

# **Increasing the Percentage of the Female Faculty at the College of Engineering by Understanding the Reasons for the High Enrollment and Retention Rates of Female Engineering Undergraduate Students**

**Sonia M. Bartolomei-Suárez, Viviana Cesani-Vázquez, María Irizarry  
Department of Industrial Engineering**

**Freya M. Toledo-Feria  
Department of General Engineering  
University of Puerto Rico Mayagüez**

## **Abstract**

For the last fifteen years the University of Puerto Rico at Mayagüez (UPRM) has been noted for the high percentage of female students in its College of Engineering (COE). Current enrollment statistics show that 35% of its students are females, one of the highest rates in the United States. According to the American Association for Science and Engineering Education (ASEE), during the academic year 2002-03, the UPRM engineering program was one of the largest in the nation, ranked number 13 in engineering undergraduate enrollment (4476 students) and number 19 in engineering Bachelor's degree awarded (710 degrees) [3]. That year, approximately 39% of such degrees were awarded to women ranking UPRM as one of the universities with the highest number of degrees in engineering conferred to women.

During the same academic year (2002-03), the faculty of the COE consisted of 183 professors, of which only 26 were female with tenure or in tenure track, comprising only 14.21% of the faculty.

When that female representation within the faculty of the COE is compared to the success achieved in recruiting and retaining female students at the undergraduate level, a serious concern arise. At the COE there is a bigger pool of potential female candidates for graduate school and academia than in other higher learning systems but this is not reflected in its current faculty composition.

In this paper the reasons for the high enrollment and retention rates of female undergraduate students are investigated and possible courses of action are recommended to the COE in order to increase the percentage of female faculty.

## **Introduction**

Puerto Rico has a combined public and private system of higher education with an enrollment of over 170,000 students. Of these, over one third is enrolled in the University of Puerto Rico's (UPR) state multi-campus system. The Mayagüez Campus of the UPR (UPRM), with approximately 12,000 students enrolled, houses the only College of Engineering within the state university system. It offers programs in Civil, Chemical, Electrical, Computer, Industrial, and Mechanical Engineering, all accredited by ABET. Master's programs in all

basic sciences, mathematics, and engineering, and PhD programs in Civil, Chemical, and Computer Science Engineering are also offered. The UPRM has approximately 5,000 students enrolled in science programs and more than 4,500 in engineering.

For the last fifteen years, UPRM has been noted for the high percentage of women studying engineering. Enrollment statistics show that 35% of students are females, one the highest rates in the United States. Furthermore, according to the American Society for Engineering in Education (ASEE) our engineering program is one of the largest in the nation. For the academic year 2001-02, UPRM conferred 680 degrees in engineering and forty percent of such degrees were awarded to women. UPRM rank as one of the universities with the highest number of degrees in engineering conferred to women. Throughout the years many factors have been hypothesized as possible reasons for such high recruitment and retention rates, however, no formal studies have been conducted to validate these.

Despite the UPRM success in the recruitment and retention of engineering female students, women are significantly underrepresented in the engineering faculty workforce. Presently, less than 15% of the faculty members are females with tenure or on tenure track. This percentage is well below the national average.

This paper addresses the situation of female students and faculty in the COE. First it presents a profile of the students at UPRM. Then it presents a study on the factors leading to the high female students' enrollment and retention rates. Later it presents the female faculty profile and at the end it suggests courses of action to increase the female faculty in the COE.

### Students Profile at UPRM

Enrollment statistics per engineering department of the UPRM for fall 2004 are included in Table 1. The Department of Chemical Engineering has the highest female enrollment per department (64%), followed by Industrial (55%), Civil (31%), Electrical/Computer (24%), and Mechanical Engineering (21%). Longitudinal data covering from 1990 to 2002, presented in a study by Bartolomei-Suárez and González-Barreto [1], shows a similar

Table 1- Enrollment statistics for the fall 2003-04

Engineering Department	Percentage Male Students	Percentage Female Students	Total No. of Students
Chemical	36	64	688
Civil	69	31	1064
Electrical/Computer	76	24	1375
Industrial	45	55	581
Mechanical	79	21	768
Total	65	35	4476

enrollment trend by department. Average values for that period include Chemical (59.8%), Industrial (57%), Civil (32%), Electrical/Computer (28%), and Mechanical Engineering (22%).

