

STEPS TOWARD THE IMPROVEMENT OF RECRUITMENT AND RETENTION EFFORTS OF ENGINEERING FEMALE PROFESSORS AT THE UPR-MAYAGÜEZ

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Abstract

The University of Puerto Rico at Mayagüez (UPRM) ranked at the top in the list of institutions in the United States on the number of bachelor's degrees in engineering awarded to women, 34% of undergraduate engineering students enrolled in UPRM are female. In spite of this pool of potential candidates, female faculty continues to be significantly underrepresented in all of the engineering fields. This is a major concern at UPRM.

Currently, in the faculty at the College of Engineering (COE) only approximately 12% are female with tenure or in tenure track, a value well below the 22% national average. The COE has not succeeded in attracting female faculty with PhD degrees. This could be a direct result of the limited number of women pursuing PhDs in engineering and, particularly of UPRM's failure in motivating its best undergraduate female students to continue doctoral studies and return as member of the faculty.

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. Another concern is that less than half of the female faculty has positions higher than Assistant Professor. This results in a lack of representation at administrative levels including departmental and faculty personnel committees.

To address these problems, this paper proposes the creation of a program with the mission of encouraging and helping women in academia by creating a supportive structure and institutional transformation conducive to professional advancement and success.

The program proposes a set of innovative initiatives, including but not limited to, the establishment of a consortium of renowned PhD degree granting institutions and a cooperative research program. These and other initiatives could serve as models for other universities in Puerto Rico and in the mainland.

KEYWORDS:

Female engineering faculty, Female engineering students, High recruitment rate, High retention rate

1. Introduction

1.1 Undergraduate engineering students profile

The University of Puerto Rico Mayagüez Campus (UPRM) is a Land Grant, Sea Grant, and Space Grant University founded in 1911. Approximately 13,000 students are enrolled at the UPRM in its four colleges: Arts and Sciences, Agricultural Sciences, Business Administration, and Engineering. The College of Engineering houses the only College of Engineering within the State University System, offering ABET accredited programs in Civil, Chemical, Electrical, Computer, Industrial, and Mechanical Engineering. Master’s programs in all basic sciences, mathematics, and engineering and PhD programs in Civil, Chemical, and Computer Science and Engineering are also offered. The UPRM has more than 4,400 enrolled in engineering and over 5,000 students in other science programs.

The UPRM has played and will continue to play a critical role in training future scientists and engineers for Puerto Rico and the United States. In terms of the undergraduate student enrollment in engineering, it is among the largest engineering institutions in the United States, ranking fourteenth, as depicted in Figure 1.

