Abstract
There has been a lack of diversity in engineering education in the United States. This is due to having fewer minority students such as Blacks/African Americans, Hispanics, Asians/Pacific Islanders, American Indians/Alaskan Natives, and females in engineering education. The statistics on minority representation among tenure-track faculty in many disciplines remain alarmingly low. At many U.S. universities, tenure and non-tenure track minority faculty are less than 10% of the total faculty. The reason for this is the low number of females and minorities with Ph.D.s graduating each year. Existing statistics show that the number of women and minority Ph.D. graduates in engineering are less than 20% of total Ph.D. graduates. Many universities across the nation are helping minority students by vigorous recruitment, retention, orientation, and professional development programs and workshops. Universities are also increasing their funding to attract minority-engineering students. This paper addresses minority Ph.D. graduates in engineering, minority faculty in engineering, and a case study from the University of Florida. The case study depicts issues of diversity and proposes certain solutions to enhance minority-engineering education through offering various teaching workshops, and active minority mentoring programs. It is in the nation's universities best interest to increase minority students’ enrollment at both graduate and undergraduate levels.

Introduction
While efforts to broaden the diversity of technically trained individuals with undergraduate degrees have been largely successful since the late 1960s, far less progress has been made in efforts to produce individuals with graduate level degrees in engineering and science. Clearly, the technological demands of the future will require more individuals at not only the bachelor’s level but at the master’s and doctoral level as well. As the United States economy faces increased competition from other technology-based nations, there is a need for more technically trained individuals in the near future. The problem is that there is still a lack of diversity in engineering education in the United States. This is due to having less minority students (e.g., Blacks/African Americans, Hispanics, Asians/Pacific Islanders, American Indians/Alaskan Natives, and females) in engineering (1).

The American economy needs greater participation of educated minorities and women to maintain a competitive edge in world trade and to sustain a standard of living (2). The Quality Education for Minorities Project (QEMP) report stresses that the United States will not be able to remain globally competitive if it continues to rely upon populations that traditionally have supplied its technical needs. That report also stresses that if Americans are to maintain the ability to compete in the world and sustain its standard of living, it should improve education and significantly increase the participation of minority students in the mathematics, science, and engineering fields (3). 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. Roland Haden, dean of the

---

1 Ph.D. graduate student, Department of Civil and Coastal Engineering, University of Florida, P.O. Box 116580, Gainesville, Florida 32611
2 Professor, Department of Civil and Coastal Engineering, University of Florida, P.O. Box 116580, Gainesville, Florida 32611
Dwight Look College of Engineering at Texas A&M University said that the economy has been so hot that all students are going to work with bachelor's degrees, whether minority or majority. While the recession that began in 2000 is causing a major headache for the economy and the population, it may be beneficial to engineering schools because economic downturns typically lead to an increase in graduate school enrollment (4). This may not be always the case because students need to be attracted, stimulated, and encouraged to consider a continuation for a higher education degree in engineering. This paper addresses the issues of diversity and presents a case study on minority programs at the University of Florida.

**Minority Ph.D. Graduates in Engineering**

The number of doctorates awarded by the American research universities in 2001 fell to a level not seen since 1993. Nationally, the total Ph.D. graduates in 1998 was 42,654. This number decreased to 40,744 in 2001, a decline of 4.5%. The dip can be explained by a large decrease in doctorates awarded in science and engineering disciplines, which fell 6.5% since 1998. The number in fields outside science and engineering dropped by only 0.9% over the same period. There is still a need to attract more women and minorities to the engineering fields. Women have historically not enjoyed a high representation in the sciences. This could partly explain why the overall number of science doctorates is falling. Students in general are looking at the opportunity costs and opting to go to law school and business school rather than engineering (5).

Women are represented in engineering in much greater numbers today than they were 30 years ago. However, there are still many hurdles to overcome to reach equitable representation (6). The number of women Ph.D. graduates in engineering from 416 institution granting Ph.D.s have been below 20% for the past 10 years as seen in Figure 1 (7). This is because women are more likely to earn their doctoral degrees in the non-science and engineering fields such as health, humanities, and education than men. Females have also shown a 2.12% decrease in the number of Ph.D. awarded in engineering from 2000 to 2001 as seen in Figure 1 (7, 8).