## Factors Leading to a High Female and Retention Rates

A questionnaire was designed and distributed among engineering students to improve the understanding of the reasons behind the COE's success in the enrollment and retention of female students. Questions addressed mainly high school performance and coaching; cultural and motivational factors, family profile, and university environment. A second objective of the survey was to identify perceptual differences between male and female students.

A total of 199 students were interviewed from which 47% were females and 53% were males. The sample's gender profile is very similar to the gender profile of the college of engineering where 40% of graduates are female. As shown in Figure 1, the sample's profile of females among departments is similar to that of the college of engineering in the sense that the highest percentages of females were from the chemical and industrial engineering departments.

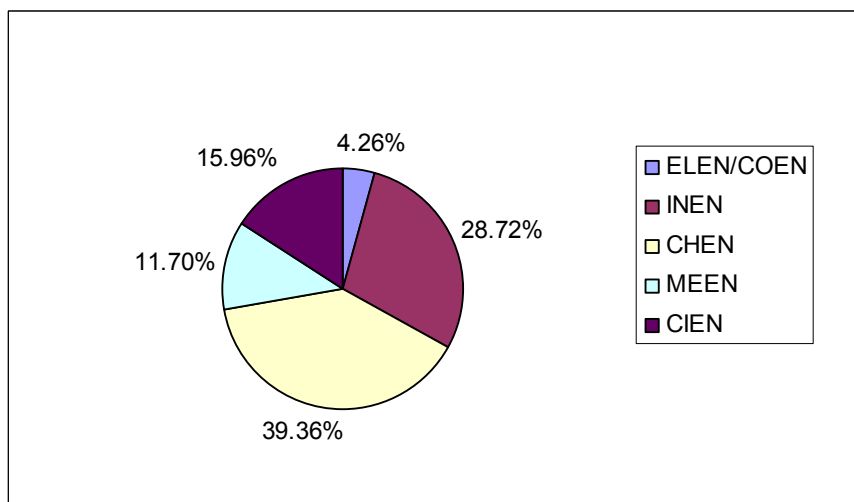


Figure 1 - Distribution of Female Students among Departments

Results from the survey also show that 58% of the students came from the public school system whereas 42% came from private schools. As shown in Figure 2, almost 50% of the students surveyed came from family with incomes under \$30k. One of the questions in the survey asked if low tuition cost was a factor for having such a high enrollment of female students. Results showed that females gave a higher percentage of positive answers (66%) when compared to males (54%). Tuition cost at the UPR is very low when compared to universities at the United States. This added to the fact that 80% of students at UPRM have some kind of financial assistance, might explain why this question did not get a higher percentage of positive answers. In Puerto Rico, students have a great opportunity to study an engineering career. All it takes is a good high school performance in math and doing well on the College Board exam. Unlike many other school systems, math in Puerto Rico is a required course through K-12.

