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Women at UPR's College of Engineering: Students and Faculty, Quite a Distinct Reality

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ABSTRACT: *For the last fifteen years, UPRM has stand out by the high percentage of women in its College of Engineering. Current enrolment statistics show that 35% of students are females, one of the highest rates in the United States. According to the American Association for Science and Engineering 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. In this paper, we discuss two important aspects of the College of Engineering (COE) at UPRM: students and faculty. We focus our attention in engineering female students and faculty.*

The paper provides a profile of engineering students and through the administration of a survey we investigate the reasons for such high enrolment and retention rates. The results of the survey showed that social, economical, cultural, and educational factors influence students in their decision to purse an engineering career.

The female representation within the faculty of 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. Currently, the percentage of female professors with tenure or in tenure track is a value well below the USA average. 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. The most significant conclusion from these results is an overwhelming need for an institutionalized support to help female face its particular needs and responsibilities.

1 INTRODUCTION

Puerto Rico has a combined public and private system of higher education with an enrolment 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 University of Puerto Rico (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 stand out by the high percentage of women in its COE. Enrolment statistics show that 35% of students are females, one the highest rates in the United States. Furthermore, according to the American Association for Science and Engineering Education (ASEEE) our engineering program is one of the largest in the nation. For the academic year 2001-02, UPRM conferred 680 degrees in engineering; 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 such hypotheses.

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 14% of the faculty members at the College of Engineering are females with tenure or in tenure track. This percentage is well below the national average.

This paper addresses the situation of female students and faculty in the COE. Section 2 contains a profile of the students while Section 3 presents a study of the factors leading to the high female enrolment and retention rates. Section 4 presents the female faculty profile and discusses the current effort in the COE to increase the number of female faculty. Finally, Section 5 contains conclusions and future efforts.

2 STUDENTS PROFILE AT UPR-M

Enrolment statistics per engineering department of the UPRM for fall 2004 are included in Table 1. The Department of Chemical Engineering has the highest female enrolment per department (64%), followed by Industrial (55%), Civil (31%), Electrical/Computer (24%), and Mechanical Engineering (21%). Longitudinal data covering from 1990 to 2002 shows a similar enrolment trend by department. Average values for that period include Chemical (59.8%), Industrial (57%), Civil (32%), Electrical/Computer (28%), and Mechanical Engineering (22%).

Table 1- Enrolment statistics for the fall 2003-04

Engineering Department	Male Students	Female Students	Total No. of Students
Chemical	248	440	688
Civil	732	332	1064
Electrical/Computer	1040	335	1375
Industrial	264	317	581
Mechanical	608	160	768
Total	2892	1584	4476

3 FACTORS LEADING TO A HIGH FEMALE ENROLLMENT AND RETENTION RATES

A questionnaire was designed and distributed among engineering students to improve our understanding of those aspects for which our college of engineering has been so successful in the enrolment 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 perceptional 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 females. 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.