![Figure 1: Percent Male and Female Engineering Doctorates Awarded in U.S. (Citizen or Permanent Residence)](image)

The majority of the Blacks/African Americans earn their Ph.D.s from non-science and engineering related fields as well. Hispanics, which consist of Puerto Ricans, Mexican Americans, and other Hispanics, are more likely to earn their doctoral degrees in life sciences, social sciences, and humanities. There is a higher percentage of Asians/Pacific Islanders in engineering fields as compared to other minorities. A big difference in fields of study is seen by the culture, race, and gender. Due to the higher percentage of minority students in non-sciences and engineering fields, there has been a
decline in minorities in engineering related fields. The main reasons why there has been a decline in the engineering majors is because of the following (9):

1) Math is the “Brussel Sprout” of high school students
2) Engineering is considered “dry”
3) Lack of role models (Women only constitute 8% of the engineering faculty in the U.S.)
4) Computer related fields “stealing” potential candidates

The results over the last ten years (416 Universities) have shown a steady improvement in increasing diversity (Figure 2). It can also be seen in this figure that the number of Hispanic students have decreased in the past ten years. They remained below the 9% average mark. The American Indians/Native Alaskans have shown the lowest percentage of awarded engineering doctorates for the past ten years. They have remained below 1%. Asians/Pacific Islanders have stayed within the 20% or below average through this past decade but has shown a dramatic decrease after 1995. Although Blacks/African Americans have been below the 5% average, they slightly increased in 2001(7, 8).

The minority students that are seeking careers in math and science face a whole host of obstacles. Many grow up in urban and inner city areas where access to technology is often limited. For example, a fall 2000 study by the U.S. Department of Commerce found that white (46.1%) and Asian American/Pacific Islander (56.8%) households continued to have Internet access at levels more than double those of Black/African American (23.5%) and Hispanic (23.6%) households (10).

Figure 2: Percent of Engineering Doctorates in U.S. Awarded by Race (Citizen or Permanent Residence)

**Minority Faculty in Engineering**

Most individuals who pursue doctorates enter graduate school with plans to teach after graduation. However, a much smaller number actually accept academic positions in the critical first years after doctoral completion. Moreover, some of those who accept an academic position had not planned to teach. This difference between initial plans and employment may result from various factors such as changing plans during the course of graduate school or success in efforts to obtain a position in one’s
sector or first choice (11). The statistics on minority representation among tenure-track faculty in many disciplines remain alarmingly low. In many U.S. universities, Black/African American, and Hispanic faculty remain less than 5% of the total through 1999 and 2001 as seen in Table 1. Asians/Pacific Islanders made up less than 20% of tenure and non-tenure track minority faculty through 1999 and 2001. It can also be seen that American Indians/Alaskan Natives make up less than half a percentage. The percentage of females serving as either an assistant or full professor increased from 1999 to 2001. Although the percentage of female associate professors increased by 0.6% from 1999 to 2001 there is still a relatively low percentage of female faculty in engineering. The reason for this is the low number of females and minorities that graduate from Ph.D. programs each year (4,7).

