

New Trends in Engineering Education: The AGEP: CNY-PR

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Abstract - Engineering education is facing difficult times attracting women, African-Americans, and Hispanics in academia in the United States. The problem worsens in graduate education as the statistics for women and minority faculty at engineering graduate schools across the country are depressingly low. As the quest for knowledge increases we must provide PhD students with new tools and resources to compete and succeed in the global economy. In 2002, a unique partnership between Syracuse University, Cornell University, Rensselaer Polytechnic Institute, and the University of Puerto Rico-Mayaguez was established under the name of “*The Alliance for Graduate Education and The Professorate: Central New York-Puerto Rico*” (AGEP: CNY-PR). The alliance has been successful in increasing the number of minorities and female obtaining PhD degrees in Science, Mathematics and Engineering while promoting research and education collaboration among the allied institutions.

Index Terms – Graduate Education, Partnership.

INTRODUCTION

Engineering education is facing difficult times attracting women, African-Americans, and Hispanics to its faculty lines, however, there are only few schools implementing novel ideas to solve the problem. The problem worsens in graduate education. Statistics for women and minority faculty at engineering graduate schools across the country are depressing. For example, of the 6,085 Ph.D. graduates in engineering in 2001, only 16.9 % were women. The percentage of African-American and Hispanic doctoral graduates was even worse—3.9 % and 3.3 %, respectively [1, 2]. It is clear that we need more Hispanics and women in academia and top positions in industry. It is imperative that colleges and universities implement within their student/faculty recruitment and retention efforts a high-level and comprehensive program that includes a strong mentoring and support system for minority students and faculty in

Science, Mathematics and Engineering fields. Table 1 shows the distribution for various professorial ranks among ethnic groups.

Groups	Tenure or Tenured Track	Assistant Professor	Full Professor
African American	2.1 %	3.5 %	1.3 %
Female	8.9 %	17.5 %	4.4 %
Hispanics	2.9 %	4.1 %	2.2 %
Asian	17 %	19.3 %	16.0 %

Table 1: Statistics for Minority Faculty [3].

New NSF-sponsored programs, like AGEP, have played a key role in increasing the number shown in Table 1. However, students need also someone who will lobby on their behalf. They need individuals who know what it is to be a minority in academia, individuals who are willing to advocate for the students or faculty on campus.

As the quest for knowledge increases we must provide PhD students with new tools and resources to compete and succeed in the global economy. Companies in this new global economy merge many times in order to place their corporations in competitive positions in the global market. Therefore, in this age of accelerated technological advances, increased career specialization and extremely competitive job opportunities, society has a vested interest in promoting technical careers such as engineering, math, and sciences as never before. Moreover, the need for specialized knowledge and the acquisition of professional credentials place increasingly high demands on college graduates and higher education institutions. In addition, this means that institutions

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must partner in order to provide unique training opportunities to PhD students.

In 2002 a unique partnership between Syracuse University, Cornell University, Rensselaer Polytechnic Institute, and the University of Puerto Rico-Mayaguez was established under the name of “The Alliance for Graduate Education and The Professoriate” (AGEP). The program has been successful in increasing the number of minorities and female obtaining PhD degrees in Science, Math and Engineering. This unique partnership will keep bringing more Hispanics, African-Americans and women into PhD programs who will eventually become professors.

Under the umbrella of the AGEP infrastructure we have proposed several other pioneer programs aiming to the development of minorities and female groups. For instance, a multidisciplinary graduate education training program has been proposed to the National Science Foundation-IGERT program. The program will make use of Fluids Mechanics research and education to interconnect emerging disciplines such as Bioengineering, Materials Science, and Multi-scale Transport Systems. The key idea is that institutions under the partnership share equipment, students and research initiatives; consequently it greatly stimulates true collaboration among partners.

As a result of this collaboration the infrastructure of the University of Puerto Rico-Mayaguez as a world-class research institution is clearly enhanced. Some of the activities and research initiatives that encompass this program include an international research experience, research coop program though the partnership with research centers and even with other AGEP programs in the country. Another example of expanded opportunities is the newly proposed post-doctoral program for minority PhDs also developed under the platform of the AGEP. In the following sections the focus will be given to the AGEP program and some of its main activities.

