A Year-Long Entry-Level College Course Sequence for Enhancing Engineering Student Success

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Abstract - **The College of Engineering at NC State University, located in Raleigh, NC, USA, attracts some of the most talented high school students in the country. Each year, an entering freshman class of 1400 new engineering students includes 17% women and 20% minority students. The entire engineering undergraduate and graduate enrollment of 7700 students comprises 16% women and 25% minority students. While our international reputation as a top-tier engineering university, coupled with academic recruiting scholarships, continues to attract a diverse set of entering freshmen, acclimating these students to engineering and a large diverse campus of 30,000 students is a continuing challenge. This paper focuses on our two-semester sequence that is our freshman-level Engineering Professional Student Development courses. We describe the demographics of our student population and share details on both courses. The first course offers early and intrusive support that promotes student persistence towards graduation and academic achievement, while exposing students to goal setting, decision making and effective communication techniques. The second course focuses more on the professional development of the students, and includes topics such as preparing for a summer internship, co-operative education experience, or full-time employment.**

Index Terms - Diversity, engineering, minority, student success, under-represented.

THE ENGINEERING STUDENT DIVERSITY CHALLENGE

As a land grant university as designated by the United States federal government, our university has a mandate to provide practical education to the citizens of this state, while maintaining nationally ranked and recognized research programs. In line with this land grant responsibility, our College of Engineering seeks to recruit the highest achievers while maintaining a diverse and inclusive campus community. On our campus, student diversity is enhanced by increasing the numbers of African-American, Native-American and Hispanic-American students (together referred to as minority or under-represented students). These three groups are designated under-represented by the US federal government because the rate at which they seek college degrees in science, technology, engineering and mathematics, is disproportionately lower than their percentages in the general US population. Research has shown that first year student success is highly dependent on support services and programs, particularly for minority students [1, 2].

Attracting minority students to rigorous engineering programs is a challenge that colleges and universities across the country continue to face. This challenge is even greater for traditionally white institutions (TWI) in comparison to Historically Black Institutions (HBCUs) [3]. Efforts to recruit and attract African-American, Native-American, and Hispanic-American students must be effective in making the student feel "comfortable" in an environment where familiar faces are few. Our College of Engineering continues to seek innovative programs to recruit, enroll and graduate students from our engineering programs. In order for these programs to be effective, the student as well as their family must be embraced [4]. Tables I & II show our fall 2006 undergraduate and graduate engineering student enrollment. Abbreviations are NA = Native-American, AA = African-American, HA = Hispanic-American, and AsA = Asian-American. Also note that percentages are rounded and may not sum to 100%.

TABLE I
FALL 2006 UNDERGRADUATE ENGINEERING ENROLLMENT

	M	%	F	%	TOTAL	%
White	4035	86	645	14	4680	81
NA	39	93	3	7	42	1
AA	303	75	99	25	402	7
HA	130	78	36	22	166	3
AsA	333	80	85	20	418	7
Other	90	88	12	12	102	2
TOTAL	4930	85	880	15	5810	101

In the fall of 2006, the freshmen engineering class included 1407 students, where 10% of the students were under-represented minorities and 17% were women. Table III shows complete ethnicity and gender composition of our fall 2006 new freshman engineering class.

TABLE II
FALL 2006 GRADUATE ENGINEERING ENROLLMENT

	M	%	F	%	TOTAL	%
White	708	82	156	18	864	45
NA	3	50	3	50	6	0
AA	49	72	19	28	68	4
HA	29	76	9	24	38	2
AsA	665	78	186	22	851	45
Other	54	75	18	25	72	4
TOTAL	1508	79	391	21	1899	100

TABLE III
FALL 2006 NEW FRESHMAN ENGINEERING ENROLLMENT

	M	%	F	%	TOTAL	%
White	942	84	186	16	1128	80
NA	7	100	0	0%	7	0
AA	73	79	19	21	92	7
HA	27	73	10	27	37	3
AsA	78	80	19	20	97	7
Others	41	89	5	11	46	3
TOTAL	1168	83	239	17	1407	100