Table 1: Full Time Engineering Faculty in U.S. by Rank, Ethnicity, and Gender

<table>
<thead>
<tr>
<th>Type of Professor</th>
<th>Male</th>
<th>Female</th>
<th>White</th>
<th>Asian/ Pacific Islander</th>
<th>Black/ African American</th>
<th>Hispanic</th>
<th>American Indian/ Alaskan Native</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full</td>
<td>97.8%</td>
<td>2.2%</td>
<td>78.7%</td>
<td>17.7%</td>
<td>1.5%</td>
<td>1.8%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Associate</td>
<td>90.5%</td>
<td>9.5%</td>
<td>75.7%</td>
<td>16.6%</td>
<td>4.4%</td>
<td>3.1%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Assistant</td>
<td>85.2%</td>
<td>14.8%</td>
<td>73.5%</td>
<td>19.4%</td>
<td>3.8%</td>
<td>3.0%</td>
<td>0.3%</td>
</tr>
<tr>
<td>2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full</td>
<td>95.6%</td>
<td>4.4%</td>
<td>80.5%</td>
<td>16.0%</td>
<td>1.3%</td>
<td>2.2%</td>
<td>NA</td>
</tr>
<tr>
<td>Associate</td>
<td>91.1%</td>
<td>8.9%</td>
<td>78.0%</td>
<td>17.0%</td>
<td>2.1%</td>
<td>2.9%</td>
<td>NA</td>
</tr>
<tr>
<td>Assistant</td>
<td>82.5%</td>
<td>17.5%</td>
<td>73.1%</td>
<td>19.3%</td>
<td>3.5%</td>
<td>4.1%</td>
<td>NA</td>
</tr>
</tbody>
</table>

Case Study
The University of Florida (UF) is trying to increase the number of minority students in graduate engineering by starting to recruit minorities in their freshman year. To attract more minority students, UF stepped up recruiting of top minority scholars in neighboring states, forged partnerships with five inner-city schools, and added an essay component to its application in hopes of recognizing minorities through race-neutral criteria. It is UF’s second year of trying this method and they have showed more success than other schools that have gone though a similar public policy change. Most of the recruiting comes from word of mouth and traveling to different states and countries encouraging high school minority students to enroll in UF even if their SATs or ACTs scores do not meet entrance requirements. This makes students feel welcomed and gives them the support to continue their education (12).

The University of Florida (UF) has dramatically increased its minority student enrollment for fall of 2002 as seen in Figure 3, a topic that has largely been lost in the debate over ending affirmative action in admissions. They were part of a 43% surge in black students at UF as compared with last year, and a 13% increase in Hispanic Students over the summer and fall. Enrollment in the fall semester, which is tougher to get into than the summer, has shown an increase in black and Hispanic students. Through aggressive and creative recruiting, UF has become the first flagship university in the country to overcome the effects of an affirmative action ban in admissions. In 2000-2001, UF ranked third in the nation in the number of bachelor’s degrees awarded to Black and Hispanic students. It ranked 11th in the number of master’s degrees awarded to Blacks and fourth in the number of master’s degrees awarded to Hispanics. UF also ranked 13th and fifth in the number of doctoral degrees awarded to Black and Hispanic students in 2000-2001. In addition, it ranked fourth and first for Black and Hispanic students for the number of professional degrees awarded. Part of the explanation for UF’s
success is its high admissions standards, minority programs, minority scholarships and awards, and minority transfer workshops (13,14).

![Figure 3: Percentage of Black and Hispanic Freshmen Enrolled at the University of Florida](image)

The Annual High School Scholars Program is designed to acquaint minority high school students and their families with the University of Florida campus and all of its colleges and programs. UF invites high school juniors and their parents from all over Florida and the Atlanta, Georgia area to spend two days on campus at the university’s expense. Scheduled activities provide an opportunity for participants to learn about student life on campus and to meet and talk with students, faculty, and administrators. Guided tours of the campus are conducted and students visit departments and campus areas of personal interest. Eighty-three percent of the students attending the program submitted a UF application and eighty-eight percent of those who submitted applications were admitted. Thirty-six of those students admitted received scholarships and three or four percent, were awarded the National Achievement Scholarship in the year 2000 (14).

Another successful program is the Minority Transfer Workshop. This workshop focuses on recruiting African American transfer students to the University of Florida. The workshop is a two-day program designed to inform prospective students about admissions, financial aid, housing, and career placement. This year, the workshop hosted 93 students and 10 counselors. The workshop is one of the more successful recruiting tools utilized by the university. In addition to the workshop, the Admissions Office uses student contact cards, minority brochures, UF campus visits and the Minority Transfer Scholarship to recruit minority transfer students (14).

