3. Undergraduate Education: Looking Beyond The Traditional Pool

For the United States to remain competitive in a global technological market, it must take serious steps to create a diverse and well-trained workforce. Faced with lessened general interest in engineering and science careers {2} {16}, coupled with an increase in demand for engineers and scientists, companies worldwide are looking beyond the traditional pool of talent (largely Caucasian men) and targeting the growing workforce population of women and minorities.

3.1 Women Underrepresented in Some Sciences

Although the numbers of women in some SMET fields have been rising, women remain underrepresented in engineering and physics. The U.S. enrollment of women students in engineering curricula grew from less than 2% of engineering enrollments in the 1960s to only a little less than 20% in 1998 (see Table 3-1) {32}. In 1999, women received 19.8% of the bachelor's degrees in engineering (Table 3-2) {33}. (Although the percentage of bachelors degrees in engineering earned by women increased from 15.4% in 1990 to 19.8% in 1999, this meant an increase in actual numbers of only about 2,230 {33}). Physics is another field where women are underrepresented. For example, in 1997 women received 19.2% of the physics bachelor's degrees (Table 3-3) {34}.

Table 3-1: Total Undergraduate Enrollment of Women in Engineering, 1990-98

Year	Total	Number of Women	Percent of Total
1990	380,287	61,816	16.3
1991	379,977	63,536	16.7
1992	382,525	66,065	17.3
1993	375,944	66,532	17.7
1994	367,298	66,655	18.1
1995	363,315	67,286	18.5
1996	356,177	67,618	19.0
1997	365,358	70,765	19.4
1998	366,991	72,393	19.7

Source: Commission on Professionals in Science & Technology (Washington, D.C.), data derived from Engineering Workforce Commission, *Engineering and Technology Enrollments*, Fall 1990 through 1998 {32}.

Table 3-2: Total Undergraduate Degrees Earned by Women in Engineering, 1990-99

Year	Total	Number of Women	Percent of Total
1990	65,967	10,130	15.4
1991	63,986	10,016	15.7
1992	63,653	9,972	15.7
1993	65,001	10,453	16.1
1994	64,946	10,800	16.6
1995	64,749	11,303	17.5
1996	65,267	11,737	18.0
1997	65,091	12,160	18.7
1998	63,271	11,797	18.6
1999	62,500	12,360	19.8

Source: Commission on Professionals in Science and Technology, data derived from Engineering Workforce Commission, Engineering and Technology Degrees, 1990 through 1999 {33}.

Table 3-3: Total Undergraduate Degrees Earned by Women in Physics, 1990-97

Year	Total	Number of Women	Percent of Total
1990	4,193	679	16.2
1991	4,245	670	15.8
1992	4,107	672	16.4
1993	4,080	677	16.6
1994	4,005	710	17.7
1995	3,836	675	17.6
1996	3,703	684	18.5
1997	3,393	652	19.2

Source: National Science Foundation, Division of Science Resources Studies, Susan T. Hill, *Science and Engineering Degrees: 1990-97*, 2000 (NSF 00-310) {34}.

Women drop out of engineering at higher rates than men do. The persistence rates in science, math, and engineering majors varies between 39–61% and 30–46%, for men and women, respectively, depending upon the type of institution {35}. Research indicates that women's educational experiences differ considerably from men's, even when they attain the same grades in engineering courses; and the women who leave engineering have higher grades than men who do so. Women who leave engineering do not leave because of poor academic performance, though they do display a higher degree of academic dissatisfaction.

3.2 Minority Enrollment in Freshman Engineering Declines

Minorities are enrolled at an even lower rate than females (Table 3-4) {32}. For example, in 1998 16% of all engineering undergraduates were from underrepresented minority groups and 20% were women. Recent trends in first-time undergraduate enrollment in engineering are even more alarming. From a peak enrollment of 15,181 African American, Latino and American Indian freshmen in 1992-93, minority freshmen in engineering enrollment declined 8.2%, dropping to 13,929 in 1997-98 {32}. This percentage decline far exceeded the drop in engineering enrollment overall (2.4%) during the same period. For the past several years, the retention rate of minority students in engineering has averaged 35%. In 1996-97, underrepresented minorities constituted one of every ten new engineers {36}.

