Careers in Science and Engineering for Black Americans

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A specific demand for scientists and engineers who are members of certain racial and ethnic minority groups—blacks, Chicanos, Native Americans, and Puerto Ricans—results from the need of research and development performers who receive federal funds to show through affirmative action that they are equal employment opportunity (EEO) employers. Since the federal government supports, either fully or in part, at least half of the research and development jobs in the United States, the EEO-induced demand for minority-group scientific and technical personnel is large.

In the past, the United States met any new demand for scientific and technical manpower from foreign sources (*1*) and by increased output from traditional internal sources (*2*). No serious attempt has been made to develop and utilize the scientific and technical talents of racial and ethnic minorities. Less than 2 percent of the scientific and technical personnel is drawn from these groups, which comprise some 36 million people (about 16 percent of the national population).

Federal research and development contractors charged with compliance with EEO affirmative action regulations find that the demand for minority scientists and engineers far exceeds the supply. Efforts to increase participation in U.S. science by members of these groups have been hampered by constraints on entry and career development.

Data used here to illustrate these constraints relate to black Americans: the inaccessibility of relevant information on Chicanos, Native Americans, and Puerto Ricans imposes this limitation. While many of the critical data on black Americans are contradictory or lacking, more information is available on the educational and economic situation of blacks than on that of any other underutilized minority group.

There are three chief elements to be presented:

1) Underparticipation—The minimal participation of black Americans in scientific and technical careers constitutes a serious problem for the nation and for black people.

2) Increased demand—Because the EEO-induced demand for scientists and engineers who are black exceeds the supply, participation of blacks could be significantly increased, given adequate resources, by establishing and meeting intermediate and long-range goals and timetables.

3) Problems of access and so forth —Complex problems of access, entry, and retention must be overcome to attain even modest intermediate and long-range goals.

The Present

Why is the present degree of participation of blacks in the sciences and engineering viewed as creating an undesirable and unnecessary moral, ethical, and economic problem?

Low participation of blacks in scientific and technical occupations limits their access to a significant number of well-paying, relatively stable jobs. Their problems that might be ameliorated by science and technology would enjoy greater national priority if the ratio of black scientists and engineers to nonblacks were higher. Further, if the pool were larger, the points of view of blacks would receive greater exposure in scientific and technical advisory bodies that often deal with matters impinging directly on the lives of minorities, matters such as urban environment, transportation, and health (*3*). Greater participation by blacks in the scientific and engineering meritocracy should help to achieve a more equitable distribution of responsibility, power, wealth, and status within the United States.

Of the 1.75 million scientific and engineering workers in the United States in 1971, 1.1 million were engineers and about 650,000 were scientists (*2*). The two groups represented 16 percent of all professional and technical workers. In 1971, 185,000 scientists and engineers, or 10.6 percent of the total, held doctorates.

The exact number of black scientists and engineers is not known, but estimates of degrees awarded to blacks in these fields between 1940 and 1971 have been made. The National Science Foundation estimates that there were about 7300 black engineers in 1970 (*4*). About 400 blacks per year receive a baccalaureate in engineering. A conservative guess would be that there are about 7600 blacks working as engineers in the United States. This number is smaller than the number of blacks awarded engineering degrees, since some never enter the field and many leave the occupation after a few years (*5*).

The number of blacks with doctorates in the sciences and engineering who are still active in the labor force is estimated at about 1500, based on the number of doctorates awarded to blacks in these areas between 1940 and 1971 (*6–8*). About three-fourths of these degrees were received between 1958 and 1971.

It is difficult to estimate the number of blacks with baccalaureate and master's degrees who work as scientists. However, of those scientists listed in the National Science Register (members of scientific societies), about 37 percent have doctorates, 29 percent master's, and about 30 percent baccalaureates. If these percentages hold for blacks, there would be some 4,050 black scientists. This would yield an estimated total of 12,000 black scientists and engineers, less than 1 percent of the total work force in these fields in the United States.

The 12,000 black scientists and engineers would represent 1.6 percent of the total number of black professional and technical workers. Since 16 percent of all professional and technical workers are scientists and engineers

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and only 1.6 percent of black professional and technical workers are scientists and engineers, increased black participation in these occupations could be accomplished both by attracting those headed for other professional and technical occupations into science and by creating access to science and engineering careers to more blacks.

Table 1. Hypothetical intermediate and long-range goals for increasing the quantitative participation of black Americans in U.S. science and engineering.