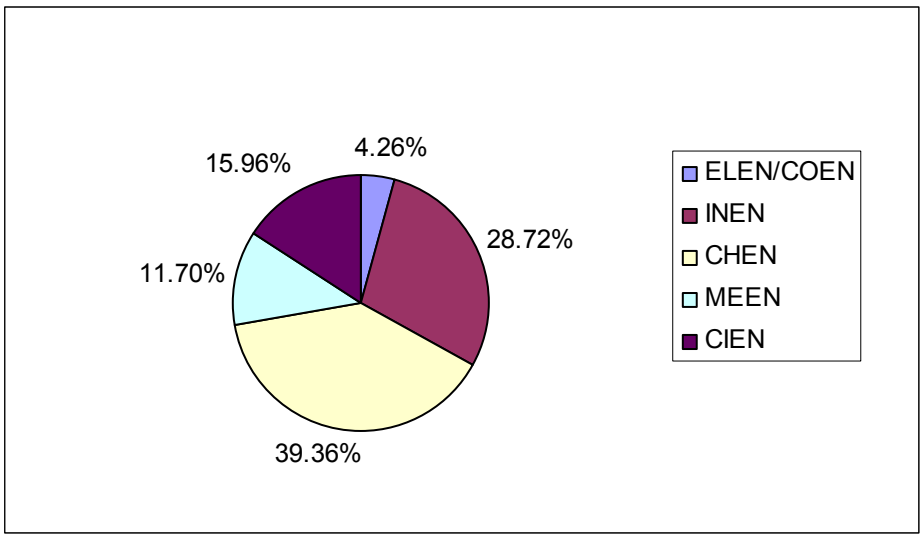

Figure 1 - Distribution of Female Students among Departments

The majority of the students in the sample (94%) are from Puerto Rico (PR). Furthermore, statistics from the Institutional Research Office show that 80% come from cities within one hour from the university campus. Results from the survey also show that 58% of our students come from the public school system whereas 42% come from private schools. As shown in Figure 2, almost 50% of students come from family with incomes below $30k. One of the questions in the survey asked students if low tuition cost was a factor for having such a high enrolment of female students. Results showed that females gave a higher percentage of positive answers (66%) when compared to males (54%). Tuition cost at the University of Puerto Rico 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. At PR students have great opportunities to study an engineering career. All it takes is having a good high school performance in math and doing well in the College Board exam. Different from other school systems, math in PR is a required course from K-12.

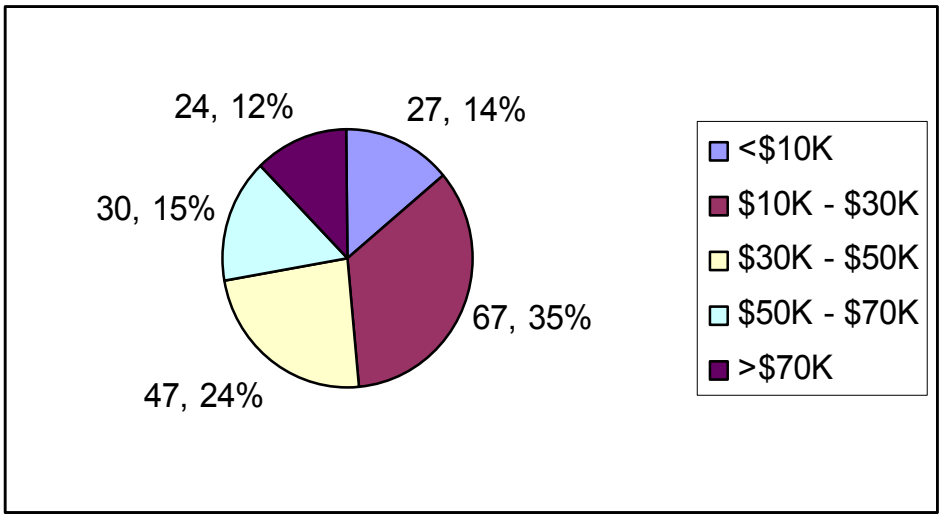

Figure 2 - Distribution of Students by Family Income

When asked if they were the first sibling to attend a university or college, a yes 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 had an influence in their decision to study engineering. Results for the female and male population are presented in Figure 3.