By individual science and engineering field in 1996, the proportion of baccalaureates earned by Hispanics ranged from a high of 6.9% in psychology to a low of 3.1% in the agricultural sciences {37}. Hispanic women earned a higher proportion of bachelor's degrees in comparison to their male counterparts. They earned 2,730 (4%) of master's degrees in science and engineering. Baccalaureate degrees awarded to minorities and women in engineering are shown in Table 3-5 on page 16 {33}.

In 1996, African Americans earned 7.4% of baccalaureates awarded in science and engineering, but there are differences among the individual disciplines,

Undergraduate Women Speak Out

"In Calculus III and Advanced Calculus, there were only two women in the class. There just have to be more capable women out there than that. One was a friend of mine. She just didn't think she could handle it—and that comes from your self-image. I was advised not to take it by my physics advisor, but I was confident enough to know I could do it. And the women with me in the earlier class were very smart—they knew how to handle it. But, like me, they were advised not to try it."

Female science major

"It's set up that women have to be more male in engineering to get along. I notice that women in other majors don't seem to like that they have to change themselves like I did in order to fit in. To make it in engineering, I had to learn to be more male, but to me, that's a real turn-off. I think it makes you rougher, because eventually, you've learned to take more stuff. You may be more strong than when you first came in. But it always bothered me that I had to change."

Female engineering major

Table 3-4: Undergraduate Enrollment of Underrepresented Minorities in Engineering as a Percent of all Undergraduate Enrollment, 1990-98

		All Underrepresented Minorities		African Americans		Hispanic Americans		Native Americans	
Year	Total	No.	%	No.	%	No.	%	No.	%
1990	380,287	46,770	12.3	23,562	6.2	21,601	5.7	1,607	0.4
1991	379,977	48,692	12.8	24,563	6.5	22,441	5.9	1,688	0.4
1992	382,525	51,517	13.5	25,722	6.7	23,863	6.2	1,932	0.5
1993	375,944	52,437	14.0	25,920	6.9	24,586	6.5	1,931	0.6
1994	367,298	52,238	14.2	24,994	6.8	25,216	6.9	2,028	0.6
1995	363,315	53,670	14.8	25,569	6.9	25,998	7.2	2,103	0.6
1996	356,177	53,801	15.1	24,922	7.0	26,483	7.4	2,396	0.7
1997	365,358	57,811	15.8	24,809	6.8	30,580	8.4	2,422	0.7
1998	366,991	56,919	15.5	25,699	7.0	28,802	7.8	2,418	0.7

Source: Commission on Professionals in Science and Technology, data derived from Engineering Workforce Commission, *Engineering and Technology Degrees*, Fall 1990 through 1998 {32}.

Table 3-5: Baccalaureate Degrees in Engineering by Gender, Minority Group, and Citizenship, 1990-1999[1]

		Women		African Americans		Hispanic Americans		Asians		Native Americans		Foreign Nationals	
Year	Total	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1990	65,967	10,130	15.4	2,173	3.3	2,473	3.7	5,989	9.1	112	0.2	5,121	7.8
1991	63,986	10,016	15.7	2,304	3.6	2,663	4.2	6,305	9.9	146	0.2	4,540	7.1
1992	63,653	9,972	15.7	2,374	3.7	2,708	4.3	6,479	10.2	163	0.3	4,389	6.9
1993	65,001	10,453	16.1	2,637	4.1	2,845	4.4	6,764	10.4	175	0.3	4,604	7.1
1994	64,946	10,800	16.6	2,769	4.3	3,045	4.7	6,881	10.6	207	0.3	4,908	7.6
1995	64,749	11,303	17.5	2,897	4.5	3,409	5.3	7,056	10.9	230	0.4	4,893	7.6
1996	65,267	11,737	18.0	3,120	4.8	3,557	5.4	7,333	11.2	263	0.4	5,042	7.7
1997	65,091	12,160	18.7	3,203	4.9	4,005	6.2	7,625	11.7	265	0.4	5,017	7.7
1998	63,271	11,797	18.6	3,144	5.0	3,939	6.2	7,131	11.3	351	0.6	5,083	8.0
1999	62,500	12,360	19.8	3,171	5.1	4,073	6.5	7,226	11.6	328	0.5	5,052	8.1
Total	**644,431**	**110,728**	**17.2**	**27,792**	**4.3**	**32,717**	**5.1**	**68,789**	**10.7**	**2,240**	**0.3**	**48,649**	**7.5**