THE AGEP ALLIANCE

Who we are and what the partnership is doing to advance and promote the growth of minority PhDs in academia? The AGEP: CNY-PR program proposes to expand existing programs within each institution of the alliance. The CNY-PR alliance goal is to use a holistic approach to substantially increase minority participation in the STME areas obtaining Ph.D. degree and entering into academic positions. The goals of this partnership are:

- Review and recommend innovative measures and guidelines for graduate admission criteria
- Aggressively recruit and retain the best minority students
- Provide multi-year funding package for accepted minority graduate students
- Provide research experiences for undergraduate students
- Provide summer faculty programs for the development of UPRM professors
- Organize short courses on professional development
- Mentoring programs
- Job fairs within an annual symposium.

- Promote a research and education international experience for students and faculty
- Foster and promote research/educational collaboration among our partners
- Change the culture at the institutional level in order to have a more nurturing and welcoming environment for students and faculty alike.

In the following sections examples of the AGEP activities within the CNY-PR alliance are given.

I. Review and recommend innovative measures and guidelines for graduate admission criteria

A study done at Wesleyan University (1997) established the fact that “...by the year 2050, nearly half the population of the United States will be composed of ethnic and racial minorities.” Yet, according to Turner & Myers (1999), “many institutional barriers and discriminatory practices” have historically prevented people of color from attaining faculty status in higher education [4, 5]. Additional findings from this study showed a substantial under representation of African American and Native Americans, significant under representation of Latinos in certain states; while there was no apparent under representation of Asian/Pacific Islanders, their representation in faculty positions has stagnated. Above facts delineate the nature of the “pipeline problem” that constricts access to academic careers for minorities. Since the gateway for academic careers is graduate education, it is clear that universities cannot merely position themselves reactively and passively waits for the number of minority graduate applications to increase. Rather, they must aggressively develop innovative means of discovering academic potential among the existing pool of minority graduate applicants.

Using measures beyond standardized testing such as GRE and GPA cutoffs would seem pertinent in attracting ethnic and racial minorities to graduate study. As part of transforming the culture we are looking at the admission process from a holistic point of view; particularly when students from UPRM are applying to any of our allied institutions. For instance, we considered, among others, the student involvement in undergraduate research, engineering design, awards, letters of support and leadership exerted in the community or professional societies. This allows the faculty to evaluate deeply the student ability to perform in graduate school, assessment elements normally not shown in standardized test or in the grade point average criterion.

For instance, during the admission process at Rensselaer we involved the Dean of the Graduate school, the Dean of Admission, the Department Chair of a given department and the AGEP co-director. This process not only allows us to get better information at any time of a particular student, but it also enables us to fix or address any problem about the applicant. During the recruitment process, students are guided and mentor prior to the admission process by one professor of the alliance monthly visits to the UPRM campus. Once potential candidates are identified and as part of the admission

process, students are invited to a campus visit prior to applying to the chosen institution within the alliance. Students are matched with faculty mentors and introduced to other graduate minority students according to his area of research interest and cultural background among others. The faculty selected as mentors are among the most active in research and proponents of novel education programs making them more sensitive to students needs.

II. Provide multi-year funding packages

One of the problems for minority students is to ensure the institution commitment to provide them with financial support. Our faculty team recognize this need, thus we offer students with funding spanning the entire education process by using one or several mechanisms: (i) The NSF Graduate Student fellowship, (ii) The AGEP program fellowship, (iii) Industry levered fellowship, (iv) Research Assistantships, and (iv) Teaching Assistantship.

Turner and Myers (1999) reported that “an under-supply of PhDs has less of an affect on minority faculty representation than the influence market wages exert on higher education.” In order to increase research productivity and enhance the interest of underrepresented groups in faculty positions, institutions of higher education must invoke an effectual commitment to valuing the service and teaching activities of these individuals. Our intent is to help targeted groups to overcome feelings of being excluded, isolated and alienated due to ethnic bias and racism. Providing a positive work environment and increased levels of research support helps to maintain successful participation of underrepresented SME students in graduate school.