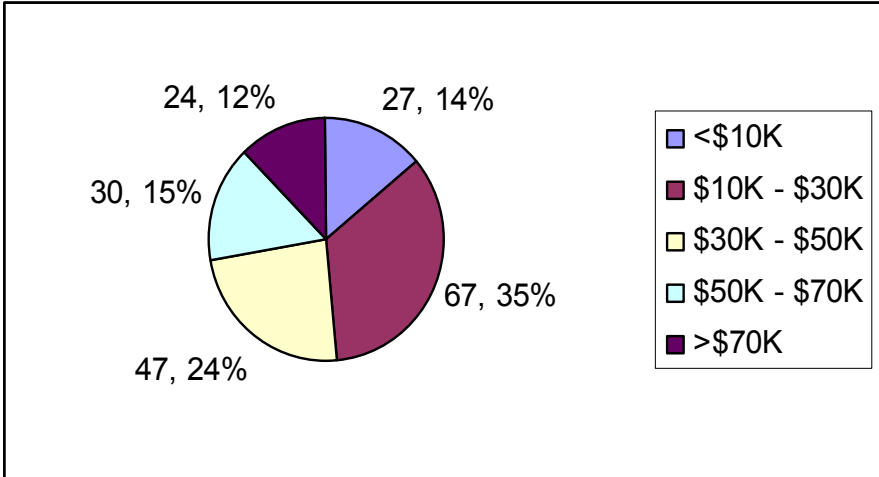


Figure 2 - Distribution of Students by Family Income

When asked if they were the first sibling to attend a university or college, an affirmative answer was given by 37% of males and 43% of females. When asked if they were the first sibling to attend an engineering college or university, positive answers were almost identical for the female (75%) and male (79%) population.

One of the questions in the survey asked students to select from a list those factors which ones had influenced their decision to study engineering. Results for the female and male population are presented in Figure 3.

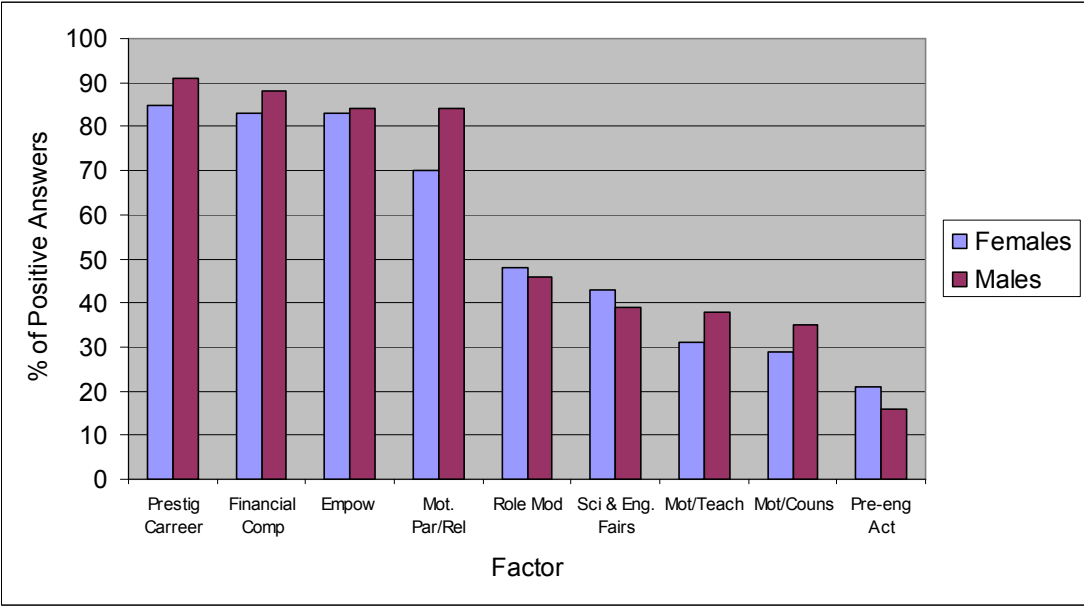


Figure 3 - Factors Influencing their Decision to Study Engineering

Factors with the highest scores for both males and females were: engineering is a prestigious career, the career offers good financial compensation, engineering leads to empowering positions, and positive motivation from parents and relatives. An interesting result is that role models, motivation from teachers and counselors, and participation in science and

engineering activities, all obtained significantly lower scores for both the male and female populations. Motivation from teachers, counselors, and relatives obtained higher scores by the male population than the female population.

Another question was designed to capture the student’s perception on the reasons behind a higher enrollment of engineering female students than the national average. Reasons with the highest percentage of positive answers are presented in Figure 4. It strikes from the results how women perceive themselves and how male responses support this perception. Women in the Puerto Rican culture perceive themselves as highly capable, self-sufficient, and willing to accept challenges and empowering positions. Once again, good role models, participation in science and engineering activities, and encouragement from teachers and counselors are perceived as playing a smaller role.