[1]This table contains degrees granted in engineering at the baccalaureate level broken out by gender, race/ethnicity, and citizenship Degree data on minorities are for U.S. citizens and permanent residents only. Total engineering degrees are shown for comparison purposes.

Source: Commission on Professionals in Science & Technology, data derived from Engineering Workforce Commission, *Engineering and Technology Degrees*, 1990 through 1999 {33}.

ranging from 5.7% in the physical sciences to 6.1% in engineering, 6.3% in the biological sciences, and 7.8% in mathematics and nearly 11% in computer science {38}. African American women earn a higher proportion (64%) of bachelor's degrees in comparison to their male counterparts than do women of other races. In science and engineering fields, they earned nearly 60% of the bachelor's degrees awarded to African Americans. However, of the 17,355 bachelor's degrees in science and engineering earned by African American women, nearly 65% were in the social and behavioral sciences.

A major barrier for minority students is unmet financial need, which places them continually at risk if something unexpected happens. In addition, many universities still use only SAT scores to determine "merit." Since standardized test performance is highly correlated with family income, minority students are more likely to be excluded from educational opportunities simply because of low test scores. The current backlash against affirmative action policies has exacerbated institutional factors that impede student retention. These include the domination of certain aspects of university culture by white males, low expectations of and unsupportive attitudes towards minorities and women, gender and ethnic isolation, a lack of mentors, and an absence of peer support {35}.

3.2 Persons with Disabilities Likely to Major in SMET

The difference in science and engineering degree completion rates by disability status is related to differences in high school completion rates, college preparation level and enrollment rates, and college persistence and attainment rates. Persons with disabilities are less likely than those without disabilities to graduate from high school, enroll in four-year colleges, and graduate from college. The good news is that individuals with disabilities who are attending college are as likely to major in science and engineering as their peers without disabilities.

Representation in Postsecondary Education

A 1996 study of undergraduate institutions {40} found that approximately 6% of students reported having a disability (Figure 3-1) {40}. This self-reported figure is significantly below the 1994-95 Census Bureau estimates that about 20% of the population had some form of disability, and about 10% had a severe disability. A wide range of disabilities was reported among the undergraduate population, including visual, hearing, speech, orthopedic (mobility), and learning disabilities, as well as other disabilities or impairments. Students with learning disabilities comprised the largest group, and are also the fastest-growing segment of the population with disabilities. The range of disabilities reported indicates that a wide array of needs, accommodations, and technologies will be necessary to address the requirements of this diverse population {41}. Compared with students without disabilities, those with disabilities were more likely to be male, older, and white, non-Hispanic. Students with disabilities are, however, as likely to study science and engineering as students without disabilities (27.2% verses 28.5%), as shown in Table 3-6 {40}.

Table 3-6: Percentage Distribution of 1995-96 Undergraduates, by Disability Status According to Major Field of Study

Major field of study	Total	Does not have a disability	Has a disability
SMET total	28.3	28.5	27.2
Computer/ information science	3.4	3.3	3.9
Mathematics	0.6	0.6	0.2
Physical sciences	1	1	0.6
Life sciences	5.7	5.7	3.4
Social/behavioral sciences	9.5	9.7	9.4
Engineering	8.1	8.2	9.7
Humanities	14.6	14.5	17.6
Education	8.5	8.7	8.3
Business/management	19.7	19.8	17.4
Health	12.7	12.8	11.4
Vocational/technical	2.7	2.6	3.8
Other technical/professional	13.5	13.3	14.2

Source: National Science Foundation, *Women, Minorities and Persons with Disabilities in Science and Engineering: 2000*, (NSF 00-327).