At Rensselaer, recruited students are initially funded by our AGEP program (i.e., the first year) and then moved to Research Assistantship or others fellowships by the guidance of his faculty mentor and the AGEP co-director. For instance, last two years several students won one of the following: the NSF Graduate Student Fellowship, the NASA Harriet Jenkins fellowship, or the AT&T fellowship among others. This additional fellowship programs not only enhances the student credentials, it also enables us to leverage resources by opening new slots to recruit more AGEP fellows.

III. Recruiting

Based upon the literature on minority student recruitment and retention and minority faculty development, we understand the importance of taking a pro-active and personable approach to enhance awareness about and possibly attract individuals from underrepresented groups who may be interested in seeking advanced degrees in SME.

The CNY-PR allied institutions provide travel expenses to invite the interested minority graduate applicants for a campus visit, in which they meet with the faculty members. This essential hands-on approach definitely assist prospective candidates in establishing initial and hopefully, long-lasting relationships with faculty members. In fact, this mechanism

alone has been very successful in attracting top quality students from UPRM that may have gone to other schools.

IV. Provide undergraduate summer programs

Undergraduate summer programs provide research experiences to minority students in turn promoting graduate education and helping them to smooth the transition from undergraduate study. Faculty mentors are responsible for the academic and career success of their protégés by being readily accessible, building a rapport with the students and facilitating a research project pertinent to the specific SME discipline.

At Syracuse University, one of our allied universities, seminars which include topics for preparing students for the GRE, job interviews and teaching careers, development of a professional vita or resume and guidance and feedback on selecting and applying for graduate school, and internships and job applications have been very successful in increasing confidence of minority students for applying to graduate school.

Furthermore, the summer research experience has been a critically positive mechanism to attract more minority students into graduate school. In fact, at Rensselaer 95% of the students that participated in a summer research program entered graduate schools either within the alliance or to other graduate schools.

V. The Summer Faculty Program and Sabbatical Leaves

In 2003 a summer faculty program was initiated at Rensselaer. The idea was that by inviting professors and students from the University of Puerto Rico-Mayaguez to spend between 5 to 10 weeks in an intense summer research project with a collaborator/mentor faculty at Rensselaer, the research collaboration between our alliances and funding resources for our AGEP fellows would increase. In fact, this program has been such a success that in the summer of 2004, we brought three professors from UPRM to various departments in the School of Engineering at RPI and will be expanded during the summer of 2005 to Syracuse University. Through this program, we have coordinated three research sabbatical leaves, i.e., one UPRM faculty has spent a sabbatical leave at RPI and two RPI faculty members has spent sabbatical leave at UPRM.

Again, the rationale is that faculty from UPRM will be writing more proposals, archival articles, and engaged in new research projects with world-class researcher faculty within the alliance. In this manner, due to the faculty-student relationships and by a chain mechanism the number of underrepresented students participating in research and applying to PhD degrees is increasing also.

The goal is to increase the reputation of UPRM as a world class institution in such a way that using the AGEP infrastructure we can apply for and later build a Science and Technology Center (STC) founded by National Science Foundation and lead by UPRM. In a way we are building the infrastructure first and funding levels before submitting a

project at the requirement levels of an STC or Engineering Research Center (ERC). The important aspect to remember is that all of these activities are possible due the platform developed by CNY-PR alliance under the AGEP program.

VI. Future-Faculty Preparation Program & Professional Development

To become a successful academician, it takes more than mastering knowledge of the subject matter. A high level of technical, administrative and professional communication is essential.

The main idea is not limited to bringing the students to RPI, SU, UPRM or Cornell. Rather, once students arrive at any of our institutions, we must provide them with a support system necessary to ensure their success in graduate school and beyond. Moreover, it is also important that the PhD students have a clear understanding of the career opportunities and the job searching process in academia as well as in industry. It is a known fact that minority faculty has difficulty in achieving tenure at major research universities, and even more difficulty in achieving the rank of full professor.

In order to prepare our students to succeed in the academic environment there are three main skills we developed for our students. These are: (a) *Teaching Ability*; (b) *Writing Proposal and Technical Papers* as well as identifying funding programs and opportunities; and (c) *Research Ability and Networking*. These skills are developed and enhanced by creating workshops, seminars and practice sessions. In many cases, acting as mentor we bring our AGEP students to visit the funding agencies and have a one to one chat with program managers.