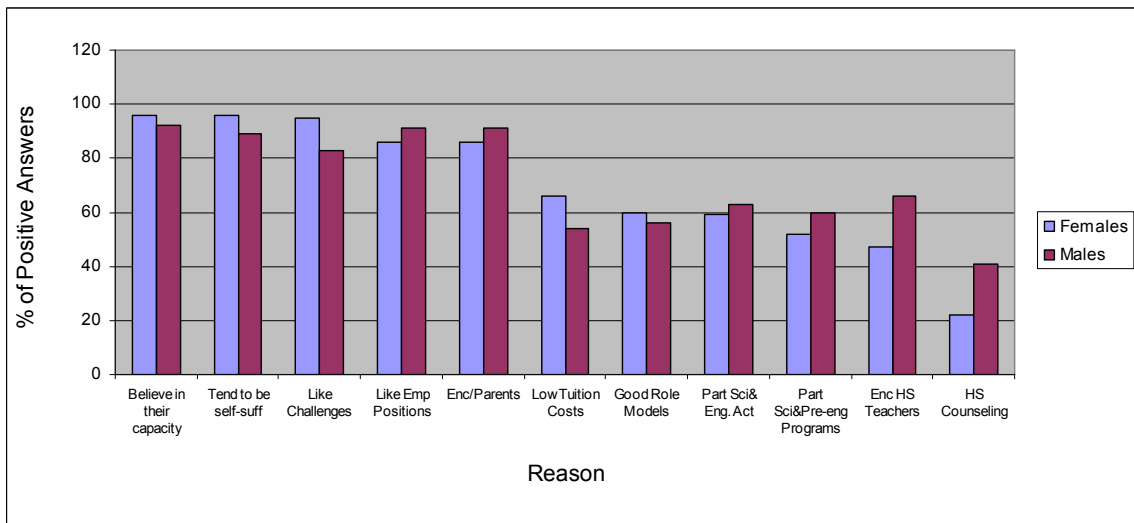


Figure 4 - Factors Perceived as Reasons for Having a High Female Enrollment

The parents’ level of education could be a significant factor influencing the students’ motivation to study engineering and as well as their strong believe in themselves. As shown in Figure 5, more than 69% of female student’s mothers and approximately 56% of their fathers have a bachelor, masters, or doctoral degree. Statistics for the male population were quite similar with 65% and 58%, respectively, with a bachelor or higher degree. Parent's scholastics seem to serve as a motivator even though students did not perceived role models as significant.

Students were also asked to select among a list of factors those perceived important for the high retention rate among female students. As shown in Figure 6, factors deemed important were good studying habits, support and encouragement from other engineering students, non-hostile environment, and support from engineering professors. Results were very similar for the female and male populations.

The fact that at UPRM, in the great majority of cases, the number of students in the classroom does not exceed thirty might explain the importance gave by the surveyed students to the factors related to environment and support. Some of the benefits this scheme promotes are a better interaction among students and between the professor and the students and the possibility of having a better understanding of the students’ needs.

