

Involvement of Women Engineers at Mercer University

Monika Bubacz¹, Joan M. Burtner², Laura Lackey³, Laura E. Moody⁴

Abstract – The goal of this research was to evaluate the position of students and faculty woman engineers and to report their perception regarding belonging to the community of the School of Engineering at Mercer University. Women currently represent about 23% of the engineering faculty, which is well above the national average of around 10%; yet out of six departments two have none and two have only one female representative each. Since the 1990s, the national average of female engineering students has been relatively stable and is approximately 20% of the engineering student population; freshmen enrollment at the Mercer University School of Engineering follows this trend. However, according to ASEE Prism Magazine [1], Mercer University School of Engineering is number three in the United States for awarding the highest percentage of engineering bachelor's degrees to women. This paper consists of statistical analysis of employment and enrollment data and information obtained from interviews and open discussions with students and faculty.

Keywords: engineering education, gender studies

INTRODUCTION

The National Academy of Engineering envisions an “Engineer of 2020” as a person who demonstrates dynamism, agility, resilience, and flexibility to design for an uncertain and rapidly changing world. This vision shows a growing recognition of the need for a more diverse engineering workforce. According to the literature and our experience, women prioritize teamwork as a key component of engineering. Also, women define engineering in terms of designing/creating/building at a higher rate than men [2]. Men reported higher gains than women on the technical skills, including confidence on engineering knowledge as a career and problem-solving skills. However, analysis of this and other data revealed that women are able to learn the material as effectively as the male students and define engineering, approach engineering problems, and engage in their overall engineering education more broadly than men. It is important to force a shift away from a perception of engineering as a “cold” technical profession to a perception that it facilitates invention, innovation, and helping society and the environment.

Based on 2000 NSF data [3] the nation’s workforce is composed of 46% women, but only 23% of scientists and engineers are women. Engineering is one of the least equitable professions with 9% women, earning approximately 95% of the wages earned by men [4].

Potentially, the reason for the gender exclusion can be found in the origin of the profession [5]. Engineering duties may involve labor intensive, sometimes dangerous and physical encounters. Historically, such activities were

¹ Assistant Professor, Department of Mechanical Engineering, Mercer University, 1400 Coleman Avenue Macon, GA, bubacz_m@mercer.edu

² Associate Professor, Department of Industrial Engineering, Mercer University

³ Associate Professor, Department of Environmental Engineering, Mercer University

⁴ Associate Professor, Department of Industrial Engineering, Mercer University

perceived as inappropriate for women. Other forces that reinforce the masculinity of the profession are that makers of model trains, cars, and airplanes, and other technological toys, market them only to boys influencing them into becoming future engineers. Young girls who express technical interests are often deliberately discouraged by negative remarks from family or teachers. In general, women's choices are based on short and long term goals, self identity and psychological needs that are different from those of men. Women have an inner sense of connection to others. Good teachers and team work are positive themes while independent work separates and isolates, and when topics become decontextualized they are uninteresting.

According to the October 2007 edition of ASEE Prism magazine [1] Mercer University School of Engineering (MUSE) is ranked third out of a pool of 261 schools in the United States for awarding the highest percentage of engineering bachelor's degrees to women. During the 2006-07 academic year, 36.6% of MUSE engineering graduates were women. Only schools that awarded 50 or more B.S. engineering degrees were considered in the study.

“Named one of the top undergraduate engineering schools in the Southeast by U.S. News & World Report for the past nine years, the Mercer School of Engineering is known for producing graduates ready to work in industry and government. The School's innovative curriculum emphasizes teamwork as well as opportunities to gain hands-on experiences. Mercer engineering graduates are known for their strong communication skills, as Mercer is one of few engineering institutions in the nation to house a Technical Communication Department within the Engineering School.” [6]