The Office of Multicultural Engineering Programs (OMEP) provides a support service to minority students in an effort to ensure the success of all students in the College of Engineering. Within this framework exists the Minority Programs Focus (MPF) and the Women Programs Focus (WPF), each of which promotes the provision of academic support services designed to increase the success rate of African Americans, Native Americans, Hispanics, Women, and other groups that are underrepresented in the field of engineering in the United States. For the first time, the College of Engineering offered two summer camps designed specifically for middle school girls and the other for middle minority students. Two additional camps, one for all middle school students, and one for all high school students, were added to the program. The College of Engineering also offered a girls’ summer camp specifically designed for middle school girls. The number of students attending these camps increased significantly from the first year to the second year. The success of these programs is evident in the high retention rates of minority students in engineering programs at the University of Florida.
students were also offered in the summer of 2001. The STEPUP (Successful Transition through Enhanced Preparation for Undergraduate Programs) program has continued to be one of the most successful minority engineering retention programs in the nation. STEPUP incorporated an intensive summer residential component of workshops, classes, peer mentoring and study halls for incoming minority freshmen. In addition, OMEP provides an array of academic services to minority and women engineering students at the undergraduate and graduate levels. Fifty-six minority students received college-wide engineering scholarships in 2000-2001, and several others received university wide and departmental awards (14).

Conclusion

There has been a lack of diversity in engineering education in the United States. The number of doctorates awarded by U.S. universities in 2001 fell to a level not seen since 1993. The statistics on minority representation among tenure-track faculty in many disciplines remain alarmingly low. In many U.S. universities, Blacks/African Americans, and Hispanics of tenured and non-tenured track minority faculties have remained less than 5% of the total faculties through 1999 and 2001. Fortunately, many colleges and universities across the country are doing all they can to help minority students (1). They are pooling resources, creating special classes and programs, and soliciting funding in an effort to increase the pool of minority engineering students.

The University of Florida has dramatically increased its minority student enrollment and graduating rate by its aggressive recruiting, retention, seminars, workshops, and through minority mentor programs. University of Florida has become the first flagship university in the country to overcome the effects of an affirmative action ban in admissions. The college of Engineering faculty, staff, and students participate in various activities in middle schools and high schools. They visit these schools and give presentations on engineering education. By increasing the population for different races in the university, there is a better chance of increasing the number of minority students in engineering.

References


11. Hoffer, Thomas and Lance Sefla (July 13, 2001), Academic Employment of Recent Science and Engineering Doctorate Holders, Division of Science Resources Studies, Issue Brief, National Science Foundation 01-332.

12. Miller, Carrie (July 8, 2002), “UF’s Summer B Figures Point to a Rise in Minority Enrollment,” The Gainesville Sun, Gainesville, Florida.


**Sofia M. Vidalis**

Sofia M. Vidalis is currently a Ph.D. Student of the Public Works program in the Department of Civil and Coastal Engineering at the University of Florida. She earned her Master’s and Bachelor’s Degrees in Engineering from the Department of Civil and Coastal Engineering at the University of Florida.

**Dr. Fazil T. Najafi**

Dr. Fazil T. Najafi is a Professor at the Department of Civil and Coastal Engineering (CCE) at the University of Florida in Gainesville. He is also the Coordinator of the Public Works Engineering and Management Division. Dr. Najafi earned his BS (Architectural Engineering), MS, and PhD degrees (Civil Engineering) from Virginia Polytechnic Institute and State University (VPI&SU). He also has a BSCE from the American College of Engineering, Kabul, Afghanistan. Dr. Najafi came to the United States with a Fulbright scholarship in July 1966 and started his formal education at VPI&SU. His teaching responsibilities include graduate and undergraduate courses in Public Works Engineering & Management and Introduction to Engineering. His research focuses on diverse areas such as the development of User Cost Data for Florida’s Bridge Management Systems, Radon Reduction in the construction of new houses, the Oil Spill Response System in Florida, methods to reduce Urban Congestion, Transportation Planning and Cost Optimization, including Maglev systems, High Speed Rail, Tort Liability related to utility, Public Works Planning and Management, Construction Engineering and Management, Legal Aspects of Engineering and Engineering Cost Analysis.