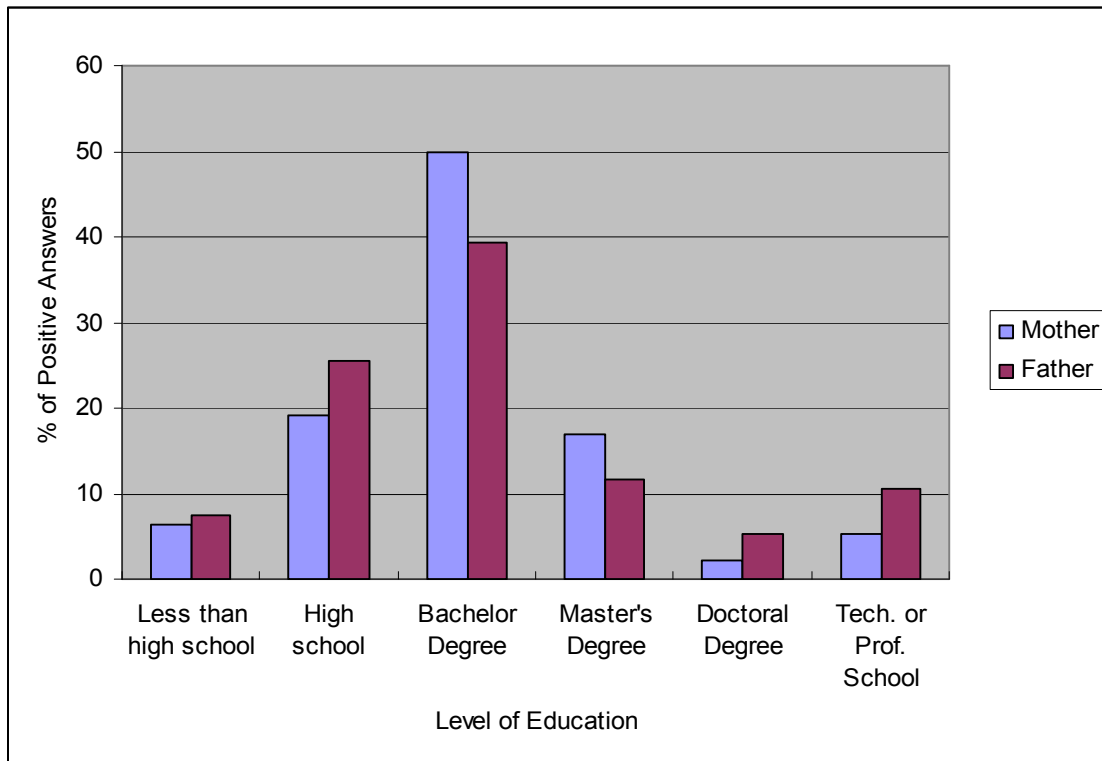


Figure 5 - Parents' Level of Education – Population of Female Students

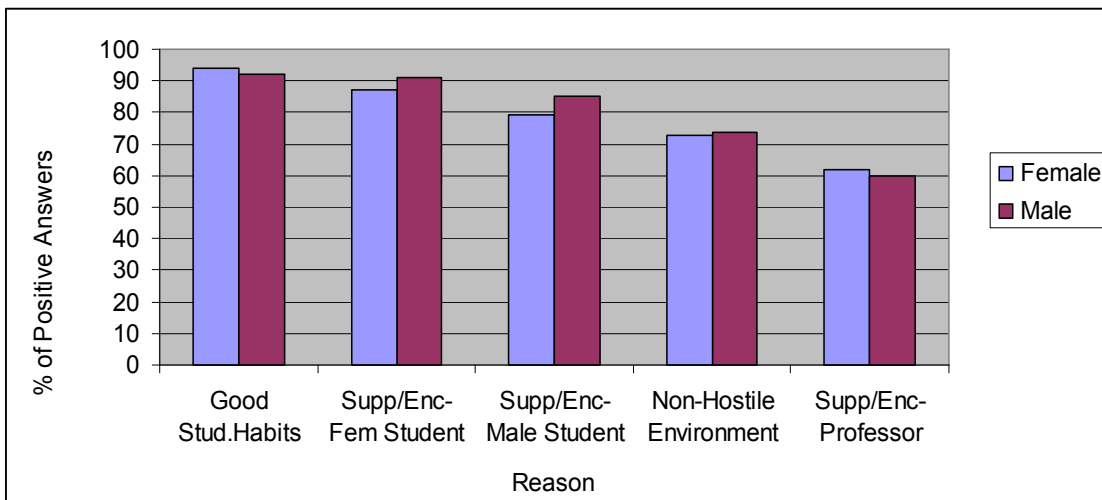


Figure 6 - Factors Related to a High Female Student Retention Rate

### Female Faculty Profile

The faculty of the COE is comprised by 183 professors, of which only 26 are female with tenure or on tenure track, only a 14.21% of the faculty. Table 2 shows the gender distribution by departments, while Table 3 presents the distribution by ranking. Of concern is that less than half of the female faculty has positions higher than Assistant Professor. This result in a

lack of representation at administrative levels including at committees that deal with contracting and evaluating for tenure and promotion.