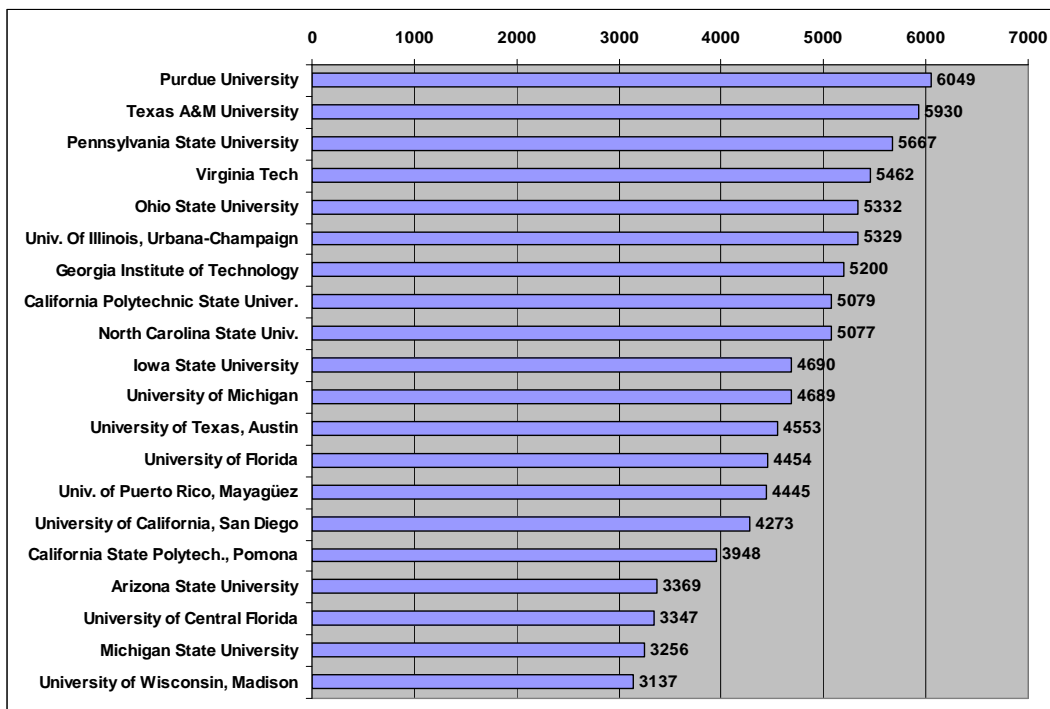


Figure 1: Largest Engineering Institutions of Higher Education According to Undergraduate Enrollment 2003-04 [ASEE 2005]

As shown in Figure 2, since 1988, on average 34% of undergraduate engineering students enrolled in UPRM are female. This seems to contrast sharply with fact such as that Latinas earned less than 3% of all science, mathematics, and engineering degrees awarded in the USA [NSF 1999]. There is a shortage of female engineers in the United States in both institutions of higher education and in the labor market [NSF 1996]. Furthermore, national statistics reveal that only 13% of women states they are going to pursue studies in the fields of natural sciences, math or engineering and that only 18% of those enrolled in undergraduate engineering programs are women.

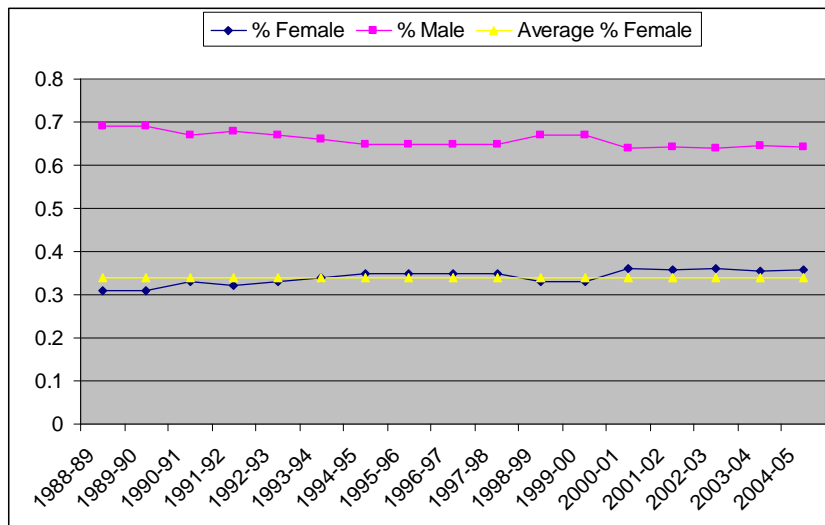


Figure 2: Trend of Undergraduate Enrollment from 1988-2005 [IRPO_UPRM 2005]