In January of 2004 we held an annual symposium in Puerto Rico with about 50 graduate students and their respective faculty mentors from UPRM, RPI, University of Cornell and Syracuse University. One of the workshop sessions discussed proposal writing and identified funding opportunities for students as well as faculty. In these workshop sessions we present the students with examples of how proposals are reviewed and funded at various government agencies such as NSF, NASA and Department of Defense (DOD).

Another workshop session discussed journal publications and the peer review process. These activities enabled our students to better understand academic careers and gave them a better understanding of the PhD programs and expectations in academia as junior faculty. During the same event students presented their research work via oral and poster presentations.

By integrating their educational and research concerns into a comprehensive program that provides with answers and solutions the number of students succeeding in academia could drastically improve. This is an important chain mechanism because if we have more successful role models/mentors in the classrooms, then they will automatically encourage and motivate other minority students to follow the path.

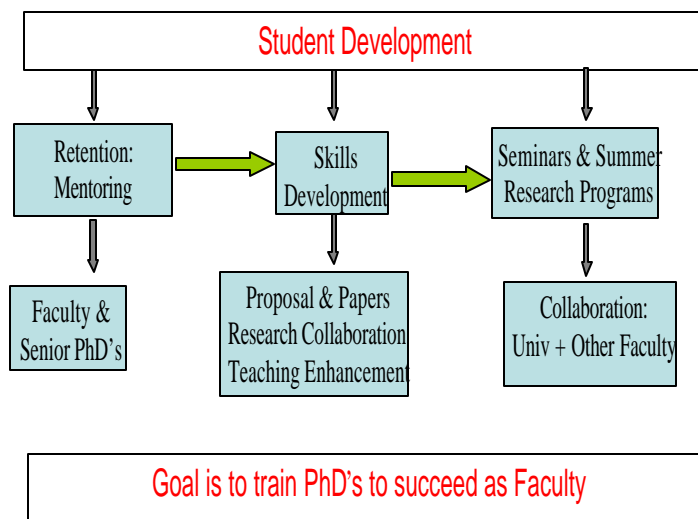


Figure 2: Student Development for the CNNY-PR.

Figure 2 shows a diagram of each of three areas of focus under minority student development and their corresponding sub-areas of interest. In order to train students to succeed as faculty or scientists we must have a strong retention/mentoring program. For a successful mentoring program it is required the involvement of faculty and senior graduate students as key players.

VII. Changing the Culture

All previous activities are great, but in order to transform the actual *status quo* of institutions mechanisms it is clear that we need the involvement and cooperation of top-level administrators. For this reason we had included a session for Dean's and Director's meeting as part of the AGEP Annual Symposium.

On February 20th, 2003 the *First Deans & Directors Meeting* took place at the Rincon by the Seas Hotel in Puerto Rico. During this meeting, deans, vice-provosts, provosts, directors of the different engineering and science schools of Puerto Rico discussed important issues concerning research and education opportunities for minority groups. Each school representative made a twenty minute presentation that focused on each of their engineering, math or science schools along with their future plans.

The main purpose of this meeting was brainstorming on two important issues (i) to find common areas where these institutions could collaborate in both research and education in order to further develop AGEP students, and (ii) to find mechanisms to increase the participation of minorities in academia. This meeting allowed the creation of a unique synergy that will equally benefit our institutions and students.

VIII. International Programs

The international program provides the student plenty of opportunities. In the unique partnership among UPRM, RPI,

Cornell and Syracuse Universities as the lead institutions we foresee to expand the opportunities of minority PhDs to international forums, which will provide them with global perspectives of their education and career. We identified unique partners abroad with whom we have had close collaboration in the past to further expose our students to unique facilities, experts, and knowledge. Our international partners include: Chalmers University (Sweden), University of Rome (Italy), Victoria University (Australia), and Tohoku University (Japan). In addition, not only we are expanding the collaboration to provide better resources and opportunities to our students but this international alliance has submitted a proposal for a research center lead by Syracuse University through Professor Higuchi as the principal investigator.

