

LEVERAGING INSTITUTIONAL AND GOVERNMENTAL RESOURCES TO BENEFIT MINORITIES AND WOMEN IN ENGINEERING AND THE SCIENCES

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Abstract — A primary commitment of the Engineering Research Center (ERC) for Particle Science and Technology (PS&T) is to encourage minorities and women to participate in PS&T educational and research opportunities. The Center supports Undergraduate Research and Scholarship Awards Programs that most recently consisted of 40% women and 28% minority participation. Last year the ERC Graduate Program had 39 % women and 9% minority participation. To further enhance minority participation at the graduate level, the ERC entered into a collaboration with the UF College of Liberal Arts and Sciences and Office of Graduate Minority Programs as well as with Florida A&M University to develop an NSF Alliance for Graduate Education and the Professoriate (AGEP) Program. This collaboration has resulted in an increase in ERC minority graduate students to 16%. This paper describes the synergistic collaboration that allowed the ERC to make this significant enhancement. Roadblocks to enrollment and retention that were overcome as well as the lessons learned during the implementation of this highly successful program will be discussed.

Index Terms — graduate minority education, academic careers, Alliance for Graduate Education and the Professoriate

INTRODUCTION

Particle technology is a core technology in chemical, pharmaceutical, agricultural, mining and microelectronic areas. As such, it impacts over 1\$ trillion dollars of industrial output each year. Particle manufacturing, packaging and sales are growing businesses and there is a need to improve fundamental understanding in PS&T. PS&T is by its very nature a multidisciplinary field. Engineered systems level PS&T problems can require input from chemical, materials science, environmental, mechanical, aerospace and agricultural engineering as well as chemistry, physics, pharmacy, microbiology and computer science, among others.

The National Science Foundation has established national centers of research to enhance the competitiveness of American industry and to promote new educational models to meet the changing needs of research and industry. These Centers are a collaboration between the government, universities and industrial partners and each is focused on a particular area of research. The Engineering Research

Center (ERC) for Particle Science and Technology at the University of Florida (UF) is the only Center dedicated to the investigation of critical issues in particle science and technology. Industrial and academic leaders in the field met last year to discuss future opportunities in PS&T across many industries, and to determine the optimum educational model that will produce students to meet these challenges. The group agreed that there were major changes taking place in industry, and universities must react to these changes. The group concluded that significant changes were occurring including the trend in microelectronics to small, faster and cheaper, the surge in opportunities in biotechnology areas. Particle systems present unique challenges to industry and these programs are exacerbated when examined on the nano level. Conclusions of the workshop participants were:

- There is a need for PS&T trained professionals a variety of disciplines
- Current graduates are not coming out with the right set of tools
- Nanoparticles will become increasingly important and present special challenges
- Bio areas are already a growth market and will continue to be in the future

A key feature of the NSF Engineering Research Center program is the commitment to improve the quality and diversity of engineering graduates entering the technical workforce. ERC's are challenged to encourage participation of women and underrepresented minorities on all levels of their program. Over the past six years, the ERC for Particle Science and Technology has offered 143 graduate and 718 undergraduate students opportunities to conduct research in the Center. The Undergraduate Research and Scholarship Awards Programs most recently consisted of 40% women and 28% minority participation. Last year the ERC Graduate Program had 39% women and 9% minority participation. The ERC has consistently exceeded national averages for participation of women and minorities, but continued to explore opportunities for further enhancing the diversity of its educational program.

THE NSF ALLIANCE FOR GRADUATE EDUCATION AND THE PROFESSORIATE (AGEP)

The ERC's most recent effort at diversifying the student population was focused on increasing minority participation

at the graduate level. The Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development (CAWMSET) clearly articulated the need for increased effort at educating underrepresented populations in SEM to meet the needs of the country for a highly educated workforce. They concluded that the shortage of technically capable workers would be significantly lessened "if women, underrepresented minorities, and persons with disabilities were represented in the U.S. science, engineering and technology (SET) workforce in parity with their percentages in the total workforce population." [1]