Quantitative increase	Intermediate		Long-range:
	1971	1980	2000
Baccalaureates in engineering awarded to blacks	407*	1500	
Percent of total awarded	1	3	10
Doctorates in the sciences awarded to blacks	400†	900	
Percent of total awarded	1	2	5
Doctorates in the sciences and engineering awarded to blacks	200	500	
Percent of total awarded	1	2	5

* Data from *Engineering and Technology Graduates, 1971*, Engineering Manpower Commission, Engineers Joint Council. † Unpublished estimate from the Office of Scientific Personnel, National Research Council.

Possible Futures

Tentative estimates (9) of future need and availability of doctorates in the sciences and engineering indicate a stepped-up demand for holders of such degrees over the next decades. Manpower studies have not yet begun to consider the effect of EEO efforts on the demand for and utilization of minorities and women. But since federal funds support about half the research and development jobs, such inquiry would be useful.

The entry of blacks into the sciences and engineering is influenced at present by the same discouraging information that nonblacks read in the press: the general reduction in opportunities for employment in the sciences and engineering; the reduction of federal support for graduate fellowships and traineeships, based on predictions of oversupply; and the reduction of both science and engineering enrollment and graduates as a percent of the total. This adversely affects attitudes about the feasibility and desirability of entering these fields. Blacks, over time, have been frustrated by the "last hired, first fired" syndrome, which prevails during fluctuating economic circumstances. It is difficult for them to believe that a demand for their services exists, much less that it is greater than the general demand. Further, many blacks believe that, unless one can hope to "star" in an untried field, it is better not to enter: There are few second-string blacks in professional sports, for example. Mediocrity remains a "white man's luxury" in many occupations.

The information that there is a special demand for blacks has to bridge a strange credibility gap. The actual unemployment rate of black scientists and engineers is near zero, but their numbers are so small as to render them invisible within black communities. Special efforts will be required to bring to light the highly favorable employment situation.

Increasing the annual output of blacks from engineering schools and departments to meet the intermediate targets set in Table 1 should not be difficult. The training capacity of black engineering schools could be increased. Schools that now have an excess training capacity because of recent reductions in nonblack enrollment could be encouraged to admit more minority students. In addition, many schools (for example, Cornell, University of California at Los Angeles, Georgia Institute of Technology, the Newark School of Engineering, and the University of Delaware) have special programs for minority engineering students, and these programs should receive greater support. The 1980 engineering graduates can be encouraged now, since they began high school only in 1972. Half of the 1500 target in Table 1 will probably become engineers even if nothing more is done. This is counter to the trend of nonblack freshmen. Increasing numbers of black freshmen at predominantly black colleges say they want to become engineers, but resources for studying engineering at such institutions are limited.

A national effort could be made to raise the number of blacks entering first-year classes to 5 percent of the total by 1975. Serious efforts to keep these students—including a commitment from industry that career opportunities will be open to graduates—should result in a 3 percent output by 1980 (this target assumes that the total annual output of engineers will reach 50,000 by 1980).

To attain a 10 percent black output from engineering schools by the year 2000 would require a major national commitment from the entire system of education, government, industry, and black Americans themselves. The attainment of this goal would be aided by the fact that, during this 25-year period, the percentage of black engineering graduates in the general population would increase. As these professionals became more visible, they would serve as role models for black children.

Increasing the annual output of blacks with doctorates in the sciences and engineering to meet the 1980 target set in Table 1 (from 200 to 500 per year) can be accomplished by providing sufficient financial assistance to those already well along in the educational system. While some of those who will receive their doctorates in 1980 are now second-year college students, many are already part-time graduate students who will take more than 10 years to complete their degrees. Some able black students will leave the system or fail to enter solely for economic reasons. The cost per doctorate can be lowered by reducing economically induced attrition. Clearly, if one wants to produce a Ph.D. over the short run, it would be cheaper, quicker, and more certain to pay a stipend for 1 year (say $15,000) to help a mature Ph.D. candidate with a family complete a dissertation than to support a high school graduate through perhaps 10 years of uncertain undergraduate and graduate education.

The attainment of the long-range objective of an annual output of 5 percent of the total (see Table 1) will be inhibited by factors described later. This annual output might mean as many as 2,500 black doctorates in the sciences and engineering by the year 2000, based on an estimated total annual output of 50,000 doctorates in these fields.