CURRENT NATIONAL MINORITY ENGINEERING STUDENT STATUS

According to the most comprehensive research data released by the National Action Council for Minorities in Engineering [NACME], Inc., freshman enrollment, the gateway through which minorities enter the engineering profession, was considerably lower at the end of the period studied. From a peak enrollment of 15,181 African-American, Hispanic-American and Native-American freshmen in 1992-93, minority freshman enrollment declined 8.2 percent, dropping to 13,929 in 1997-98. Nationally, that downward trend continues to the present day. Not surprisingly, for both African-Americans and Latinos, losses were concentrated among engineering institutions enrolling the largest numbers of, and providing the greatest access to, minority students [3]. Also, many studies have proven that under-represented minority under-graduate students drop out of engineering at a higher rate than their white and Asian peers [4–7]. African-Americans are only half as likely to graduate as their white counterparts [8].

For decades several programs at the national and local levels have been developed and attempted to help meet the projected shortage anticipated in an ever-increasing high-technology work force. In 1998, Bowen and Bok published results of a comprehensive longitudinal study of one specific, significant thrust at addressing minority student success: affirmative action. Their study [9] provides defensible, concrete proof of the positive impact affirmative action has had not just on minority participants, but also on society as a whole. While such results are notable from a historical perspective, anyone serious about minority student success will quickly acknowledge that there remains tremendous work to be done in reaching a point where access to education, and a diverse, well-prepared work force pool, is assured. Many under-represented minority students do not see engineering as a career for them [7]. They know few minority engineers themselves, and need to be exposed to programs and activities that increase their awareness early into their undergraduate education career.

BRIEF BACKGROUND ON OUR COLLEGE OF ENGINEERING

Our land-grant University is the largest state-supported school of the sixteen-campus University system. Our College of Engineering is among the best in the country, offering outstanding degree programs and preparing students for exciting and rewarding careers. Our graduates are heavily recruited for positions in a variety of settings, including business, construction, transportation, hardware and software development, and design. The College comprises 12 departments offering 18 BS, 17 MS, and 14 Ph.D. degree programs and conducts the largest undergraduate and graduate engineering education and research programs in the State. The College continues to rank among the nation's leading colleges in the total number of degrees awarded, the number of degrees awarded to women and minorities, the quality of the graduate programs, and research and extension activities. Our fall 2006 undergraduate enrollment was 5,810, approximately 25% of our total university undergraduate enrollment. Total campus enrollment at all levels approaches 30,000 students. We have the second largest African American engineering undergraduate enrollment of all non-Historically Black Colleges and Universities (HBCUs) in the nation. Among non-HBCUs, in 2005 we award the second highest number of Bachelor of Science in engineering degrees to African-Americans [10].

MINORITY FRESHMEN ENGINEERING CLASSES

In the fall semester, all minority freshmen are enrolled in E144 - Academic and Professional Preparation for Engineers I. This course offers early and intrusive support that promotes student persistence and academic achievement, while exposing students to goal setting, decision making and effective communication techniques. The course is designed specifically for minority students, although it is open to all engineering freshmen. The course objectives for the students are as follows: 1) develop tools to improve their chance for

academic success; 2) gain exposure to academic survival and time management skills; 3) cultivate a supportive community environment with other students who share common interests, concerns, and goals; and 4) develop an understanding of the engineering profession.

The fall class goes over academic preparation such as time management skills, study skills, managing academics with extracurricular activities, graduate school and professional opportunities. In the fall the course focuses more on the transition to college and academics. Another integral part of the fall class is the minority career fair. Each year the Black Student Board in conjunction with other student organizations such as the National Society of Black Engineers (NSBE) sponsors a career fair on campus. This is the premier fall recruiting fair for the university. NSBE sponsors an "Afternoon Affair" each year the day before the career fair so minority students will have an opportunity to meet industry representatives and network. As part of a class assignment, students in E144 must attend the Afternoon Affair and the minority career fair. Other significant components of the fall course are upper-division minority engineering student information panels. These students share their undergraduate experiences and advise the students on success strategies associated with course scheduling combinations, preferred course sections and professors, campus involvement in discipline and ethnic-based organizations, and making summer internships, co-operative education and undergraduate research choices.