The international program has been very successful in enhancing the training of our PhDs by providing global awareness and education and it has enabled us to attract more students into our PhD programs because of the unique experiences students gain while abroad.

IX. Retention and Mentoring

It was imperative that the alliance established a mentoring program involving faculty, undergraduate and graduate students, and administration. A unique feature about our AGEPE structure is that the faculty representative of Hispanics, African Americans and women are committed to participating in the program, thereby allowing students to relate in a positive and direct manner with the faculty advisors.

In January of 2004, we created a two-day mentor/fellow workshop where we discussed with the students various topics such as proposal writing, journal publication and the peer review process. We also conducted a workshop on strategies on how to succeed in academia aiming to become full professor, and another on *how to better mentor the students and understand the needs of the mentees*. We also sought feedback from the students on how we can better support them and their needs.

Another feature of the mentoring program is the chain mechanism in which the faculty supervises the PhD student, the PhD student supports and supervises the Masters students, the Masters students then supports the undergraduate students and the undergraduates in turn support minority students in high school interested in learning more about science and engineering. While the mentoring chain is operating, the faculty mentor also works directly with a given student looking for feedback and assessment. In addition, they have direct access to the AGEPE Co-Directors in the event of any difficulty (i.e., qualifying exams, funding, travel, faculty-student relationships, etc.). The interaction between undergraduate and high school students is possible due to the participation of student technical chapters, such as, the Society of Hispanics Professional Engineers (SHPE) and National Society of Black Engineers (NSBE). Moreover, involvement of technical societies is crucial for the continuation of the program beyond the current AGEPE funding period.

Engaging top level administrators in this AGEPE project has been a key element in getting more support and commitment at the University level. Doing so ensures the survival of the program in the long-term. Support from top-level institutional leadership is also the key for institutional cultural transformation and minority development to occur. At the administrative level, the additional support will be given to: 1) help ensure the financial stability of students; 2) coordinate the student program through existing administrative offices and programs, and 3) monitor student progress. Thus, the management structure has several advantages: *First*, it ensures and monitors the progress of the students avoiding drop-outs. *Second*, it allows the PhD students to supervise other graduate students, which is something they will be expected to do once they complete their degree. And *third*, because of the interaction of undergraduates and graduate students, some students will be inspired by their mentors to pursue higher degree studies.

X. The Annual Symposium and Graduate School Fair

On February 21, 2003 the first Graduate School Fair was held at the Mayaguëz Resort in Puerto Rico with the participation of over 160 graduate and undergraduate students from universities throughout Puerto Rico.

This Graduate School Fair consisted in educational and motivational talks by invited speakers within and outside the alliance members, a key-note speech, informational talks by alliance members about opportunities for graduate school, and a poster session and presentations given by our graduate students.

Several student associations housed on the Mayaguëz Campus presented their projects at a booth exhibition which allowed them to present their research projects as well as to serve as a vehicle to exchange ideas. The AGEPE partners participated in the booth exhibition and offered informative material as well as application for graduate programs. Promotional material was distributed and interaction between graduate-school administrative officials, faculty and students were established. This also provided with a positive way of disseminating the goals and accomplishments of the current project and also exposed the students to various opportunities currently within the alliance.

CONCLUSION

It is clear that having new programs tailored to change the culture at the institutional level while having champions who will support and growth the programs makes a significant difference in the development of minorities and the preparation and nurturing of the future minority faculty. A unique partnership between Syracuse University, Cornell University, Rensselaer Polytechnic Institute, and the University of Puerto Rico-Mayaguez, *The Alliance for Graduate Education and The Professorate: Central New York-Puerto Rico* has been successful in increasing the number of minorities and females obtaining a PhD degree while promoting research and teaching collaboration among the partner institutions. AGEPE has supported ideas encompassing

the whole spectrum of women and minority professional development, from undergraduate education and research up to graduate school, up to strategies for job allocation as junior faculty member and further success to attain tenure and full professorship. Moreover, activities that promotes the research collaboration, which involves faculty and students, is the key to the sustainability of the program after the five years of the funding period. In addition, it was shown that in order to train the next generation of PhD leaders with skills to work in the global market we must exposed our graduates to international experiences during their career.

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