Currently, underrepresented minorities more often chose an industrial job than an academic position. Greater diversity in faculty in the U.S. would not only enrich the scientific contribution of academia, but would also provide students with role models that are an important factor in educational path and career choices. The presence of role models has been shown to be of critical importance in influencing career choices [2], [3], [4], [5]. It has been shown that a large percentage of minorities in science and engineering today had a role model in the person of a parent or relative who works in a technical field [4]. In the absence of a family role model, professors can fulfill this role. A study of African American computer science students at historically black institutions also highlighted the importance of role models [6]. Given the lack of diversity in many faculties, it is an exception when a professor can serve as a role model for underrepresented groups. In 1994, the number of minority faculty in full-time teaching positions in science and engineering was 1% African American and 2-3% Hispanic [2], providing few role models for students from underrepresented groups.

To remedy this situation, NSF developed the Alliance for Graduate Education and the Professoriate Program. This program is designed to go beyond financial support to include recruiting and retention components, to insure the success of minority students who chose an academic career path. The program is designed to produce systemic change that improves the climate for minority science, engineering and mathematics (SEM) PhD students across campus.

NSF has been a strong supporter of undergraduate minority programs in SEM, and this new initiative is a natural extension of these undergraduate programs. To develop an efficient and effective minority program on any campus, collaborations with other NSF and/or University supported efforts is critical. The NSF Louis B. Stokes Alliance for Minority Participation in Science, Engineering and Mathematics is just one example of a program that can be leveraged to mutual benefit. For example, the Florida-Georgia LLSAMP program was established in 1992. Since that time, the number of SME B.S. graduates at participating institutions has more than quadrupled and at least 346 students have enrolled in graduate school. The ERC and UF decided that a collaboration with the FGLSAMP would produce a strong program.

THE UF AGEP PROGRAM

The UF AGEP proposal is a collaborative project between the University of Florida and Florida A&M University to develop a comprehensive professional development program which identifies and nurtures minority students who have the ability and interest to pursue an academic career in SEM. It builds on the strengths of other programs while incorporating current understanding of the obstacles faced by students who chose to enter this career track. This program brings together the University of Florida, a leading graduate research institute in Florida and Florida A&M University, the state institution which has been identified for the past two years by *Black Issues in Higher Education* as the institution that awards the highest number of African American science and engineering baccalaureate degrees in the country.

A program development committee was composed of representatives from the UF College of Engineering and College of Liberal Arts and Sciences and FAMU. Obstacles that minority students face include: isolation, low self-confidence and self-efficacy, lack of role models, financial problems, lower expectations by faculty and peers, and inadequate computer resources and/or access [2], [3], [6]. Program components were developed that addressed these obstacles. The program was designed to bring students into a department in pairs, to decrease isolation. Mentors were assigned in the first year, and AGEP scholars are in turn asked to serve as mentors to the new class of AGEP scholars. Monthly meetings with program managers representing the College of Engineering, College of Liberal Arts and Science and the UF Office of Graduate Minority Program ensure regular contact between the AGEP Scholars and program managers. Professional Development seminars are also offered. To enhance motivation and confidence, each student is sent to a professional conference in their first year, such as the annual NSBE Convention. This provides the student with role models and also helps them to begin to network with others in their field.

In order to ensure its students come to UF prepared to meet the challenges of education and research in the information age, the University has recently established a requirement that all students enrolling at UF matriculate with personal computing resources. Given this requirement, the program provides each entering AGEP Scholar with a laptop.

The AGEP program is not designed to provide financial support to the student throughout their academic career but rather to initiate systemic change in how departments respond to these students. Therefore, the program was developed as a collaboration with academic departments. The grant funds the student for the first full year. This allows the students to focus solely on the demands of graduate school. The first year requires significant

adjustment and is a critical transition point, so financial support at this stage is important. To enroll an AGEP Scholar, the department must make a commitment to support the student in their second year. During this year, they will be assigned to work as teaching assistants to prepare them for their academic career. In subsequent years, students will be assigned by faculty as Research Assistants.