Preparation Level and Institutions Attended

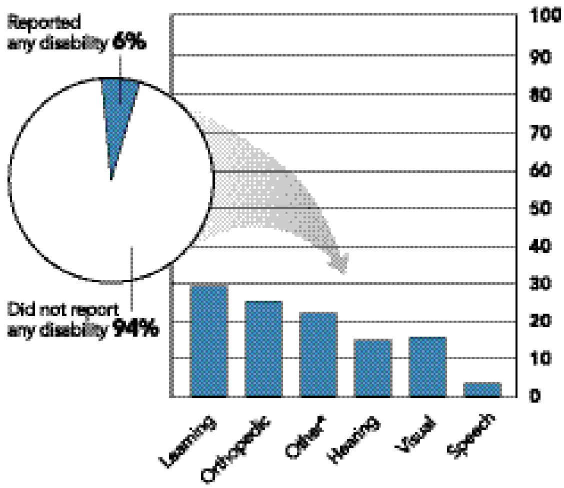
The National Education Longitudinal Study of 1994 {31} found that students with disabilities are less academically prepared for college than those without disabilities. Students with disabilities were, for instance, more likely to have taken remedial courses, less likely to have taken advanced placement courses, and have lower grade point averages and SAT scores than those without disabilities. The 1994 study found that among 1988 eighth graders who went on to complete high school, students with disabilities were less likely than those without disabilities to have enrolled in postsecondary education by 1994 (see Table 3-7 on page 18) {31}. A 1998 study of college freshmen found that students with disabilities were more likely than those without disabilities to have earned Cs and Ds in high school; less likely to have met the recommended years of high school study in mathematics, biological sciences, and physical sciences; and more likely to have spent more time between high school graduation and entry into college {44}.

Challenging Stereotypes

"When I had my accident, leaving me with a severe disability, my Division of Vocational Rehabilitation Counselor told my parents not to expect too much of me. That 'people with such severe disabilities' are not generally able to succeed academically or in the workforce."

College freshman with quadriplegia.
Note: This student went on to earn a Ph.D. and become employed

Figure 3-1: Percentage of 1995-96 Undergraduates Who Reported a Disability, and Among Those with Disabilities, the Percentage Reporting Each Disability Type: 1996



* Any other health-related disability or impairment.

Source: National Science Foundation, *Women, Minorities and Persons with Disabilities in Science and Engineering: 2000*, (NSF 00-327) {40}.

Table 3-7: Among 1988 8th Graders Who Completed High School the Percentage who Enrolled in Postsecondary Education by 1994, and Percentage Distribution According to Type of Institution, by Disability Status and Type: 1994

Disability status and type	Total	4-year institutions	Public 2-year institutions	Other institutions[1]
Total	70.4	59.4	34.4	6.2
Does not have a disability	71.7	61.5	33.3	5.3
Has a disability	62.8	42.0	44.9	13.1
Visual impairment	70.4	48.4	44.2	7.4
Hearing impairment or deaf	60.2	39.8	47.0	13.2
Speech impairment	58.5	49.0	47.6	3.5
Orthopedic impairment	73.9	71.4	23.6	5.1
Learning disability	57.5	28.2	53.9	17.9
Other disability or impairment[2]	65.9	44.3	42.8	13.0

Sources: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, Third Follow-up survey, 1996 (NELS: 88/94); Data Analysis System within *Students with Disabilities in Postsecondary Education: A Profile of Preparation, Participation, and Outcomes*, Laura Horn and Jennifer Berktold, (NCES 1999-187) U.S. Department of Education, Washington, D.C. 1999 {31}.

1 Private for profit-institutions, public less-than-2-year institutions; or private, not-for-profit less-than-4-year institutions.
2 Any other disability, including health problems, emotional problems, mental retardation, or other physical disabilities.