Many studies have indicated that present educational technology at primary and secondary levels in this country requires for success a large input from extrascholastic influences, particularly the family. Other studies suggest that a high proportion of black children grow up in circumstances that stifle rather than nourish creative talent. However, as the number of black

families headed by college graduates continues to increase over the next 20 years, and as their children enter higher education, it is reasonable to expect that it will be easier to sustain these students through the difficult years of graduate study.

Bond concluded from his study of black scholars (*7*) that the family is indeed of decisive importance in the production of persons of unusual academic ability from an underprivileged population. About 25 percent of the fathers and 17 percent of the mothers of the sample of black doctorates in Bond's study were themselves college graduates. Bond also found that 27 percent of the grandfathers and 53 percent of the fathers of this sample of black doctorates had been white-collar workers.

Problems to Be Confronted

In a 1971 report on educational progress in science, it was stated that blacks at four ages—9, 13, 17, and 26 to 35 ("young adults")—performed between 12 and 16 percent below the national average. With the data balanced for parental income, area, and so forth, performances ranged from 7 to 10 percent lower than the national average (*10*). The report summarized: "Blacks performed best on those science exercises largely dependent upon daily experiences and common knowledge, and worst on those which involved a detached research attitude towards the objects and phenomena of science" (*10*, p. 2).

The assessment, designed to measure demonstrated knowledge of science, did not consider, for example, which individuals had been exposed to formal opportunities to learn science; what correlation existed, if any, between performance by blacks and educational level of their parents; or how inner-city black subjects and inner-city white subjects compared in performance.

Earlier, Gardner (*11*) and Coleman *et al.* (*12*) had reported that blacks had fewer of the facilities that seem closely related to academic achievement, such as science and language laboratories. Further, well-trained, experienced teachers are in short supply and usually can and do elect to work in the better equipped schools, which are attended by the children of the affluent.

The report *A National Profile of Black Youth: The Class of 1971* (*13*) summarizes information about high school preparation of more than 45,000 black students who expected to enter college in 1971. Twenty-eight percent reported only 2 years of mathematics, and 46 percent only 2 years of natural science. Of the black youth responding, 93 percent would enter college with 4 years or more of high school English. Yet Kendrick predicted that if all black 12th graders took the SAT (Scholastic Aptitude Test) verbal test, 10 to 15 percent at most would score as high as 400, and only 1 or 2 percent would score 500 out of a possible 800 (*14*). The mean SAT verbal score for all enrolled high school seniors is 375. Astin found that among the 1966 freshmen only 1 percent of the disadvantaged black students and 20.9 percent of the disadvantaged nonblack students had combined SAT scores of 1101 to 1550 (*15*). While it is true that the proportion of black students who meet national standards of academic excellence is low, it is also true that secondary schools produce more black students of high ability than later graduate from college.

For black students, gaining entry to higher education means overcoming one of a series of obstacles to a technical career (*16*). Access improved significantly between 1964 and the academic year 1971–72. In that period, the enrollment of blacks went from 234,000 to 485,000 full-time and part-time students.

In 1970, only about 6.9 percent of the full-time and part-time college enrollment of 8.1 million was black, while 11.5 percent of the college-age group was black (*17*). By 1973, it was estimated that 47.6 percent of the black high school graduates and 49.4 percent of white high school graduates went on to college. For the two groups, then, on the basis of this estimate, the probability of entry into college is roughly the same.

As to distribution by type of institution, 33 percent of the black students enrolled in college in 1971 attended 2-year community colleges, 35 percent were in predominantly white 4-year institutions, and 32 percent were in traditionally black institutions.

In the past, black college students have been discouraged by peers, parents, well-meaning teachers, and vocational guidance counselors, to some of whom science or technical work seemed impracticable to blacks or irrelevant to their compelling disability—racism. However, Bayer (*18*) found that, in the freshman class of 1971, 8.3 percent of the black males and 9.7 percent of the nonblack males said they intended to become engineers, while 2.2 percent of the black males and 3.4 percent of the nonblack males said they intended to become research scientists. Moreover, relatively more blacks in that class than nonblacks said that they had participated as high school students in summer programs sponsored by the National Science Foundation (blacks, 1.6 percent; nonblacks, 0.7 percent) and in state or regional science programs (blacks, 2.8 percent; nonblacks, 1.9 percent) (*18*, p. 11).