Table 2 - Faculty distribution by department

	Faculty	Female		Male	
		Total	%	Total	%
Chemical	25	1	4.00	24	96.00
Civil/Surveying	33	6	18.18	27	81.82
Electrical/Computers	50	4	8.00	46	92.00
General	35	7	20.00	28	80.00
Industrial	18	6	33.33	12	66.67
Mechanical	22	2	9.09	20	90.91
Total	183	26		157	
Overall %		14.21		85.79	

Table 3 - Faculty distribution by academic ranking

	Instructor		Assistant Professor		Associate Professor		Full Professor		Other contracts (i.e.)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Chemical	1	0	3	1	7	0	11	0	2	0
Civil /Surveying	1	2	5	2	5	1	16	1	0	0
Electrical /Computers	2	1	6	2	13	1	25	0	0	0
General	5	2	4	2	9	2	10	1	0	0
Industrial	3	3	2	0	4	3	3	0	0	0
Mechanical	2	0	4	0	3	1	11	1	0	0
Total	14	8	24	7	41	8	76	3	2	0
Overall %	7.65	4.37	13.1	3.83	22.40	4.37	41.50	1.64	1.09	0.00

Table 4 - Ratio of female faculty to female students by engineering department at UPRM

Engineering Department	Female Students	Percentage Female Students	Female professors	Percentage of female professors	Student/professor ratio
Chemical	440	64	1	4.00	440:1
Civil	332	31	6	18.18	55:1
Electrical/Computer	335	24	4	8.00	84:1
Industrial	317	55	6	33.33	53:1
Mechanical	160	21	2	9.09	80:1
Total			19		

Table 4 contains the ratio of female faculty to female students by engineering department (excluding the General Engineering Department which is not a degree granting department). It is important to understand that with a lower the ratio of female faculty to female student comes a higher chance of a positive interaction between them. As shown in the table, the IE Department shows an impressive female student percentage (55%) however the female student-to-female professor ratio is 53 to 1. Although, this is the lowest ratio it is still a very high ratio to assure a proper number of role models for female students. A critical scenario takes place at the Chemical Engineering Department, where, while having the highest number

of female students in any department of the COE (64 %), has an appalling female student-to-female professor ratio of 440:1.

The female faculty representation within the COE, when compared with the success achieved in recruiting and retaining female students at the undergraduate level, is way behind from where it should be. Even though the correlation between the percentage of female faculty and the percentage of female students is not very strong, we strongly believe, as evidenced through the statistics presented in Figure 5, that female faculty play an important role in motivating female students in pursuing an academic career. Therefore, some actions should be taken in order to reduce the female student to faculty ratios and improve the interaction between them.

### **Recommendations to Increase the Number of Female Faculty in the COE**

The administration of UPRM, including its Chancellor as well as the Dean of Engineering, is aware of the situation presented in the previous section. Based on the findings of this survey and a previous study directed toward our female faculty (Bartolomei et. al., 2002) [2] several recommendations to university administrators can be made. The main focus should be on developing institutional programs aimed at increasing the number of female faculty in the COE.

One program that has been beneficial to the COE in recruiting new faculty is the sponsorship of our best undergraduate students to pursue graduate studies in engineering fields. Under this program, UPRM pays students a monthly stipend and the full tuition throughout the duration of their masters and doctoral studies in prestigious universities outside Puerto Rico. After completing the PhD degree, the student returns to UPRM as an Assistant Professor to teach and do research for at least the same length of time she/he was sponsored. Unfortunately, very few female students are currently participating in this program. In order for this program to be successful in recruiting women to join the engineering faculty, a certain number of the sponsorships should be set aside specifically for female candidates. It is clear that university administrators should devote time and funding to promote academia as a career, particularly, among the significantly large female undergraduate population. Two findings of the survey specifically support the need for this program: 1) almost 50% of the surveyed students come from a family with an income below \$30K, and 2) surveyed students think low tuition cost was a significant factor for having a high enrollment of female students.