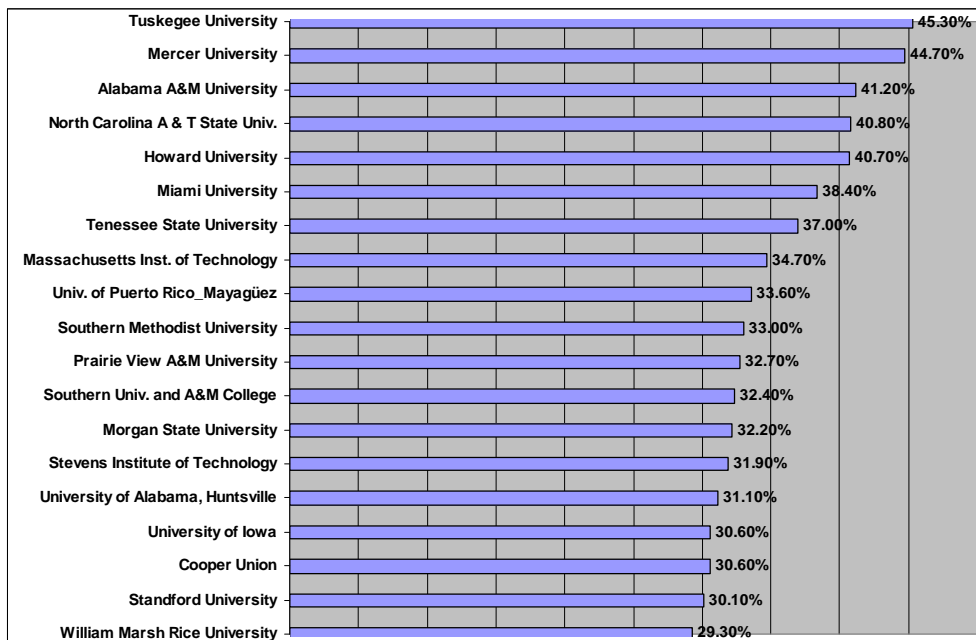


Figure 3: Percent of Bachelor's Degrees Awarded to Women in Engineering, 2003-04 [ASEE 2005]

Figure 3 shows that in 2004, 33.6 % of all bachelor's degrees awarded in engineering at the UPRM were given to women. It should be noted that, although UPRM appears ninth in Figure 3, it is the only university in this list that also appears in Figure 1 as one of the largest engineering institutions of higher education in terms of undergraduate enrollment. This leads to the conclusion that the other universities listed in Figure 3 are not comparable to UPRM in terms of the total number of bachelor's degrees in engineering awarded to women. Therefore, in 2004 UPRM ranked first on the number of engineering degrees awarded to women among the higher education institutions with the highest enrollment in engineering.

1.2 Faculty profile

The faculty of the COE is comprised of 144 professors of whom only 17 are female with tenure or in tenure track. Table 1 presents the distribution of professors and students by gender. From this table the

percentage of female professors by department is estimated as: 4.5% in Chemical, 8.11% in Civil, 5.26% in Electrical and Computer, 20% in Industrial, and 10.53% in Mechanical Engineering. In contrast, the percentage of female undergraduate students in each department is: 60.36% in Chemical, 32.02% in Civil, 27.92% in Electrical and Computer, 54.4% in Industrial, and in Mechanical 20.54%. Regardless of UPRM's leading role awarding engineering degrees to women in the United States, women faculty recruitment and advancement is considerably low when compared to what seems to be a significant number of potential candidates for faculty.

The low representation of females in engineering faculty could be, in part, due to a variety of factors inherent in the career decision-making process. This process is influenced by demographic, socioeconomic, cultural, institutional, and structural variables, among others. These variables may explain the occurrence of a high female student enrollment in engineering, more than twice the national average, and the low percentage of female professors in engineering, in spite of a greater potential pool of candidates.

Table 1: Ratio of female faculty to female students by engineering department at UPRM

Engineering Department	Female professors	Male Professors	Female students	Male students	Female student/ professor ratio
Chemical	1	21	419	272	419:1
Civil	3	34	285	605	95:1
Electrical/Computer	2	36	346	947	173:1
Industrial	4	16	315	264	79:1
Mechanical	2	17	161	623	81:1
General	5	20	-	-	-
Total	17	144	1526	2711	

The last column in Table 1 presents the ratio of female students to female professors. 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. Currently, in the faculty at the College of Engineering (COE) approximately only 12% are female with tenure or in tenure track. This percentage is well below the 22% national average mentioned by NSF [NSF 2002].