In the spring semester, students may choose to enroll in E145 - Academic and Professional Preparation for Engineers II. Approximately 2/3 of the E144 students elect to enroll in E145. The spring semester focuses more on the professional development of the student, such as preparing for a summer internship, co-operative education experience or full-time employment. Students learn about the services available across campus. The co-operative education program at NC State is the 2nd largest non-required program in the nation among engineering schools. Seventy per cent of the students who participate in the co-op program are engineering majors. A minority representative from co-op will talk to the class about the benefits of co-op, the eligibility and how to become apart of the co-op program. The students also visit the University Career Center. The Career Center serves as a placement office for internships, co-op and full-time positions. The students meet the career counselors for the College of Engineering, learn about the interviewing process and how to put resumes online with the career center. Also, industry representatives speak to the class to discuss interviewing skills, goal setting, teamwork, understanding money, and professional development. Inviting these industry representatives, many of whom are minorities themselves, reinforces to the students the goals and mission of Minority Engineering Programs: to graduate successful minority engineers. The representatives tell the students how to get jobs, sell themselves and network to become successful engineers and productive and happy members of society.

We also set up "mock" interviews for the students with industry Human Resource and Technical Managers so they can simulate what it will be like in a real interview. Many of the students may not know how to respond professionally in interviews due to cultural or socioeconomic reasons. This early interviewing training is a way for these academically talented students to become well-rounded professionals as well.

Both classes also serve as a way for freshmen to interact with the Office of Minority Engineering Programs staff. We get to know the students, their personality, their academic strengths and weaknesses. Since we interact with the freshmen on a weekly basis in E144 and E145, we let them know about scholarship or internship opportunities. These students are often given priority consideration for these scholarships since we have personal knowledge of their success. The students become comfortable with the MEP staff and because of the interaction during their freshmen year, return to our office for academic, professional and emotional support later in their undergraduate engineering career.

NATIONAL PROFILE OF OUR COLLEGE OF ENGINEERING

E144 and E145 are part of our engineering student success model that is contributing towards our goal of increasing student diversity in the engineering and computer science professions. We know we are on the right track because our College of Engineering has been honored three times in the short history of a national mentoring awards program. In 2000, we received organization recognition by being selected for the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring [11]. Two of our African-American engineering professors won individual Presidential Mentoring awards in 1998 and 2003 for their contributions to the success of under-represented minority students earning engineering graduate degrees [12-13].

For over 10 years, our Minority Engineering Programs Office has been evolving as a national model for engineering student success. Refereed paper presentations on our model have been made in recent years at annual conferences of the American Society of Engineering Education [14], Frontiers in Education [15], the International Conference on Engineering Education [16-22], the International Symposium of IGIP/IEEE/ASEE [23], and the Annual Conference of the National Association of Minority Engineering Program Administrators [24].

CONCLUDING COMMENTS

According to the Black Issues in Higher Education, through 2005, our university consistently ranked in the top five nationally in undergraduate engineering degrees awarded to African-Americans [25]. This accomplishment is even more significant when one considers that the engineering program on our campus comprises approximately 25% of the total student population, and African-Americans comprise approximately 9% of our total undergraduate engineering student enrollment. Further, across the United States, there are nine Historically Black Engineering Colleges, all of which are over 90% African-American. Only a few of these

nine produces more African-American undergraduate engineers than our university[1].

At the graduate level, recent significant research contributions have been made by our College of Engineering African-American Ph.D. students in computer science [26], electrical engineering [27], and computer engineering [28]. The all-time national record at that time in 2000, of six Ph.D. degrees awarded in one year to African-American females by our engineering college, resulted from a long-standing commitment to hiring, mentoring, promoting and celebrating a faculty that at the time included eight African-American professors. These faculty mentors and scholars provide additional credibility to campus-wide commitments through national recognition of their own accomplishments.

Two of these African-American faculty members are recipients of the 1998 [29] and 2003 [30] Presidential Award for Excellence in Science, Engineering and Mathematics Mentoring. Another is the first and only winner of the US Air Force Research and Development Award for research work done in support of the NASA International Space Station [31-32].

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