The program development committee also was aware that a main attrition point for students in the science and engineering pipeline is after the baccalaureate degree. Therefore this program, was designed to be a long-term, comprehensive professional development program to encourage talented students to continue their education beyond the baccalaureate degree. Program components were included for the early identification of students interested in pursuing an academic career and the establishment of connections between UF and FAMU SEM students at a critical stage in their academic career.

Prospective AGEP students are identified at FAMU in their Sophomore year and are provided with research and professional development opportunities on the FAMU campus. Fifteen students each summer are offered undergraduate research experiences on the UF campus. UF Campus visitation program and guidance are provided to the student throughout their undergraduate years, to ensure encouragement and adequate preparation for an academic career.

LESSONS LEARNED

The implementation of such a comprehensive program across all SEM departments is a major undertaking. As each department has its unique requirements, the program must be flexible enough to allow students to participate in the AGEP while satisfying all departmental requirements. One example is that the AGEP program calls for the students to spend the first year concentrating on their studies, relieving them of the necessity of working in this critical transition year. The TA experience is scheduled for year 2. However, in at least one department this requirement was lifted in order for the student to TA her first year as this is the norm in that department, and to not do so would put her at a disadvantage with her colleagues, as significant bonding occurs in the first year among TA's.

Also, the NSF stipend in some cases is lower than the departmental standard, and in this case the department has supplemented so that the AGEP students would have parity with the others in the department. In at least one instance, one department was excluded from participating in the program because of failure to commit to an adequate level of funding for the student's second year.

The program requires a significant level of communication between the two institutions that involve face-to-face as well as electronic contact. Each College

must have a designated representative who can act as a liaison between the College and the program managers.

Given the long-term nature of the program, it is expected that FAMU graduates will begin to arrive on campus in greater numbers beginning 2002. In the meantime, the program was expanded to include minority graduate students from many different undergraduate institutions with high underrepresented minority populations.

Although the program was designed to bring students into departments in pairs, it was not always possible to do so. In those cases where individual students were accepted, each was assigned an AGEP mentor from a closely related department.

THE FIRST TWO YEARS

As a result of this program 17 AGEP scholars including 8 women, are currently pursuing graduate work at UF. This exceeds the 15 originally planned for due to the popularity of the program on campus. These students are working in Materials Science and Engineering, Civil Engineering, Agricultural and Biological Engineering, Chemistry, Microbiology and Cell Science, Entomology and Animal Science. These students have participated in the 2000 National Society of Black Engineers Meeting, The American Society of Tropical Medicine & Hygiene Annual Meeting, The 9th International Symposium on Superalloys, the Transportation Research Board 80th Annual Meeting, the Compact for Faculty Diversity Meeting, and the QEM/MGE Network Conference

The first cohort of AGEP Scholars were assigned to mentor the second group. These students have subsequently become involved in other campus organizations including the Black Graduate Student Organization (BGSO) and have assumed leadership positions in NSBE and the UF BGSO.

The most successful department participating in the AGEP is the Materials Science and Engineering Department that now has 9 AGEP scholars that includes 5 women. The climate for women and minority student has significantly improved due to this program. This is the result of strong support by the Department Chair and department administrators

UF hosted 11 FAMU students for Summer Research Experiences and they participated in research projects in engineering, biology, microbiology and cell science and botany. Additionally, a core of AGEP scholars on the FAMU campus were identified and were provided with various professional development and research opportunities. The AGEP opportunities were promoted at the 2001 FGLSAMP EXPO which attracted over 300 minority students.

AGEP AND THE ERC

As previously discussed, the ERC committed to increasing the diversity of its graduate student population. Currently, 50 graduate students participate in PS&T research. Through participation in the AGEP program, the ERC was able to increase minority participation from 9% to 16% over the two first two years of the program. The ERC was able to accomplish this by leveraging its resources with the NSF AGEP program and by collaborating with other UF Colleges and FAMU. By joining into partnerships with other NSF funded programs on several different campuses, the ERC was able to accomplish more than would have been possible individually. Programs that seek to make systemic change on large campuses must rely on these types of partnerships to produce significant change. The AGEP program at UF is entering its third year and is poised to continue to support the AGEP Scholars as they work towards their goal of entering academia, while simultaneously laying the groundwork to prepare future students to follow in their footsteps.

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