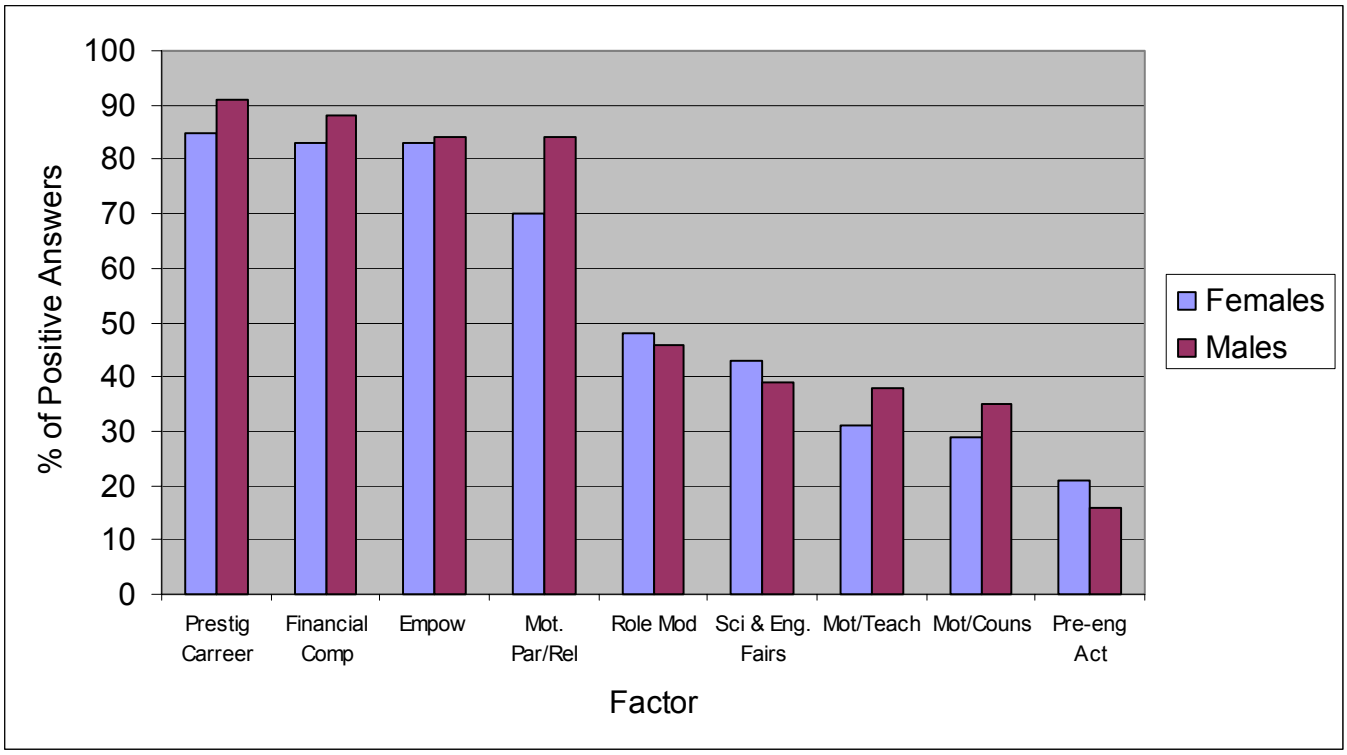

Figure 3 - Factors Influencing their Decision to Study Engineering

Factors with the highest scores for both, males and females, were that 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 population. Also, motivation from teachers, counselors and relatives obtained higher scores for the male population than the female population.

Another question was designed to capture the student's perception on the reasons for having a higher enrolment 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.

