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By Eugene M. DeLoatch

According to a recent report by the Commission on Minority Participation in Education and American Life, *"America is moving backward—not forward—in its efforts to achieve the full participation of minority citizens in the life and prosperity of the nation."*

"In education, employment, income, health, longevity, and other basic measures of individual and social well-being, gaps persist—and in some cases are widening—between members of the minority groups and the majority population."

The 37-member commission, formed in fall 1987 by the American Council on Education and the Education Commission of the States, released its report, "One-Third of a Nation," on May 23, 1988. Frank H.T. Rhodes, president of Cornell University, chaired the commission and former U.S. Presidents Jimmy Carter and Gerald Ford served as honorary chairmen.

Along a different path, in 1986, but with equal concern, the Committee on Undergraduate Science and Engineering Education of the National Science Board concluded:

> "Serious problems, especially problems of quality, have developed during the past decade in the infrastructure of college-level education in the United States in mathematics, engineering, and the sciences."

At a time when these reports and others on similar studies are being released, the United States finds its world position in scientific and technological leadership under challenge. The maintenance of this leadership will depend on both our national resolve and the quality and size of our science and engineering (S/E) work force.

The Work Force

The white male is the dominant player in the U.S. S/E work force, commanding about 75 percent of the employment. Women, having made significant gains in the last decade, held about 15 percent of the employment in 1986, compared to 9 percent in 1976. Like their male counterparts, however, white women predominate, holding about 77 percent of the female S/E positions.

Excluding Asians, who are not underrepresented in the S/E work force (6 percent employment versus 2 percent population), the combined participation of Blacks, Hispanics and Native Americans in 1986 was less than 5 percent, compared to their population total of more than 20 percent.

The comprehensive employment picture shows that 88 percent of the S/E work force is from the U.S. white community, which has only 75 percent of the national population. In a pluralistic society and in areas so important to the nation's well-being as science and engineering, the viability of this concentration is questionable.

S/E Education Pipeline

To establish oneself as S/E professional requires a successful progression through several layers of the educational system. From the primary grades through graduate school, the system is hierarchical. Advanced degrees are earned after baccalaureate degrees, which generally follow the completion of secondary school. The paucity of minorities in the S/E work force can be traced directly to the educational "pipeline."

Of the 2,000 four-year colleges and advanced degree-granting universities, about 1,400 grant degrees in the natural sciences and/or engineering (NS&E). These institutions, both public and private, are diverse in their missions and objectives. In 1982, 87 percent of the B.S. degrees in the NS&E were awarded by the upper 500 schools, (see Table 1.) In addition, 88 percent of all NS&E baccalaureate degree recipients who acquired Ph.D.s in 1981-1984 earned their undergraduate degrees at the same 500 schools.

Since it has become an accepted tradition to look to these schools for leadership in the education of S/E professionals, the preponderance of our nation's higher education resources continue to be concentrated in these institutions. While this condition may at first seem logical, it must ultimately be seen as a source of the country's growing S/E manpower difficulties.

Minority S/E students tend to be enrolled in institutions other than the "top" research universities (those with the highest concentration of federal R&D dollars) or the "most productive" four-year colleges, which are typically heavily endowed and private. Instead, about 28 percent of all Black students are enrolled at one of the nation's 82 Historically Black Colleges and Universities (HBCUs). These are a diverse group of schools including liberal arts colleges, comprehensive universities, and graduate and professional schools. The remaining Black students are generally found at other comprehensive universities.

Hispanics, on the other hand, are concentrated in large numbers at colleges and universities in a limited number of states with large Hispanic populations.

When classified by type of institution from which 1983-1985 S/E doctorates received their baccalaureate

Table 1

Concentration of degrees in academic institutions

	Top 100 UNIV.	Next 150 UNIV.	Top 100 COLLEGES	Next 150 COLLEGES	All 500
American univ. BS's (1982)	40.0%	27.0%	10.0%	10.0%	87.0%
BS's earning Ph.D.s (1981-84)	46.0%	22.0%	15.0%	5.0%	88.0%

Note: (1) Universities are ranked by federal R&D obligations.
(2) Colleges are ranked by the number of graduates earning NS&E Ph.D.s during 1981-84.

Source: National Science Foundation. Division of Policy & Analysis. PRA Report 87-2.

degrees, this becomes quite clear. Table 2 indicates that white American S/E doctorate recipients (61 percent) were 50 percent more likely to receive their baccalaureate education at either a research university or other doctorate granting institution than Blacks (40 percent) or Hispanics (41 percent).

For Blacks and Hispanics, the majority of the baccalaureate degrees were earned at comprehensive institutions. It should be noted that 80 percent of the Asian S/E doctorate recipients received their baccalaureate degrees at either a research university (23 percent) or a non-U.S. institution (57 percent).