A high percentage of students who select science and engineering change their plans within the first 2 years of college. In a recent study on changes in goals and plans of college-bound high school students, it was shown that 57 percent of the males and 41 percent of the females who had indicated science as their precollege choice were still in science 2 years later, as were 61 percent of the males who had selected engineering (the number of females who had chosen and stayed in engineering was too small for calculation) (*19*). Only 34 percent of the students who chose medicine were still enrolled in a premedical course 2 years later. This change in career objectives was also noted in a study of black and nonblack males. Watley (*20*) found that the plans of able black and nonblack males changed between 11th grade and their second year at college (*20*). Engineering was the single biggest loser. It is assumed that these students changed for reasons other than lack of academic ability. No one knows how much the change in educational plans and career aspirations from science and engineering to other fields is caused by students' perceptions of a difference between reality and their early aspirations and expectations. Stated career objectives of freshmen are often based on vague notions of ultimate benefits, not on realistic understanding of the "costs" of entry and success in a particular field.

The economic backgrounds of college-bound black students often differ markedly from those of their nonblack counterparts. For example, 44 percent of black freshmen in 1971 came from families with gross incomes of less than $6000 per year, while only 10 percent of the nonblack freshmen came from such families (*18*). Consequently, many black students rely on academic and athletic scholarships, their own work, and loans rather than on their

parents' income to meet college expenses. Such students may simply have insufficient time to engage in science classes, particularly laboratory sciences.

Haven and Horch (*21*) found that the average unmarried black sophomore in 1969–70 spent $1923, of which $403 came from parental aid. The average unmarried white sophomore spent $2528 of which $1147 came from parents.

Far more significant than continuing students' changes in career plans from the natural sciences and engineering to the social sciences and education is the high attrition of black students from colleges. This is particularly true at community colleges and predominantly white 4-year institutions. A recent study in New York State projected the following attrition rates (*22*):

Four-year colleges—open enrollment students, 60 to 70 percent; regular students, 30 to 35 percent.

Community colleges—open enrollment students, 70 to 80 percent; regular students, 64 to 74 percent.

A large percentage of the open enrollment students, both in 4-year colleges and in community colleges, is black.

Astin (*23*) has found substantially higher persistence rates for black and nonblack students, in both 2-year and 4-year institutions, than those reported by others. He suggests that lower rates in 2-year institutions are probably due to a lower level of motivation and poorer academic preparation. High school grades and ability test scores serve as the principal predictors of persistence of students along with freedom from a need to work in the academic year and higher degree aspirations at the time of entering college.

Further complicating the problem of inducing more black students to study engineering and the sciences is the meager federal support for the science and engineering programs in the schools black students attend. During fiscal year 1970, traditionally black institutions enrolled 2.1 percent (177,000) of all students in higher education, but attracted only 0.3 percent ($5.1 million) of federal funds for academic science research and instruction (*24*). Community colleges, which enrolled more than 2 million students, received 0.4 percent of such funds. Together, the black schools and community colleges received less than 1 percent of the federal funds for science awarded to colleges and universities (Table 2).

Federal funds for academic science are allocated chiefly for research and development activity, which is centered in graduate schools. Bayer's study of American faculty showed the following distribution of academics with postgraduate degrees in either the sciences or engineering: 22 percent of the faculty of the 2-year college, 34 percent of the faculty of the 4-year college, and 42 percent of the university faculty (*25*). Fewer faculty members at 2-year colleges are prepared to do the work for which federal grants are given.

Table 2. Federal support of higher education, including academic science, at black colleges and at community colleges, fiscal 1970. [Sources: (*24*); *Federal Support of Universities, Colleges and Selected Non-Profit Institutions, Fiscal Year 1970* (NSF 71-28, National Science Foundation, Washington, D.C., 1971); Southern Education Foundation, *Small Change* (Southern Education Foundation, Atlanta, 1972)]

Students and federal support	Black colleges	Community colleges
Percent of all students in higher education	2.1	~27
Percent of all black students in higher education	32	33
Percent of all white students in higher education	<1	~25
Federal obligations for support of higher education	$125.5 million	$105 million
Federal obligations for higher education, as a percent of total	3.4	3.3
Federal obligations for academic science	$8.7 million (est.)	$9.3 million
Federal obligation for academic science, as a percent of total	0.4 (est.)	0.4

Black colleges are primarily undergraduate teaching institutions with limited emphasis on basic research. In recent years, many of these institutions have added foreign nationals to their science and engineering faculties. Since some federal support programs are restricted to principal investigators who are U.S. nationals, noncitizen faculty might affect eligibility for grants.