To have a better understanding of the situation of female faculty at the COE, it is necessary to look further. Table 2 shows the distribution of female faculty in engineering by academic ranking. Of concern is that less than half of the female faculty has positions higher than Assistant Professor. This results in a lack of representation at administrative levels including departmental and faculty personnel committees. Even in elite institutions of higher education, female faculty continue to confront marginalization, discrimination, and inequality [Hopkins, et. al. 2002], stressing the importance of both, changing attitudes of male counterparts and having female faculty at decision level positions.

The reality at the COE is that to satisfy the high demand for engineering courses, the departments rely on the practice of using lecturers, mostly with masters' degrees, that work under a service contract. This is due to the lack of a pool of resources with PhD degrees. Currently, approximately 20% of the overall faculty is working under service contract, thus showing the need to recruit tenure-track professors.

UPRM requires that in order to be considered for a tenure-track position the candidate should have or be willing to pursue a PhD degree. UPRM is the only university in Puerto Rico that offers PhD degrees in Engineering and as in many universities, in-breeding is not an acceptable practice. Therefore, if a person without a PhD wants to be considered as a prospective professor, that person must go to USA or to

another country to study. This could make even more difficult the recruitment of females due to family conflicts.

Table 2: Engineering female faculty by rank at UPRM

Position	Tenure	Tenure track	Total	Percentage %
Instructor	0	3	3	17.65
Assistant Professor	3	4	7	41.18
Associate Professor	4	0	4	23.53
Full Professor	3	0	3	17.65
Total	10	7	17	100.00
Percentage	58.82 %	41.18 %	100.00 %	

The analysis of undergraduate engineering students and faculty profiles shows that the COE has a great pool of potential female candidates for recruitment. It also shows that there are very few female faculty members to serve as role models and mentors and to motivate female students to pursue an academic career. This program proposes a set of initiatives aimed at identifying barriers that impede females from pursuing an academic career or advancing to higher positions. It is proposed to use the findings of this analysis to revise the current recruitment, retention and promotion regulations, to develop activities and programs to promote academia as a career and, as a result, to increase the number of female faculty in tenure and tenure-track position.

2. Preliminary Studies

In order to decide the focus of this program, two activities were performed. The first activity was the design and distribution of a preliminary survey among female engineering faculty members. The second one was a focus group of current undergraduate and graduate students (16 females and 8 males). The results from these two activities lead us to the identification of goals for this initiative and to propose actions to reach them.

2.1 Survey

An initial step towards self-assessment was accomplished through the design and distribution of a preliminary survey among the female faculty members. This survey contained pre-defined alternatives as well as open-ended questions to which respondents answered freely. These questions were similar to those presented in Thompson [2000]. The most significant conclusion of the survey points at an overwhelming need for an institutionalized support to help female faculty face its particular problems and responsibilities. None of the respondents expressed dislike in being a professor and stated that their primary reasons for having considered leaving the academia were salary, better opportunities in the industry, the time spent with their family, and discrimination. Figure 4 contains the responses to the referenced question. Other responses included the long time required to get tenure and UPRM's environment [Bartolomei, et. al. 2002].

Upon being asked what the institution could do to offer encouragement to maintain its engineering female faculty, the respondents offered a variety of suggestions. Among them: flexible attitudes and schedules, better salaries, development opportunities, childcare facilities, support groups, teaching assistants, and mentorship.

The survey was administered for the purpose of testing and getting a glimpse of the general concerns of the population of interest. However, work is still needed in addressing these concerns and in identifying other hidden problems.