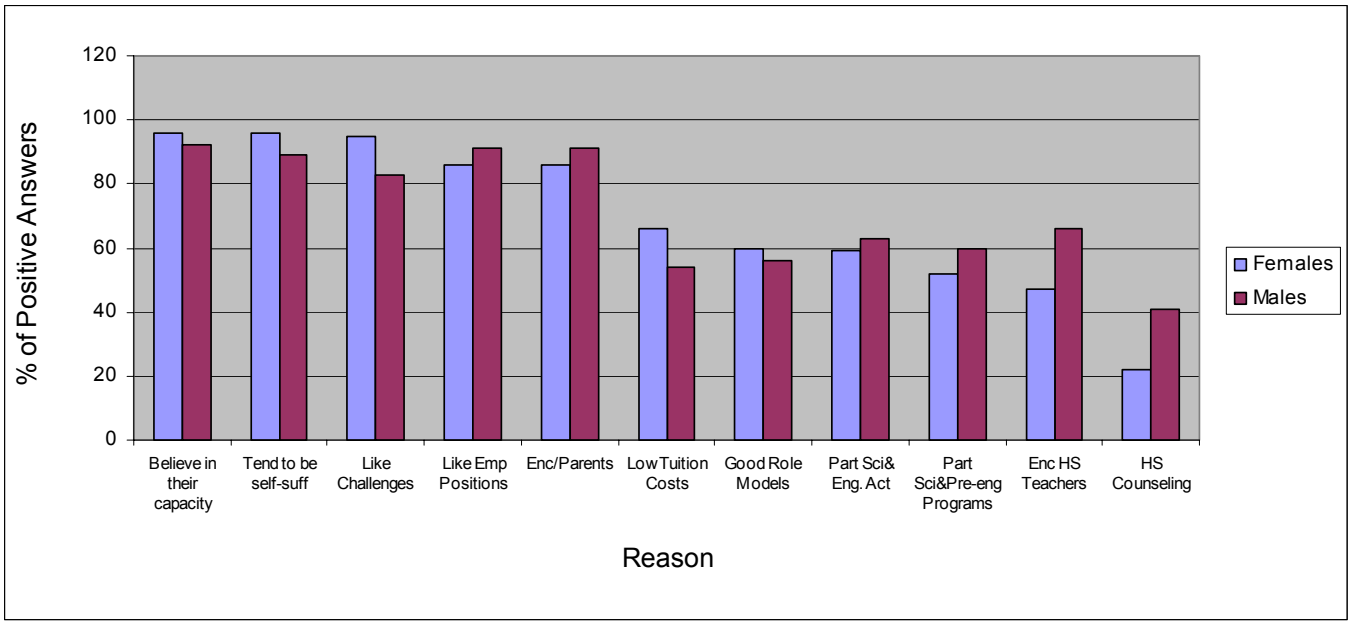

Figure 4 Factors Perceived as Reasons for Having a High Female Enrolment

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

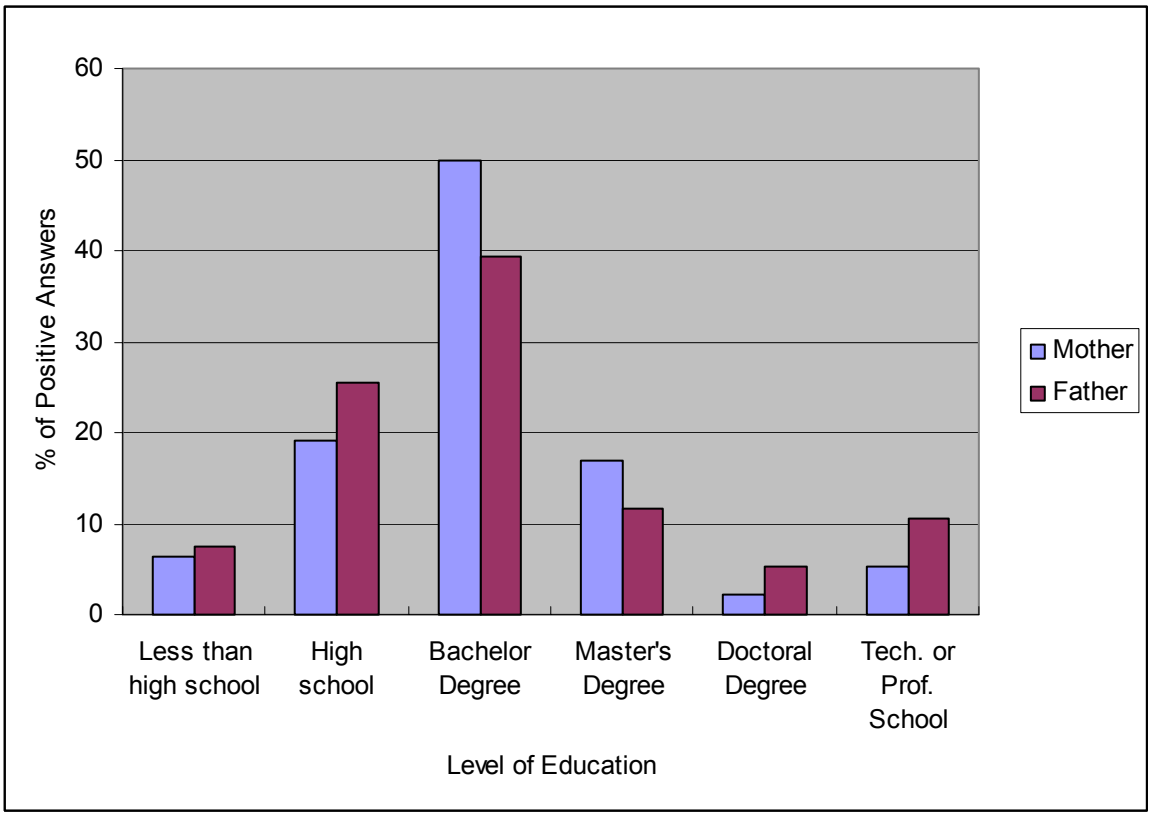

Figure 5 - Parents' Level of Education – Population of Female Students

Students were also asked to select among a list of factors those perceived important for the high female student retention rate. 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 population.

Related to the environment and support might be the fact that at UPRM, in the great majority of cases, the number of students in the classroom does not exceed thirty. Some of the benefits this brings are a better interaction among students and between the professor and the students, a more personal relationship between the professor and the students, and the possibility of having a better understanding of the students' needs.