Black colleges and community colleges also receive less than 1 percent of the federal funds specifically directed toward the improvement of science education. Drew analyzed the allocation of National Science Foundation funds for its College Science Improvement Program, designed to accelerate the development of the science capabilities of predominantly undergraduate institutions (*26*, p. 2) and found the following criteria for awards: (i) a student body with high professional aspirations and superior academic records; (ii) faculty quality, related to the percentage of Ph.D.'s on the staff; and (iii) affluence, measured by the size of the endowment (since institutions were expected to make contributions themselves). Because most black colleges and community colleges found it difficult to participate in such programs, a special opportunity fund was established for the "traditionally disadvantaged college" ($5 million in fiscal 1971).

The faculty members of community colleges and black colleges see two-thirds of the black students in higher education. To be successful, these teachers must identify intellectual potential, heal past educational wounds, and prepare these students for further training and work. These institutions will continue to serve as the first opportunity for black students to learn about science and technology. If we expect them to do more than diminish the educational aspirations or meet the social demand for certification by disadvantaged students, extensive investment will have to be made in their science education programs. Karabel (*27*) believes, however, that one cannot expect community colleges to do more than convert transfer students of low socioeconomic status into terminal students.

In 1971, it was estimated that 2.7 percent of all graduate students were black, out of a total of about 625,000. About 2.2 percent of those in biological sciences, 1.1 percent of those in engineering, 1.3 percent of those in mathematics or physical sciences, and 2.6 percent of those in the social sciences were black (*28*). By comparison, at that time 11.0 percent of the graduate students in the sciences and 20 percent in engineering in U.S. institutions were foreign nationals.

Increasing black participation in the sciences and engineering will mean, among other things, increasing the number receiving degrees. Table 3 is an estimate of current output.

In fiscal 1971, 15 percent of the doctorates awarded in the sciences and 25 percent of those awarded in engineering went to foreign nationals. Fewer than 1.0 percent of such degrees were won by blacks. The percentage of black college graduates receiving doctorates is small. According to 1972 Office of Education data, the general

ratio of baccalaureates to doctorates is 25 to 1; for blacks it is 125 to 1. The percentage of blacks receiving doctorates in the sciences and engineering is even smaller. Table 4 shows the number of doctorates awarded to blacks, as compared with total U.S. awards between fiscal 1958 and fiscal 1971.

One can infer from Table 5 and from estimates of annual output of black doctorates that twice as many black graduate students intend to get doctorates as are now getting them.

Expansion of the pool of black Americans in scientific and technical careers is not a matter of simple addition as the number of degrees awarded increases. Some new science and engineering graduates never enter these occupations. Some who do enter replace those who die, retire, become disabled, or change to nonscience occupations. Although such losses are not limited to blacks, there are some which may be so.

Black Americans are usually older than nonblacks when they complete graduate training. A Ford Foundation study showed that it took blacks significantly longer than nonblacks to obtain the doctorate: The median for blacks is 13 years after the first degree at a median age of 36, as opposed to the average for all students of 7.5 years after the first degree at a median age of 30 (*8*). This suggests that blacks with doctorates will be in the scientific and technical labor force only 80 to 85 percent of the time that the average doctorate-holder would be.

Administrative work often claims well-trained black scientists and engineers who accept jobs at predominantly white institutions—often their scientific and technical careers terminate early when they take on new functions (*29*). For example, considerable pressure has been placed on the black assistant professor of science to be concerned with nonacademic problems of minority students and employees, pressure from both minority communities and administrators. Much of this work detracts from the academic's main functions: research and teaching. After a few years, he often has become a special personnel officer or a dean and is lost to science. Similarly, in industry higher wages lure black scientists and engineers away from laboratories into EEO activities in personnel offices very early in their careers.

It should be well understood that, to expand the number of blacks in science and engineering, more blacks will have to be trained and retained in scientific and technical roles at existing centers of excellence (that is, institutions that attract the bulk of the federal funds for academic science). In order to contribute to and benefit from science, more black Americans must become full members of the social network of science and become distributed throughout the hierarchy.

The United States has yet to solve the problem of the democratization of advanced education by assuring equality of opportunity for all students, regardless of social and economic background, to compete for training and employment opportunities in the most prestigious centers. In Europe, this problem has been confronted by the Organisation for Economic Cooperation and Development, which recognized this problem among its member countries and recommended studies of policies in the economics of higher education that may lead to equality of opportunity (*30*).

Table 3. Degrees awarded by U.S. institutions, fiscal 1971.