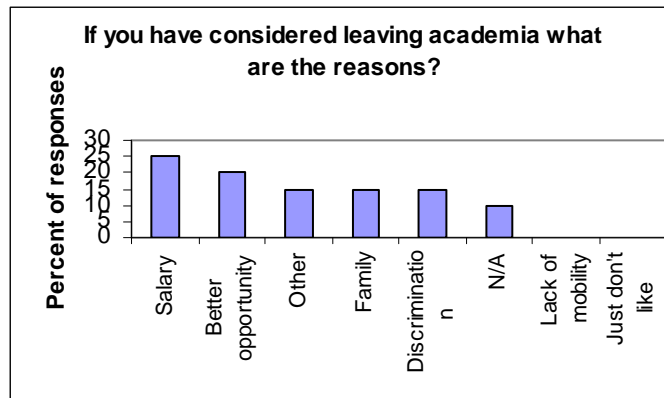


Figure 4: Responses to survey question

2.2 Focus Group

A focus group was conducted with the goal of generating additional variables, questions, gender related issues, and concerns regarding factors that impact a student's decision to pursue a graduate degree and the career and professional decision-making processes among women engineers at the UPRM. The focus group was composed by students, 16 females and 8 males.

Among the issues and concerns, the need to balance family and work/studies, upon completing the bachelors' degree, was stressed, as well as home finances. Another major concern that came up was the need to have a more nurturing male faculty since both the female and male students perceive the female professors more accessible and passionate about teaching and, thus, trustworthy and effective. Another factor that may motivate them to pursue graduate studies would be changes in the curricula and specialty courses with more opportunities for undergraduate research.

3. Proposed Program

Based on the need of the COE and the findings of the previous studies, the proposed program is aimed at the development of a set of activities to improve the recruitment, participation and advancement of female faculty. The mission of the program will be to encourage and support women in academia by creating a supportive structure and institutional transformation conducive to academic professional progress and success.

The objectives of the program are to:

- 1) identify formal and informal barriers impeding women from pursuing PhD degrees in engineering,
- 2) identify formal and informal barriers that influence women in their decision on following a career in academia,
- 3) identify major formal and informal barriers impeding women from advancing to higher positions,
- 4) identify the differences in tenure and promotion processes for male and female faculty,
- 5) identify differences in salary, space, awards, resources and workload distribution between male and female faculty,
- 6) implement programs to motivate female students to pursue PhD studies,
- 7) promote academia as a career for female engineers,
- 8) increase the number of tenured and tenure-track female faculty
- 9) increase the number of female faculty with active and funded research projects,
- 10) promote the increased participation of female faculty in leadership positions, and
- 11) contribute to the advancement of women in tenure track positions by creating an institutional environment where female faculty can achieve their full potential.

3.1 Activities to Reach the Objectives

- **Objectives 1 through 5: Identification of barriers and differences**

To identify the barriers and differences mentioned previously, this program proposes to use ethnographic techniques (i.e. focus groups, in-depth interviews) and an exhaustive self-assessment study embracing all current faculty members. The data collected through this initiative will be both qualitative and quantitative.

The qualitative data collected will be analyzed to establish commonalities and search for patterns among groups. Qualitative as well as quantitative data will be analyzed using statistical tools such as: Pareto analysis, and logistic and multiple regressions.

- **Objectives 6 and 7: Programs to motivate graduate studies and promote academia**

To motivate female students to pursue PhD studies and promote academia as a career, this program proposes to implement the following activities:

- **Provide undergraduate students with research experience at recognized institutions**

This initiative proposes the creation of The Cooperative Research Program (CORP). The CORP program is analogous to the COOP program, an academic program where undergraduate students alternate terms of full-time study with terms of full-time paid employment in a field directly related to their major. The CORP program will be administrated in the same way as the COOP program but with the specific objective of providing undergraduate female students the opportunity to alternate terms of full-time study with terms of full-time research work on different recognized institutions (e.g. research groups in others Universities and National Laboratories).