Another program, to which time, money, and effort should be devoted, is in developing programs for retaining our female faculty. Based on the findings of the survey discussed in Bartolomei et. al. (2002) [2] factors such as passion for teaching and doing research, flexible schedule to deal with work and family matters, opportunity to keep up to date with the latest trends in the field, and the opportunity to have a quality of life were of relevance in the process of choosing a career in academia. However, despite all the perceived benefits, balancing work and family was pointed out as one of the biggest challenges to face. Thus, administrators should consider expanding on campus child care facilities and providing afternoon programs for older children in order to ease the pressures of balancing work and family.



## Conclusions

This paper presents a profile of the female students and faculty of the College of Engineering. The statistics clearly show that the UPRM has been very successful in recruiting and retaining female students. The reasons for such high enrollment and retention rates were investigated using a survey administered to 199 engineering students. The results of the survey showed that social, economical, cultural, and educational factors influenced students in their decision to pursue an engineering career.

Among the factors influencing their decision, perception of engineering as a prestigious career, a well remunerated profession, and one that leads to empowering positions, as well as motivation from parents and relatives received the highest scores. One of the most interesting factors derived from the study is that the parent's level of education could be a significant factor influencing the student's motivation to study engineering and their strong believe in themselves. Statistics show that 69% of female student mothers have a bachelor, masters, or doctoral degree, compared to 56% of female student fathers. The statistics for the male population were quite similar.

The most significant factors perceived from both males and females as reasons for having a high female enrollment included the perception of Puerto Rican women as highly capable, self sufficient, and willing to accept challenges and empowering positions. Regarding the factors related to a high female retention rates, the highest scores were given to good studying habits, support and encouragement from other engineering students, a non-hostile environment, and support from engineering professors.

The low rate of female faculty dramatically contrasts with the high female student enrollment and retention rates. The most significant conclusion from these results is an overwhelming need for an institutionalized support to help female faculty face its particular needs and responsibilities.

Future work should be devoted to study in depth the gap between the high female student enrollment and retention rates and the low number of females in the engineering faculty. Answering the following questions might provide some light to this important issue: Is a career in academia perceived as less empowering and prestigious than the traditional engineering career? Is the perceived difference in salaries a major factor? Even when perceiving themselves as highly capable, self-sufficient, and willing to accept challenges, such as graduate school, why academia is not a favorite choice among the COE best and brightest female students?

All these questions and others encountered in this and previous works need to be answered. A detailed study, which is currently in its planning phase, has the specific goal of promoting the pursuit of doctoral degrees among female students.

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## Biographical Information

**SONIA M. BARTOLOMEI-SUÁREZ** is a professor in the Department of Industrial Engineering at the University of Puerto Rico Mayagüez. She obtained a Ph.D. degree from The Pennsylvania State University (1996), a Masters' degree from Purdue University, and a Bachelors degree from the University of Puerto Rico, all in industrial engineering. Her teaching and research interests includes: Simulation, Facilities Planning, Material Handling Systems and Production Control. She is a member of IIE, WEPAN, SWE, and ASEE.

**VIVIANA CESANÍ-VÁZQUEZ** is an associate professor in the Department of Industrial Engineering at the University of Puerto Rico Mayagüez. She obtained a Ph.D. degree from The University of Wisconsin-Madison (1998), Masters' and Bachelors degrees from Texas Tech University, all in industrial engineering. Her research interest includes: Production Planning and Control, Engineering Economics and Risk Analysis, and Supply Chain Management. She is a registered professional engineer and a member of IIE and APICS.

**MARÍA IRIZARRY** is an associate professor in the Department of Industrial Engineering at the University of Puerto Rico Mayagüez. She obtained a Ph.D. degree from North Carolina State University (1996), a Masters' degree from Texas A&M University, and a Bachelors degree from the University of Puerto Rico, all in industrial engineering. Her research areas are: simulation and response surface analysis, human factors, and ergonomic work design. She is a member of IIE and HFES. She is a registered professional engineer.

**FREYA TOLEDO-FERIA** is an assistant professor in the Department of General Engineering at the University of Puerto Rico Mayagüez. She obtained a Masters' degree from The University of Massachusetts at Amherst (1985) and a Bachelors degree from the University of Puerto Rico, all in industrial engineering. She is a member of SWE, Phi Kappa Phi, Alpha Delta Kappa, and Women in Transportation Seminar.