g., Women in Engineering, Society for Women in Engineering, Women in Math, Science and Engineering) was a major factor that assisted the study participants in completing a degree in engineering. The literature confirms that female students who participated more frequently in campus student organizations support activities are less likely to leave engineering than those who do not participate or who participated less frequently (Amenkhienan & Kogan, 2004; Goodman, 2002; National Research Council, 2006). Goodman (2002) reported that nearly one-third of students who attended schools with WIE programs said their decision to attend that school was influenced by the presence of a women's engineering support program. WIE programs, where they were present, frequently were sponsors of mentoring programs, internships, newsletters, engineering society activities, engineering speakers, social and academic events, and outreach to pre-college students. Goodman (2002) found that students who participate more frequently in campus activities, particularly social enrichment activities, may be more likely to remain in engineering. Additionally, Anderson (2002) stated that as a minority, women may feel isolated in engineering. Involvement in campus student organizations allows women engineering students to find the peer support and networking they need to not feel isolated, but on the contrary, feel welcome and succeed in the completion of their degrees.

Professors' dedication to class and to their students was also an important factor that assisted the participants in completing a degree in engineering. More specifically, the study participants mentioned that teaching quality, having excellent professors, and having professors who were

supportive, encouraging, and motivational assisted them in their pursuit of an engineering degree. Several research studies that have focused on women in engineering have concluded that engineering departments generally retain more female students when the faculty members enjoy teaching, put a lot of emphasis into preparing interesting lectures, support and motivate their students, and express strong appreciation for their female students' abilities and work styles (Anderson, 2002; Brainard & Carlin, 2001; Cohoon, 2006; Henes et al., 1995; National Research Council, 2006; Wentling & Thomas, 2007; Zeldin & Pajares, 2000). According to Cohoon (2006) developing positive relationships with faculty has been identified as one of the most important means to improve female students' retention in and satisfaction in the computer and engineering major. When faculty encourage female students to persist, it makes a measurable difference in women's retention. Cohoon (2006) further states that support from faculty is an effective way to balance retention rates and that those departments where the average faculty member encourages female students in their classes to persist generally retain women at rates comparable to men. The literature and the findings of this study reveal that professors who are dedicated to their classes and their students play a major role in the retention of women in engineering.

Along with having professors who are committed to preparing interesting lectures and who capitalize on opportunities to support/encourage/motivate their students, the study participants indicated that enjoyment of their engineering classes, and good performance in these classes played an important role in their retention in engineering. Regarding this issue, researchers have noted that students' experiences in their engineering classes are critical to their retention, especially their experiences in their freshmen and sophomore classes (Anderson-Rowland, Urban, & Haag, 2000; Goodman, 2002). According to Goodman (2002), freshman and particularly sophomore year were, in fact, the years women were most likely to actually leave engineering. Additionally, researchers have indicated that perceived low ability, academic difficulties, performance problems or perception of low grades are major reasons why female students quit a particular major field (Anderson, 2000; Brainard & Carlin, 2001; Goodman, 2002; Lent et al., 2002). Generally, the first engineering classes students take at the university are the hardest ones, therefore it is important to place the very best professors in the introductory courses, so that students enjoy them, perform well in them, feel supported and motivated, and do not get discouraged about their decision to obtain an engineering degree (May & Chubin, 2003; Sheahan & White, 1990).

Peer support was another factor that the majority of the study participants mentioned assisted them in completing their engineering degrees. More specifically, the participants indicated that studying with classmates/friends, and having their support were major factors that contributed to their retention in engineering. Similarly, several research studies that have focused on women in engineering have concluded that it is very important for women to have support from their peers (Cohoon, 2006; Cuny & Aspray, 2002; Goodman, 2002; National Research Council, 2006). Researchers recognize peer interaction as vital to many women undergraduates, who need to feel they are part of a larger community in engineering. Peer support and interaction allows students to build networks and to feel that their presence in engineering is important to others (Cohoon, 2006; Goodman, 2002). Peer groups can ward off loneliness because it makes it easier to meet and make friends with other students. Peer interaction can counteract the isolation that women experience by providing them with information, support, and the knowledge that they're not

alone in the challenges they face (Goodman, 2002). Peer interaction can offer both academic and personal support and provide motivation to persist in their engineering programs. By participating in peer support groups females can sought help with homework that is difficult through support activities like peer tutoring and study groups. While personal interaction with their peers can be a major source of their emotional support or other personal needs. Peer support is an important factor in students' motivation to persist in their programs (Cohoon & Aspray, 2006; Cuny & Aspray, 2002; Schultz, Main, & Huebner, 1998). The importance of having peers with whom women can share their difficulties, learn from each other, and assist each other is evident throughout the literature and participants of this study.