- **Mentoring of female undergraduates**

This initiative proposes the design of a mentorship program for female master degree and undergraduate students in the COE, to motivate them to consider pursuing doctoral studies and eventually follow an academic career. Monthly meetings will provide female students with seminars and workshops on skills needed to pursue graduate studies, seeking academic careers, fellowships, and financial aids for graduate studies, among others.

- **Motivate undergraduate students to participate in opportunities to learn about graduate programs**

This initiative promotes the participation of female undergraduate students in programs developed by other universities in order to motivate undergraduate students to pursue graduate studies (e.g. Opportunities in Engineering Conference at University of Wisconsin).

- **Create a course on women and engineering**

This initiative proposes the creation of a course on women in engineering issues. The course will be a three credit elective engineering undergraduate course. Its objective will be to study the participation of woman in the engineering field. All female undergraduate students will be encouraged to take this class.

- **Motivate female undergraduate students to take courses available in UPRM on gender related issues**

This initiative encourages female engineering students to take at least one of the courses on gender related issues that currently exist at UPRM (i.e. Social aspects of gender, Women at work, among others).

- **Objective 8: Increase the number of tenure and tenure-track female faculty**

To increase the number of tenure and tenure-track female faculty this program proposes the following:

- **Women Advancement Affairs Committee (WAAC)**

The creation of WAAC, a faculty committee composed by representatives from: Dean of Engineering, Associated Dean for Academic Affairs, Associated Dean for Research, Office of Equal Opportunities, Office of Institutional Research and Planning, Center for Women Studies, and engineering faculty representation. This committee will be responsible for the review of current regulations for recruitment and promoting engineering faculty at UPRM and developing the strategic planning to eliminate gender discrimination and actively seek qualified female candidates for recruitment. The committee will provide recommendations to the Dean and Personnel Committees for the revision of regulations related to recruitment and promotion of engineering faculty at UPRM.

- **Annual Workshop for Administrators**

COE administrators that deal with faculty recruitment and promotion processes will participate on an annual workshop on UPR regulations dealing with recruitment and promotion and its relation to gender equity issues. From the second year on, the workshop will also serve as a means to present research findings.

- **Networking**

This initiative recommends the use of existing contact and professional networks of faculty and students, discipline-based organizations, and publications and web sites that specialize in the recruitment of faculty members.

- **Forgivable loans**

This initiative requests Department Chairs and Personnel Committees to separate tenure-track positions to be filled by UPRM best undergraduate female students. The students must agree to pursue graduate degrees in a recognized institution outside Puerto Rico, with financial aid of UPRM as a forgivable loan. After finishing the PhD degree, the student will return to teach at the UPRM with a tenure track position.

- **PhD degrees through Distance Learning Programs**

This initiative seeks the development of a consortium of renowned PhD degree granting institutions with Distance Learning Programs available. This allows excellent candidates who, due to personal conflicts, cannot travel abroad, to complete a PhD degree. In order for this to be successful, efforts are geared toward the adoption of this as a feasible option by department chairs and personnel committees and the encouragement of potential female candidates.

- **Objective 9: Active and funded research projects by female faculty**

This initiative recommends the following activities to increase the number of female faculty with active and funded research projects.

- **Identification of seed money opportunities**

The center will document and publish seed money sources to support research-related expenses (equipment, materials, and travel to conferences, among others) to young or tenure-track female faculty. Currently, the UPRM Research and Development Center has a program to provide seed money for new faculty. The money will be available for two years, after that, it will be expected that funds from other sources support the female faculty research-related expenses.

- **Female faculty support group**

This initiative proposes monthly meetings to share concerns and experiences among faculty members. In addition, seminars and workshops are offered to develop skills on proposal writing, publication, networking, and skills needed to navigate through the tenure track, balancing academic careers with family responsibilities, among others.

- **Mentoring young female faculty**

This initiative provides the creation of a formal mentoring program in which senior female faculty invite young female faculty to collaborate together on research initiatives. By doing this, the senior professor become the mentor of the young professor.