In 1985, about 5 percent of the baccalaureate degrees earned by Blacks (2.6 percent), Hispanics (2.0 percent), and Native Americans (0.4 percent) were in the natural sciences and engineering.

In engineering, Blacks earned 2.6 percent of the B.S. degrees, 1.4 percent of the M.S. degrees, and 0.9 percent of the Ph.D.s. Comparable 1985 statistics for Hispanics and Native Americans were B.S. 2.5 percent and 0.2 percent; M.S. 1.7 percent and 0.1 percent; and Ph.D. 1.0 percent and 0.1 percent, respectively.

History of Engineering Education

One of the most significant pieces of federal legislation affecting engineering education was the Morrill Act of 1862. This act, which established land grant colleges and the precedent for federal and state support of institutions of higher education, had a direct impact on the expansion of engineering education, making it accessible and affordable to a larger segment of the U.S. populace.

Formal engineering education in the U.S. began with the establishment of a civil engineering program at the United States Military Academy at West Point in 1802. The design and operation of public works such as canals, roads, railroads, and water supplies were commonly associated with civil engineers in the early development of the nation's infrastructure. In the late 18th and early 19th centuries, a number of major mechanical engineering efforts were associated with the development of iron works and metal parts fabrication facilities.

Even though there was an urgent need for technically-trained persons during the early development of this country, formal acceptance of engineering by traditional academicians was slow in coming. Rensselaer Polytechnic Institute was the second school to engage in engineering studies in 1824; others did not follow until 1845. In most cases the schools adding engineering studies or emphasizing them were privately supported: Union College (1845), Yale (1846), Harvard (1847), Brown (1847), Dartmouth (1851), MIT (1862) Stevens Institute (1867), and Cornell (1868). The high cost associated with attending these schools greatly limited access to the public-at-large, particularly at a time when scientific knowledge was critical to the growth and expansion of a young nation.

Driven by the need for a more structured body of knowledge essential to the areas of agricultural and manufacturing practices, the government was forced to recognize the desire of more of its people for an affordable and accessible technical education. In response to the mounting pressure of a popular movement calling for access to low-cost practical and scientific instruction, the Morrill Act was passed.

As a result of the Morrill Act, roughly 79 schools of engineering were established between 1862 and 1880.

During the period of early growth of engineering education, Black American involvement was practically nonexistent. The Morrill Act, which authorized the use of public lands and money to subsidize and support the scientific and technical education of

U.S. citizens, did not favorably impact Blacks. In 1862 Blacks were largely concentrated in the South, where the system of slavery was institutionalized and was about to be transformed into the invidious system of segregation. The 50 to 60 year period following the passage of the Morrill Act was a dynamic period of growth for the system of higher education in this country. Between the end of the Civil War and 1915, 94 percent of the 82 four-year Historically Black Colleges and Universities were established.

There was an attempt to correct the inequities of federal and state subsidies to Black colleges and universities, with the passage of a second Morrill Act in 1890. But this new law did not have nearly the impact of the 1862 Act. The later effort has been much debated, but it appears that its intent was primarily directed at equipping Blacks with the manual skills needed in an expanding industrial society, as opposed to educating them for leadership roles in American agriculture and engineering.

Access to engineering education for Blacks was practically non-existent prior to the establishment of an engineering program at Howard University in 1910. The high population density and the denial of admission to federally and state subsidized engineering schools in the South severely limited professional and educational opportunities for Black Americans. However, due in part to lack of political and industrial support and the absence of role models, the engineering enrollment growth at Howard was very slow prior to 1942.

The post-World War II boom in American industry and the enactment of the Serviceman's Readjustment Act (G.I. Bill) of 1944 led to rapid increases in these enrollments at Howard. Indeed, by 1956 five other engineering schools were established at HBCUs. These schools soon became a critical "national resource" and by 1969 were producing about 88 percent of all Black engineers with B.S. degrees in the country.

Today there are nine HBCU campuses with programs leading to engineering degrees, and more than 30 percent of the national Black engineering enrollment is in these schools. In 1987, 22.5 percent of the baccalaureate degrees and 13.5 percent of the master's degrees in engineering earned by Blacks were awarded by these schools. In light of shifting demographics and the need for more Black engineers with advanced degrees, it is clear that these schools continue to occupy a central place in Black engineering education.