It should be noted that this study is subject to some limitations. The study focused on a single institution and addressed experiences of only female engineering students. In addition, representation from under-represented minority engineering students was low (6 percent); therefore, comparisons could not be made. More importantly this study extended the women in engineering literature and provided valuable insights from which universities, researchers, and female students can directly benefit. The uniqueness of this study relies on the fact that the population for this study involved graduating senior female engineering students. Research that focuses on these women is very valuable since these female students can provide an accurate inside scope due to the fact that they have recently gone through situations that female students experience by being a minority in engineering, and they have successfully overcome any obstacles that were presented in their way towards obtaining an engineering degree. This study expands the women in engineering literature and found valuable insights that can help improve the engineering environment in a manner that attracts further female participation.

**References**


Amenkhienan, C., & Kogan, L. (2004). Engineering student' perceptions of academic activities and support services: Factors that influence their academic performance. *College Student Journal*, 38 (4), 33-46.

Anderson, I. (2002). The social construction of female engineers: A qualitative case study of engineering education. [The University of Saskatchewan].

Anderson-Rowland, M.R. (1996). A first year engineering student survey to assist recruitment and retention. *Proceeding of the 26th Annual Frontiers in Education Conference,1,* 6-9.

Anderson-Rowland, M.R. (2000). Understanding engineering students for better recruitment strategies: A four-year study. *Proceeding of the 30th Annual Frontiers in Education Conference, 1,* 19-25.

Anderson-Rowland, M.R., Urban, J.E., & Haag, S.G. (2000). Including engineering students. *Proceeding of the Frontiers in Education Conference,* 5-12.

Anwar, S., Acar, N., & Rung, K. (2002). A university-wide women in sciences and engineering (WISE) program. *Proceedings of the 32nd Annual Frontiers in Education Conference, 2,* 11-15.

Bell, A., Spencer, S., Iserman, E., & Logel, C. (2003, October). Stereotype threat and women's performance in engineering. *Journal of Engineering Education,* 307-312.

Bennet, D. (1996). Voices of Young Women in Engineering (CTT Reports/ No. 4): Center for Children and Technology.

Blaisdell, S. (2002). Starting a women in engineering program. *Proceeding of the 32nd Annual Frontiers in Education Conference*, (2) 1-4.

Brainard, S. G., Carlin, L. (2001). A six-year longitudinal study of undergraduate women in engineering and science. In Lederman, M., Bartsch, I. (eds.), *The Gender and Science Reader*. New York: Routledge.

Bystydzienski, J., & Bird, S. (2006). *Removing barriers: Women in academic science, technology, engineering, and mathematics*. Bloomington, IN: Indiana University Press.

Camp, T. (1997). The incredible shrinking pipeline. *Communications of the ACM,* 40, 10, 103-110.

Cannon, M. E., & Lupart, J. L. (2001). Gender differences in grades 7 and 10 students towards science, math, computers, and future career choices. Paper presented at the 2001 Joint NAMEPA/WEPAN National Conference, Alexandria, VA.

Cohoon, J. M. (2006). Just get over it or just get on with it: Retaining women in undergraduate computing. In J. M. Cohoon and W. Aspray (Eds.), *Women and information technology: Research on underrepresentation*. Cambridge, MA: The MIT Press.

Cohoon, J. M., & Aspray, W. (2006). A critical review of the research on women's participation in postsecondary computing education. In J. M. Cohoon and W. Aspray (Eds.), *Women and information technology: Research on underrepresentation*. Cambridge, MA: The MIT Press.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage Publications.

Cuny, J., & Aspray, W. (2002). Recruitment and retention of women graduate students in computer science and engineering: Results of a workshop organized by the Computing Research Association. *SIGCSE Bulletin,* 34 (2), 168-174.

Diamond, W. D., & Gagnon, J. P. (1985). Obtaining pharmacy class feedback through the use of focus group interviews. *American Journal of Pharmaceutical Education*, 49 (1), 49-54.

Eccles, J. S. (1994). Understand women's educational and occupational choices: Apply the Eccles et al. model of achievement-related choices. *Psychology of Women Quarterly*, 18, 585-609.

Gibbons, M. T. (2008). Engineering by the numbers. Retrieved February 3, 2009, from http://www.asee.org/publications/profiles/index.cfm

Goodman, I. F. (2002). A comprehensive evaluation of women in engineering programs. Retrieved January 9, 2008, from http://www.grginc.com/WECE_FINAL_REPORT.pdf

Henes, R., Bland, M.M., Darby, J., & McDonald, K. (1995). Improving the academic environment for women engineering students through faculty workshops. *Journal of Engineering Education, 84* (1), 1-9.

Huff, C. (2002). Gender, software design, and occupational equity. *SIGCSE Bulletin*, 34 (2), 112-117.

Krueger, R. A. (1994). *Focus groups: A practical guide for applied research*. Thousand Oaks, CA: SAGE Publications.