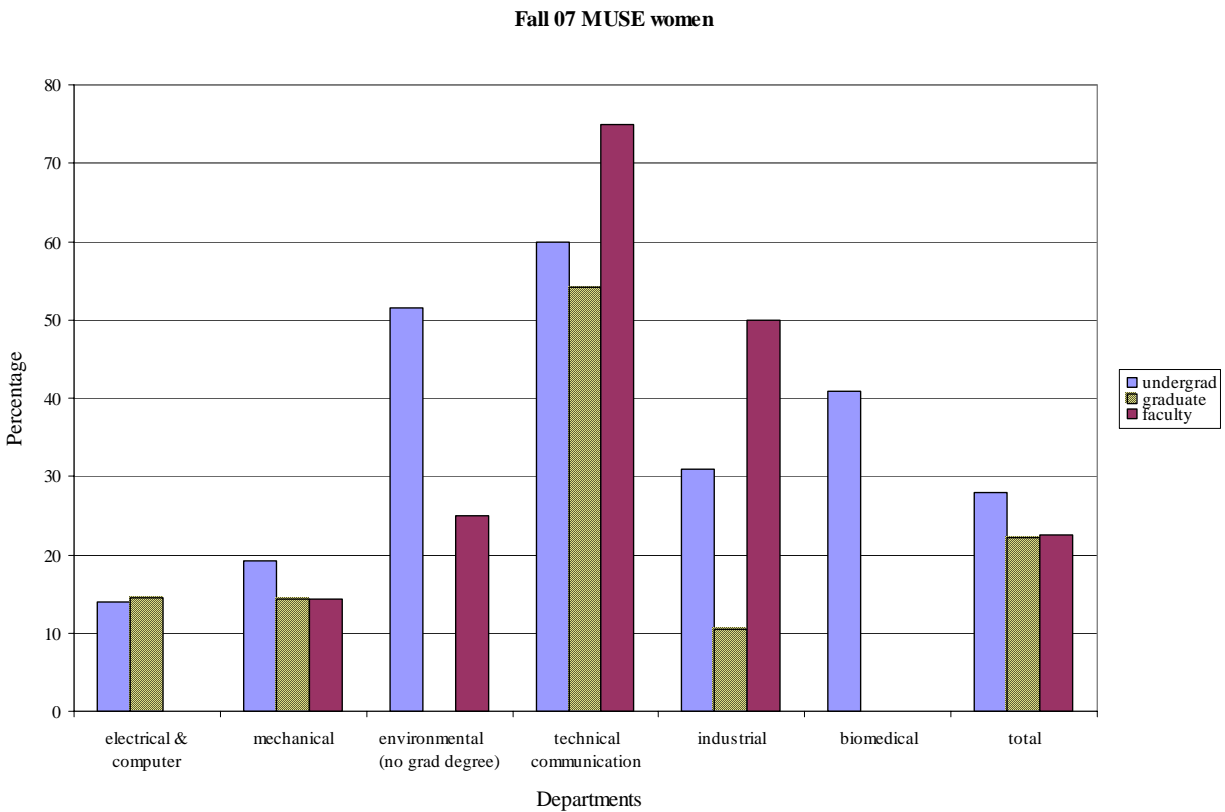


Figure 1. Current percentage of women by discipline in Mercer University School of Engineering

INVOLVEMENT OF FEMALE ENGINEERING STUDENTS

The national average of female engineering students has been relatively stable since the 90s and is approximately 20% of the engineering population; however, this trend is primary due to a growth in new types of engineering programs such as Architecture, Bio-technology, Environmental and Management Engineering that attracted women. At the traditionally 'hard core' technology based programs like Electrical, Electronics and Computer, Mechanical, and Civil Engineering, women make up no more than 5%. Mercer School of Engineering female students percentage follows a similar trend as shown in Figure 1.

The ASEE Prism article [1] also shows Mercer as tying for ninth place with 50% of graduates being female in "biomedical engineering bachelor's degrees" from a pool of 77 schools that awarded 20 degrees or more. Biomedical engineering is the fastest-growing engineering field, having increased by 187% since 1999 and currently having 40.7% of female graduates, which is the highest percentage among all the engineering fields.

Table 1 shows comparison between national averages [7] and MUSE in percent of female faculty and student enrollment and percent of degrees awarded to undergraduate and graduate female students. The Position column within the table is calculated for cases when Mercer exceeds the average; calculations are based on population conditions. Departments of Biomedical and Environmental Engineering, Industrial Management, and Technical Communication (TCO) seem to be the leaders with at least 30% of undergraduate female students. Out of these four departments currently only Technical Communication has female graduate students.