Table 2

Type of baccalaureate institution of 1983-1985 doctorate recipients, by race of recipient

	Type of baccalaureate institution					
	All Insttns	I	II	III	IV	Non-US Insttns
White						
Number	35,885	11,352	10,429	7,872	4,397	888
Percent	100	32	29	22	12	2
Black						
Number	972	196	190	358	162	48
Percent	100	20	20	37	17	5
Hispanic						
Number	831	182	158	309	59	87
Percent	100	22	19	37	7	10
Asian						
Number	2,331	525	205	130	99	1,330
Percent	100	23	9	6	4	57
Native American						
Number	99	20	39	24	8	1
Percent	100	20	39	24	8	1

Carnegie classification; I = research institutions, II = other doctoral institutions, III = comprehensive institutions, IV = liberal arts colleges.
Source: National Science Foundation. Science & Engineering Indicators, 1987.

The Hispanic Pathway

While the paths of Hispanics' historical development are different from those of Black Americans, there are

today several schools in the U.S. which have significant Hispanic-American enrollments.

Just as the HBCUs' productivity of Black engineers far exceeds their representation among all colleges and universities, the largest percentage of Hispanic graduates come from engineering schools in just five states—California, New Mexico, Texas, Florida, and New York. In 1987, schools in these states produced 66 percent of the Hispanic B.S. degree graduates. However, the major contributors of Hispanic engineers, serving as a beacon for others, are the schools in Puerto Rico.

Current State of Affairs

Led by numerous programs initiated in the early 1970s through the mid-1980s, minorities made significant gains, effectively increasing their numbers two to three-fold. Even with these gains, however, the minority percentage of total science and engineering professionals is still woefully small. For Blacks, the fraction is about 2.5 percent in each broad category of science and engineering. A closer examination of the science and engineering disciplines reveals interesting imbalances. For example, most Black and Hispanic science degrees are earned in either social science or psychology. Very few are earned in the mathematical sciences. Further, most of the gains have been in the B.S. degree category.

Data recently released on U.S. citizens earning doctorates in science and engineering in 1987 indicated that only 1.8 percent (222) were earned by Blacks. Another 2.3 percent (292) were earned by Hispanics. (By comparison, the 1978 Black total of sci-

ence and engineering doctoral degrees was 2.1 percent.)

Among Black engineering doctorate recipients, none received degrees in electrical engineering, two in computer and information systems, two in mechanical engineering, three in chemical engineering, and five in physics and astronomy. While there were 45 degrees earned in biology, this number represented only 1.5 percent of the total such degrees awarded that year.

The Future

The decline in the college-age population, the increasing percentage of minorities among those below 18 years of age, the growing disinterest of majority students in science and engineering education, the global challenge to our technology, and the continuing absence of minorities in the S/E work force, leads one to the question: What next?

The answer being offered by national planners is apparently to fill the void from "non-traditional" sources. In its 1988 report, the Committee to Study Engineering Labor Market Adjustments of the National Research Council, defined these sources to include:

- to use individuals with degrees in closely related fields (e.g., chemistry, physics, mathematics),
- to use an increasing share of foreign-born engineers in the U.S. engineering work force,
- to promote technicians without college degrees from within to perform non-R&D activities,
- to promote an increasing number of in-service training activities to get career engineers to perform jobs they had not done previously.

After concluding that significant pressure will occur due to job openings arising from growth in employment and replacement of those leaving the job market, a set of recommendations were made. They included:

- taking steps to lower the barriers to the recruitment of foreign engineers to the U.S. job market,
- encouraging more American students to pursue doctorates in engineering, and taking steps such as increasing the number and size of graduate fellowships, increasing the amount and quality of equipment on college campuses, ensuring continuity for funding of federally-sponsored research projects, and encouraging industry to stress the importance of graduate education for U.S. students,
- making federal policy more conducive to the continued use of in-service and career training by industrial firms,
- establishing policy to encourage the adoption of information technology in engineering functions to make more effective use of the existing engineering work force.

While it may not have been the intent, the recommendations of the NRC committee will predictably have very little impact on improving the plight of underrepresented minorities in the science and engineering work force. In fact, if implemented as suggested, with the resources required to accomplish them, these recommendations may serve to further delay minority inclusion. The reason for this and the continuing decline in the quality of our S/E work force is not due to low numbers of majority and foreign-born scientists and engineers. Quite to the contrary, it is due to the exclusion or absence of members of the underrepresented minorities—Blacks, Hispanics, and Native Americans.

Thus, anything short of a "Morrill-type-Act" or "G.I.-type-bill" is destined to fail. Substantial levels of resources, directed exclusively at minorities and the institutions which have been historically committed to their progress, are in order. Just as the launching of Sputnik by the Soviets in 1957 became a national challenge, the lack of Black, Hispanic, and Native American participation in science and engineering must be considered equally serious.

As we enter the new century, it is projected that 42 percent of the nation's public schoolchildren will come from minority groups. These youngsters are capable of stemming the slide in our technology, and faced with the challenge, will rise to the occasion.

The only questions which remain are:

Do we have the enlightened leadership?

Do we have the national resolve? □

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