Lent, R.W., Brown, S.D., Talleyrand, R., McPartland, E.B., Davis, T., Chopra, S.B., et al. (2002). Career choice barriers, supports, and coping strategies: college students' experiences. *Journal of Vocational Behavior, 60,* 61-72.

Loftus, M. (2007, December). Why won't she listen? *PRISM*, 26-32.

Margolis, J., & Fisher, A. (2002). *Unlocking the clubhouse: Women in computing*. Cambridge, MA: The MIT Press.

Martinez, M. E. (1992). Interest enhancements to science experiments: Interaction with student gender. *Journal of Research in Science Teaching*, 29(2), 167-177.

May, G.S., Chubin, D. E. (2003). A retrospective on undergraduate engineering success for underrepresented minority students. *Journal of Engineering Education*, 55 (4), 27-39.

McDill, M., Mills, S., & Henderson, Y. (2000, July). Tracking the gender barrier: A 1990's follow-up study. *New Frontiers, New Traditions.*

Merriam, S.B. (1998). *Qualitative Research and Case study Applications in Education.* San Francisco: Jossey-Bass Inc.

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: A sourcebook of new methods (2nd ed.). Newbury Park, CA: Sage.

Moskal, B.M. (2000, October). Looking to the future: Women in science and engineering. *Proceeding of the 30th Annual Frontiers in Education Conference,* 19-22.

National Academy of Science. (2007). *Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering*. Washington, DC: National Academies Press.

National Research Council. (2006). *To recruit and advance: Women students and faculty in science and engineering*. Washington, DC: National Academies Press.

National Science Foundation (2004). A companion to science and engineering indicators 2004*, National Science Foundation report*. Retrieved March 26, 2005, from http://www.nsf.gov/sbe/srs/nsb0407/start.htm

O'Brien, B. (2004). Engineering shortages could restrict U.S. economic growth. Retrieved March 26, 2005, from http://www.marquette.edu/opa/newsroom/news/pr06224.shtml

Peter, K., & Horn, L. (2005). *Gender differences in participation and completion of undergraduate education and how they have changed over time*. National Center for Educational Statistics, U.S. Department of Education. Washington, DC: Government Printing Office.

Robst, J., Keil, J., & Russo, D. (1998). The effect of gender composition of faculty on student retention. *Economics of Education Review*, 17 (4), 429-439.

Schultz, K., Main, K., & Huebner, J. (1998). In pursuit of science: Factors affecting the success and retention of women in science. [Conference of the Canadian Coalition of Women in Engineering, Science and Technology]. *Women in the Workplace. Achieving Harmony,* 35-41.

Seymour, E. (2001). Tracking the processes of change in US undergraduate education in science, mathematics, engineering, and technology. *Issues and Trends,* 79-105.

Seymour, E., & Hewitt, N. (1997). *Talking about leaving*. Boulder, CO: Westview Press.

Sheahan, B.H., & White, J.A. (1990). Undergraduate engineering education? [*Quo Vadis*]. *Journal of Engineering Education, December,* 1017-1022.

Teague, J. (2002). Women in computing: What brings them to it, what keeps them in it? *ACM SIGCSE Bulletin*, 34, (2), 147-158.

Thom, M. (2002). *Balancing the equation: Where are women and girls in science, engineering and technology*? New York, NY: National Council for Research on Women.

Thom, M., Pickering, M., & Thompson, R. E. (2002). Understanding the barriers to recruiting women in engineering and technology programs. *32nd ASEE/IEE Frontiers in Education Conference, F4C,* 1-6.

Tobias, S. (2000). Ideology of recruitment of women in science and math. Paper presented at the National Symposium on the Advancement of Women in Science, Harvard University, Cambridge, MA.

U.S. Bureau of Labor Statistics. (2005). *Economic and employment projections*. Office of Occupational Statistics and Employment Projections, U.S. Department of Labor, Washington, DC, 217-225.

U.S. Census Bureau (2005-2006). Statistical abstract of the United States. Retrieved on January 5th, 2008, from http://www.census.gov/prod/2005pubs/05statab/educ.pdf

U.S. Department of Education. (2006). Press release: In case you missed it: Let's get serious. Retrieved January 14, 2008, from http://www.ed.gov/news/pressreleases/2006/02/02072006.

U.S. Department of Labor. (2006). *Women workers: Trends and issues*. Washington, DC, 14-18.

Vogt, C. M. (2008). Faculty as a critical juncture in student retention and performance in engineering program. *Journal of Engineering Education*, 97, 1, 27-36.

Wentling, R. M., & Thomas, S. P. (2007). The career development of women executives in information technology. *Journal of Information Technology Management*, XVIII (1), 33-48.

Widnall, S. E. (2000). Digits of Pi: Barriers and enablers for women in engineering. National Academy of Engineering. *The Bridge*, 30 (3), 9-15.

Zeldin, A., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal, 37*, 215-246.