Table 1. Comparison of female faculty and student enrollment and degrees numbers based on ASEE 2006 Report on Engineering Education [7]

		Enrollment			Degrees		
		National average [%]	Mercer University [%]	Position	National average [%]	Mercer University [%]	Position
	Women faculty	11.28	18.18	21***	-	-	-
Undergraduate	Total	17.15	27.32	23*	19.26	36.56	3**
	Biomedical	37.84	46.84	7**	40.73	50	9***
	Computer	9.67	8.33	-	11.26	0	-
	Electrical	11.54	17.65	26**	14.18	29.41	13****
	Management (Industrial)	22.69	30.77	4****	28.57	40	(5 students)
	Environmental	40.24	51.54	10***	44.16	50	(4 students)
	Industrial	29.34	23.53	-	32.97	43.75	20****
	Mechanical	10.6	20	19**	13.1	27.78	10****
	Other (TCO)	19.26	50	2***	21.54	50	(4 students)
Graduate	Total	22.16	30.61	18**	22.56	20	-
	Biomedical	39.97	0	-	37.33	0	-
	Computer	25.45	24.32	-	27.22	23.08	-
	Electrical	19.17	30	12****	20.20	12.5	-
	Management (Industrial)	21.75	0	-	22.23	0	-
	Mechanical	13.35	10	-	13.58	0	-
	Other (TCO)	24.05	66.67	1***	24.08	50	(2 students)

Position is based on conditions:

* for minimum of 100 ** for minimum of 50 *** for minimum of 20 **** for minimum of 10

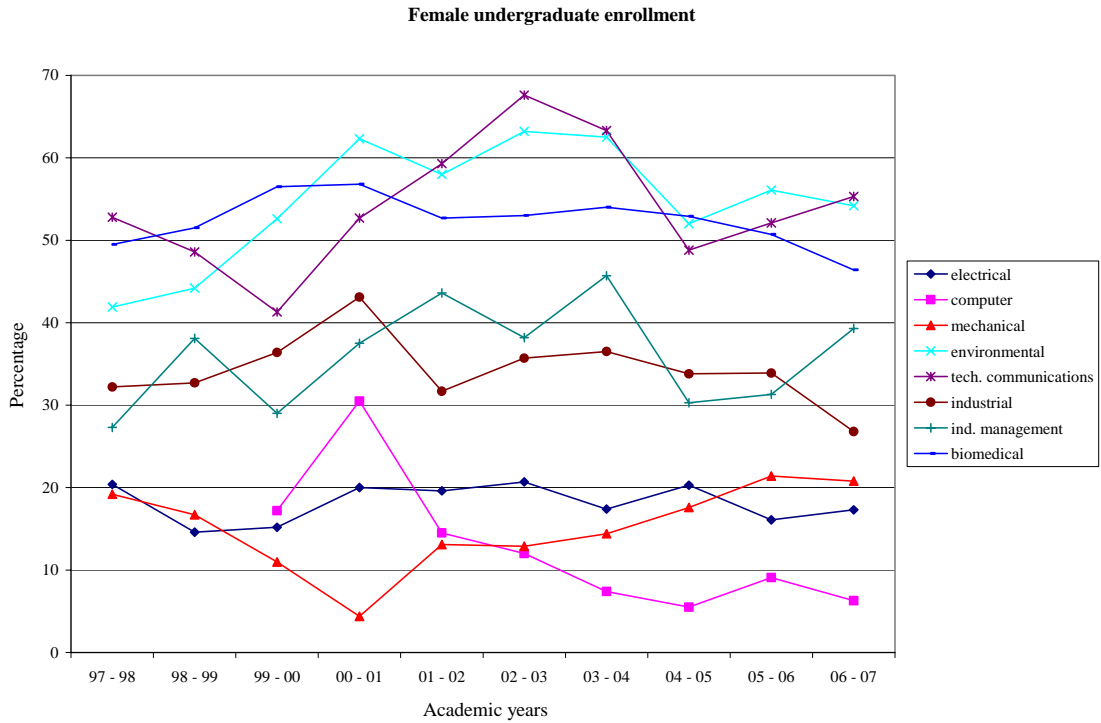


Figure 2. Percentage of female undergraduate enrollment by discipline during last 10 years