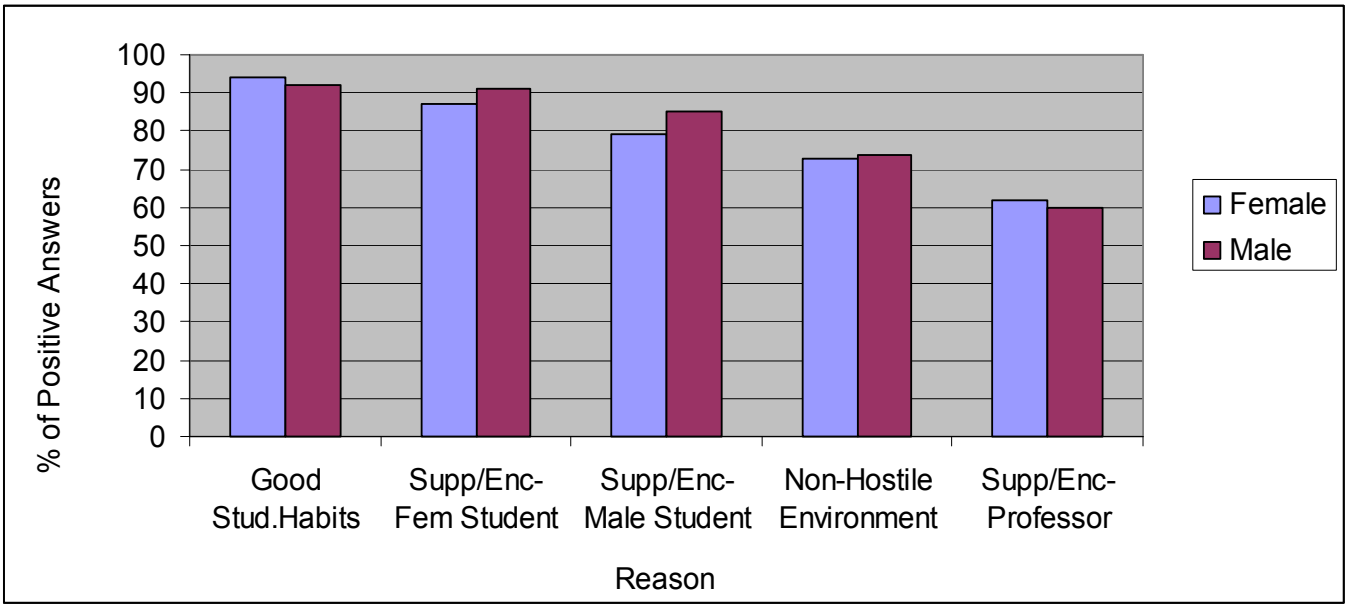

Figure 6 - Factors Related to a High Female Student Retention Rate

Despite the UPRM success in the recruitment and retention of engineering female students, women are significantly underrepresented in the engineering faculty workforce. In the next section, we present the female faculty profile at the College of Engineering.

4 FEMALE FACULTY PROFILE

The faculty of the COE is comprised by 183 professors of which only 26 are female with tenure or in tenure track, thus comprising only a 14% 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 (i.e. contracts)	
	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 contains the ratio of female faculty to female students by engineering department (excluding the General Engineering Department since it is not a degree granting department). As shown in the table, the IE Department shows an impressive female student percentage (55%) but, on the other hand, an extremely high female student-to-female professor ratio. A more dramatic case takes place at the Chemical Engineering Department, where, while having the highest number of female students in any department of the COE, has an appalling female student-to-female professor ratio of 440:1. The most recent UPRM Middle States engineering progress report refers to a general student-to-professor ratio of 20 (*UPRM Middle State Report*, 2001). None of the ratios presented on Table 4 are close to this general ratio. Evidently, in order to assure a proper number of role models for female students and, consequently, promote in them the pursuit of an academic career, the number of women in the engineering faculty at the UPRM needs to increase.

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

Engineering Department	Female professors	Female Students	Student/professor ratio
Chemical	1	440	440:1
Civil	6	332	53:1
Electrical/Computer	4	335	84:1
Industrial	6	317	53:1
Mechanical	2	160	80:1
Total	19		

The female 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. Currently, the percentage of female professors with tenure or in tenure track is a value well below the USA average. 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.

A study with an initial assessment with regard to possible factors affecting the number of female professors in the COE was conducted (Bartolomei et. al 2002). It pointed out that factors such as passion for teaching and doing research, flexible schedule to deal with work and family, opportunity to keep up to date with the latest trends of the field, and the opportunity to have a quality life were of relevance in the process of choosing a career in academia.

Through the interpretation of the survey results, basis of this paper, and the comparison of results with the previous work described in Bartolomei et al 2002, several questions have arisen. 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 more 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.

The administration of the university including the Dean of Engineering and the Chancellor are aware of the situation and has started institutional programs to attend this issue. One of such programs consists of sponsoring our best engineering female undergraduate students to purse PhD degrees in their respective fields. The university will provide a monthly stipend and tuition throughout the duration of their masters and doctoral studies in prestigious universities outside Puerto Rico. After completion of the PhD she returns to UPRM as an Assistant Professor to teach and do research and is required to remain working for the length of time she was sponsored by the university.

5 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 enrolment 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 influence students in their decision to purse an engineering career.

Among the factors influencing their decision to study engineering, perception of engineering as a prestigious career, a well remunerated profession, a profession that leads to empowering positions, and positive 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 enrolment 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, non-hostile environment, and support from engineering professors.

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

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