- **Objective 10: Female faculty in leadership position**

To promote the participation of female faculty in leadership positions the following activities are proposed:

- **Mentoring senior female faculty by faculty in leadership positions**

Every other month this program provides the opportunity to share experiences of female faculty already in leadership position (i.e. Deans, Associate Deans, Assistant Deans, Academic Senators, among others) with senior female faculty in order to prepare the latter to advance into leadership positions.

- **Mentoring senior female faculty by female corporate and governmental leaders**

This initiative provides the opportunity to share the experiences of female corporate and governmental leaders with senior female faculty in order to prepare the latter to advance into leadership positions.

- **Objective 11: Institutional environment**

To contribute to the advancement of women in tenure track positions this initiative proposes the creation of the following facilities and programs:

- **After school program**

This initiative develops after school program activities including but not limited to tutorials on science and mathematics. These activities will be lead and supervised by undergraduate students working under the work and study program or sponsored by other programs available on.

- **Child care facilities**

This initiative will request annually five spaces for child care at the UPRM Child Care Center to use them for the caring of children of female engineering faculty.

- **Facilities for nursing babies**

This initiative requests space in the COE to build an area for nursing babies.

- **Time to nurse babies**

This initiative requests administrators to consider when designing the course timetables the needs of female engineering professors nursing mothers.

4. Administrative Structure

The program will be managed by a group of professors with the appropriate clerical support. It will be necessary office space to house the program, and to hire two coordinators to be responsible for the academic and administrative affairs. The academic coordinator will organize and coordinate all the

training and workshop activities of the grant and will be responsible for designing and distributing the educational material. The administrative coordinator will be responsible for managing the after school program, the annual workshop, the mentoring and networking activities. Also, two undergraduate students will be hired to help the coordinators run the office.

5. Conclusions

This paper proposes the creation of a program to encourage and support women in academia. After the initial data gathering efforts, the way to the design of a supportive structure and institutional transformation scheme conducive to professional progress and success of women engineers in academia, was set through meetings, interviews, and brainstorming sessions.

A program comprised of a set of innovative initiatives was developed. Some of these initiatives are dependent on recurring funding and efforts toward identifying possible funding sources are currently underway. Other activities identified in this paper that can be achieved through administrative means are being proposed and pursued through the appropriate institutional channels.

Future work will report on these activities, through their implementation phases as well as their preliminary results. Depending on their documented success, or lack of, these and other initiatives could serve as models for other universities in Puerto Rico and in the mainland.

REFERENCES

ASEE, (2005), 2004 Profiles of Engineering and Engineering Technology Colleges”, May, 522 pages.

Bartolomei, S. M., Cesaní, V. I., Irizarry, M. A., Toledo, F. M., and Santos, J., (2002), “Promoting Changes Through Faculty Self-Assessment: The Results of an Initial Survey”, Proceedings of the International Conference of Women in Engineering and Science, Ontario, Canada, July.

Hopkins, N. Bailyn, L. Gibson, L., and Hammonds, E., (2002), “The Status of Women Faculty at MIT: An Overview of Reports from the Schools of Architecture and Planning, Engineering, Humanities, Arts, and Social Sciences; and the Sloan School of Management”.

Institutional Research and Planning Office of the University of Puerto Rico-Mayagüez (IRPO_UPRM), (2005), “2000–2005 UPRM Enrollment Data”, University of Puerto Rico-Mayagüez Annual Report.

National Science Foundation, (2002), Advance Institutional transformation Call for Proposals, Arlington, VA.

National Science Foundation, (1999), Women, minorities, and persons with disabilities in science and engineering: 1999, Arlington, VA, (NSF 99-87).

National Science Foundation, (1996), Women, minorities, and persons with disabilities in science and engineering: 1996, Arlington, VA, (NSF 96-311).

Thompson, J. J. (2000), “Finding heir way”, Prism, 9 (7), 20-25.

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