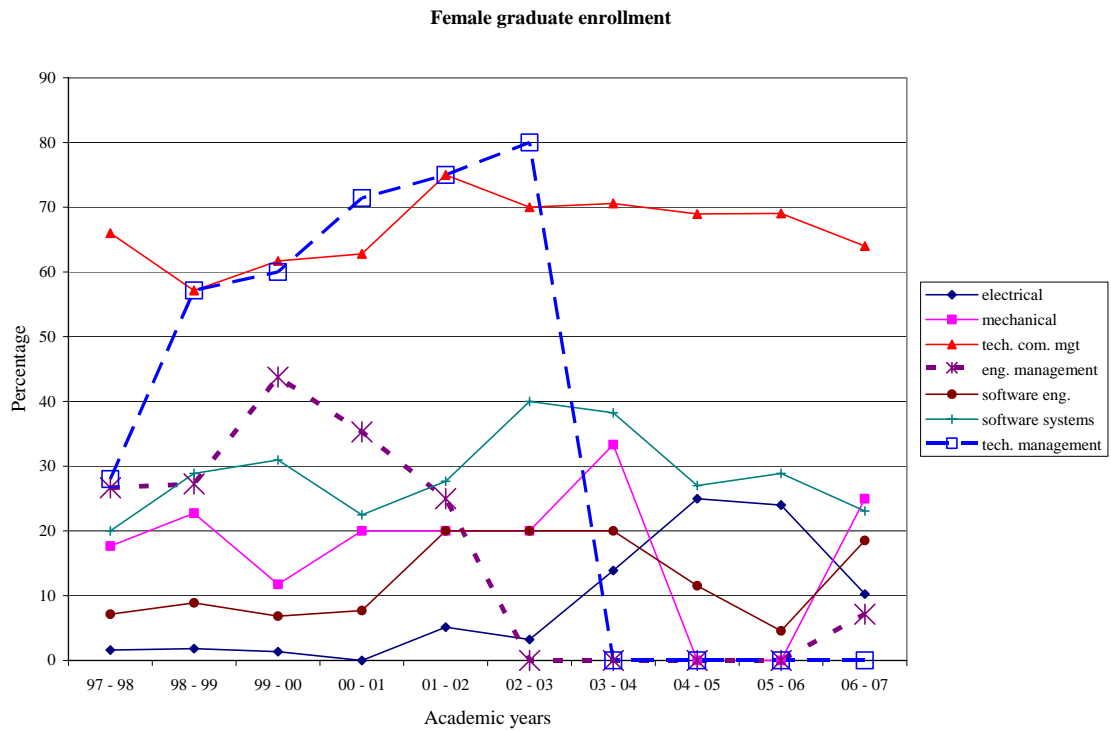


Figure 3. Percentage of female graduate enrollment by discipline during last 10 years

Figures 2 and 3 present fluctuations in the percentage of female undergraduate and graduate student enrollment over the last 10 years. Figure 2 shows that the departments having the highest number of female undergraduates are: Environmental and Biomedical Engineering, and Technical Communication. For the graduate level Figure 3 proves Technical Communication to be the most popular among the female students. Unfortunately, the Department of Environmental Engineering doesn't have a Masters degree in its curriculum and the Department of Biomedical Engineering has not had female graduate students since the beginning of the program in 2000. Also, the Technical Management graduate program offered by the Department of Industrial Engineering has not had female students since 2003.

Step one to retaining female engineering students is building a strong community for undergraduate women to help alleviate that all-too-familiar sense of isolation common among female engineers. Not surprisingly, a few open faculty office doors can make a huge difference in whether a student sticks around or not. We expect faculty to be mentors, and that means that the doors are open and students can come and talk to us about not just academia but anything in their extracurricular lives. But support programs alone can not do it all. Research shows that women have different learning styles from men. Women tend to thrive in project-based learning rather than lecture courses, especially when there is teamwork involved [8].

According to existing research data, women leave high school with less clearly defined career paths than do their male peers, and are more apt to choose a major to please important people in their lives. However, women also feel more at liberty to abandon choices which had been pressed on them if they become unhappy with their initial choice [9].

Female engineering students realize sooner than many of their male peers how important it is to support each other emotionally and intellectually. They are helped in this by a marked preference for collaboration over competition in their approach to learning and the accomplishment of tasks, and less commonly feel it is preferable to work alone.

Based on interviews and open discussions with twenty (20) MUSE undergraduate (17 out of 20) and graduate (3) students, both female (15) and male (5), we came to the following conclusions. Our students come to Mercer University basically because of small size classes and broad range of scholarships, both academic and athletic. Students also report that they are skilled in science and mathematics; however they do not want to pursue their education in these fields due to perceived limited career choices. Following family tradition, active influence of high school teachers, and better job options were other often mentioned reasons for choosing engineering. Some additional reasons mentioned by female students include:

- engineering is the hardest major and she likes the challenge (1),
- engineering is easy according to the engineers in the family (5),
- Walt Disney Imagineering (1),
- physics and engineering seminars in high school (3),
- family members are engineers (8),
- better engineering scholarship offer even though they applied for Pre-Med or Pre-Law (4).

Young women who survived the weed-out process are confident with their major choice. Both senior undergraduate and graduate students are comfortable working with male students and male only faculty. They often feel more accomplished because of working in male dominated field and would choose engineering again. Hands-on experience helps to gain some technical skills and engineering understanding, however male students usually "know better" and have common technical experience. One female student mentioned "it was weird to be the only girl in machine shop." Also, there still exists a stereotype about girls getting better grades; nevertheless both male and female students agreed that they are graded fairly. "Mercer makes you feel equal."