The difference in preparation level is reflected in the institutions attended by students with disabilities. Compared with their counterparts who reported no disabilities, students with disabilities were less likely to be enrolled in public 4-year institutions, about as likely to be enrolled in private, not-for-profit 4-year institutions, and more likely to be enrolled in sub-baccalaureate institutions such as public 2-year colleges. There were no apparent differences, however, between undergraduates with and without disabilities with respect to their general fields of study.

Undergraduate Persistence and Attainment

Not only are students with disabilities less likely to be enrolled in bachelor's degree programs, they are also less likely to have completed a bachelor's degree program within five years. Indeed, 53% of students with disabilities who were enrolled in the 1989–90 academic year were still enrolled or had attained a degree by 1994, compared with 64% of those without disabilities (Table 3-8) {40}. Conversely, a higher proportion of those with disabilities (47%) than of those without (36%) had left college without earning a degree. Among those who completed their programs in 1995 and 1996 earning science or engineering bachelor's degrees, 23% of persons with disabilities, compared with 13% of those without disabilities, had previously earned associate's degrees. Research has shown, however, that a majority

Table 3-8: Percentage Distribution of 1989-90 Beginning Postsecondary Students According to Postsecondary Persistence Status and Highest Undergraduate Degree Attained, by Disability Status: 1994

Persistence status and highest degree	Total	Does not have a disability	Has a disability
Attained degree or enrolled	63.2	64.1	52.9
Attained degree or certificate	50.0	50.7	41.1
Enrolled in 1994	13.3	13.4	11.8
Not enrolled/no degree or certificate	36.8	36.0	47.2
Highest undergraduate degree attained by 1994			
None	50.1	49.3	58.9
Certificate	12.9	12.5	18.8
Associate's	11.2	11.6	6.0
Bachelor's	25.8	26.6	16.3

Source: National Science Foundation, *Women, Minorities and Persons with Disabilities in Science and Engineering: 2000*, (NSF 00-327) {40}.

of students who enroll in the 2-year sector with the intention of later transferring to a 4-year institution do not transfer. Therefore, students with disabilities may be reducing their chances of earning a bachelor's degree by attending two-year institutions in higher proportions.

Research-Based Learning in HBCUs

The Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) assists HBCUs in implementing action plans to address minority underrepresentation in SMET. Projects prepare college students for graduate study by emphasizing research-based teaching and learning.

Awards have been used to support a variety of initiatives, such as the establishment of summer programs for college freshmen, funding of undergraduate research projects, enhancement of course technology, assistance for students and faculty who wish to attend conferences and internships, and curricular reform.

Universities are encouraged to develop and maintain a diverse faculty committed to education reforms. Project faculty, working in collaboration with other academic institutions, professional organizations, business, and industry, provide students with mentor-supervised research to complement their academic programs. In 1998 alone, HBCU-UP initiatives enrolled nearly 20,000 minority students in SMET disciplines and awarded over 2,500 baccalaureate degrees.

Collaborating institutions include participants in related NSF-supported programs, such as LSAMP, AGEP, and CREST.

Institutional Alliances Supporting Minority Participation

The Louis Stokes Alliances for Minority Participation (LSAMP) program encourages minority students to complete SMET baccalaureate degrees. Long term, LSAMP expects to impact, significantly, the number of students who earn PhDs and attain faculty positions.

LSAMP is the major endeavor funded by NSF to remedy the underrepresentation of minorities at the college level. Approximately 20,000 participants receive baccalaureate degrees in SMET fields each year.

Rather than support individuals or single institutions, LSAMP creates partnerships among academic institutions, government agencies and laboratories, industry, and professional organizations. LSAMP activities help minority students fulfill their potential in college and sustain their interest in SMET fields and graduate study through hands-on research experiences. A residential summer bridge program enrolls graduating high school seniors in college preparatory courses and, in addition, teaches them study skills and time management. LSAMP also provides mentors and role models and supports drop-in centers on college campuses for program participants.