INVOLVEMENT OF FEMALE ENGINEERING FACULTY

For many women entering college, engaging the teacher in a personal dialogue appears to be critical to the ease with which they can learn and to their level of confidence in the adequacy of their performance [9]. Young women who are looking for encouragement to bolster their self-confidence, but who cannot evoke it from faculty tend to feel discouraged even though faculty may have said nothing negative to them. The personal style of some faculty, and

their active, open encouragement of women in their classes or in advisory sessions, make an enormous difference to the confidence with which women tackle their work, and therefore, to their likelihood of persistence.

Female students in departments with no female faculty may experience more difficulty believing that their presence in the major is acceptable. Being taught by female faculty is important in helping undergraduate women feel more confident that they belong in the major and that they can succeed. Female professors tend to use a wider range of teaching techniques than male professors and to broaden their curriculum to include the female experience. Women faculty are believed to create a more egalitarian atmosphere in their class-rooms, both between students, and between teacher and learners. Where the faculty and student body is predominantly male, the male culture is stronger, and it is more difficult for women to question, tolerate, or change the atmosphere. Once the commitment to change is made, and women begin to feel the benefits of it, the effects are cumulative. Encouraging faculty to be more pro-active in their support of young women also allows a more nurturing attitude toward young men [9].

As shown in Table 1 and Figure 1, MUSE women faculty increased from 18% in 2006 to 23% at present through the addition of the author to the Department of Mechanical Engineering. The total number of the MUSE female faculty is seven (7): three (3) women housed in Technical Communication, two (2) are Industrial, and one (1) each for Environmental and Mechanical Engineering. The Biomedical and Electrical & Computer Engineering Departments do not have any female faculty. The Mechanical Engineering Department did not have a female faculty member prior to Fall 07 (with an exception of one year in the mid 90s). According to the ASEE Report on Engineering Education having 18% of the engineering faculty being female placed MUSE in a 21st position nationally.

Even though women earn more Ph.D.s than men on a national basis, they occupy the low ranks of the ladder in Academia [5]. There are more women in the Assistant Professors and 'Other' categories than full Professors and are more in four year colleges than in Research Institutions. This means the attrition rate of women before reaching the top in academia is higher than that of men. Women occupy the majority of the tenure track, and untenured categories.

A few questions arise: are women faculty treated as symbols or representatives of the minority category rather than individuals; how does the experience of being in the numeric minority influence their work and home-life; and how many women are required for a balanced situation?

Mercer School of Engineering has four female engineering faculty representatives, all of them with doctoral degree. Three of them have tenure and one is on tenure track. No other female faculty have stayed at MUSE long enough to be considered for tenure such that the success rate for women applying for and being granted tenure is 100%; the same can not be said for male engineering faculty. Two of the female tenured faculty entered the School with Masters degrees only and were encouraged to pursue a PhD; both of them accomplished that endeavor. The fourth female faculty joined the School recently. The search included both male and female qualified candidates.

Based on interviews and open discussions with MUSE female engineering faculty we came to the following conclusions. Within MUSE, female faculty do not consider themselves discriminated against; they feel accepted and equal. However, as they have been exposed to male dominated environment since their science and engineering schoolwork, they are accustomed to being a minority and may not realize they are treated as the "weaker sex." Female faculty are conscious that they may be treated differently than men because they are women. One very important question arose - "Do we have to achieve more than men to prove ourselves?" - and remained without firm answer.

As a conclusion to this study we would like to continue the research on the percentage of female engineering faculty. For instance, what fraction of the applicants are women that apply for engineering academic position openings and what is their success rate. Also, we would like to study the influence of average faculty age on general gender perception. The results of these investigations will be presented in further publications.

CONCLUSIONS

The more women we have in engineering majors, the more they collectively teach their faculty and peers how to behave towards women, and the easier it becomes for them and the women who follow them. An important task for department leaders is the development of a student culture that is intolerant of rude or discriminatory behavior, and in which the social and working relationships of young men and women settle into more comfortable patterns [9].

Based on our research on gender issues in Mercer University School of Engineering we can boldly state that women, both students and faculty, feel accepted, equal, and accomplished; Mercer University again proved to be an excellent learning and working environment for both young people and professionals of both sexes. However, that still can be improved by increasing the numbers of female engineering students.

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