Degree	All races*	Blacks	
		No.	%
Baccalaureate	800,000	45,000†	5.5
Science	217,000		
Engineering	43,000	407	1.0
Master's	195,000		
Science	54,000		
Engineering	16,000		
Doctorate	32,000	400‡	1.0
Science	16,000	190	1.0
Engineering	3,500	10	0.3

* Data from the Department of Health, Education, and Welfare, U.S. Office of Education, cited in *Statistical Abstract of the U.S., 1972* (Department of Commerce, Bureau of the Census, Washington, D.C. 1972). † Based on an unpublished estimate of the Office of Civil Rights, Department of Health, Education, and Welfare, of 90 percent of the 50,000 black, fourth-year college students in 1970 who should have graduated in 1971. ‡ Based on (*7*), and unpublished data from the Office of Scientific Personnel, National Research Council, on the estimated number of doctorates awarded to blacks.

Table 4. Fields in which doctoral degrees were awarded to blacks, compared to U.S. totals, between fiscal 1958 and fiscal 1971.

Field	Blacks*		Total U.S.†	
	No.	%	No.	%
Physical and mathematical sciences	387	14	49,638	21
Engineering	58	2	27,297	11
Life sciences	479	18	39,292	16
Social sciences	323	12	38,054	16
Art and humanities	294	11	33,619	14
Education	1033	38	42,829	18
Professional fields	129	5	10,524	4
Total	2703	100	241,253	100

* See (*6–8*); these estimates tend to be conservative, since identification of black recipients of the doctorate was made using undergraduate institutional affiliation as a proxy for actual data on race. † From annual data on doctorates awarded by U.S. institutions, collected by the Office of Scientific Personnel, National Research Council.

Some Recommendations

Current social reform relies primarily on moral and legal arguments to effect change. This is a major shortcoming. An imaginative marshaling of economic arguments would be more effective. Characterizing a discriminatory practice as wrong is necessary and important, but demonstrating its adverse economic effects may be crucial for change. To reduce economic discrimination and to meet economic competition from abroad, an organized effort must be made to assign high national priority to the development and utilization of minority talent in the sciences and engineering.

In every nation, a finite fraction of the population is capable of utilizing existing arrangements in educational institutions to become productive scientists and engineers. In the United States, portions of that fraction are blacks, Chicanos, Native Americans, and Puerto Ricans. High priority should be assigned to increasing the participation of members of these minority groups in scientific and technical careers.

I have pointed out that long-range goals, which might be attained by means of a "demographic model of participation," could not be met without major changes in the educational opportunities and occupational interests of blacks. However, intermediate goals can be achieved by strategically maximizing the yield of scientists and engineers from those blacks with great ability who finish secondary schools and enter colleges.

At the present time, many educators think of black students as synonymous with high-risk disadvantaged students. Yet it has been argued that at least 60,000 black high school graduates who intend to go to college demonstrate, by conventional testing methods, that they have the potential to benefit from higher education using existing curriculums and pedagogical techniques (*31*). The total output of blacks from higher education is about 45,000 per year. How many of these 60,000 black high school graduates actually finish, or for that matter start, a university or col-

lege education? We must find ways to get these students into and through the university and to encourage as many as possible to consider the sciences and engineering. Personal poverty should not inhibit this group from further study.

Essentially, all blacks suffer from economic discrimination, especially middle-class blacks. It has been observed that the higher the level of education and experience of blacks, the greater the disparity between their income and the income of whites with similar occupational characteristics. Even where new personnel policies have been established to make incomes equivalent within a given occupation, the area under the income curve for blacks is usually considerably smaller than that for whites. Middle-class blacks who have themselves benefited from higher education and who have worked to motivate their children in this direction often find that they cannot afford to pay the more than $5000 per year required to send an undergraduate to institutions of scientific excellence. In the absence of major changes in the U.S. educational system and in the economic levels of blacks, special support programs will be needed to encourage the children of middle-class blacks to study science and engineering at these institutions.

Remedial programs and politically motivated programs for blacks in prestige institutions have had little effect on the supply of new candidates for scientific and engineering careers. The acute rate of attrition in programs for high-risk students seems to surprise—and disappoint—administrators who had hoped for magic. Perhaps something has colored their understanding of the problem they are committed to solve. Sowell denounces three "pernicious myths" affecting educational opportunities for blacks (*32*):

1) College recruiting must be directed toward badly schooled blacks because there is no sizable pool of well-schooled ones.

2) Bright black students do not need scholarship help because their parents have money.

3) Traditional admission standards (for example, college board test scores), which reliably predict success in black schools, cannot predict success or failure of black students in other schools.

Assistance to black students already enrolled in the sciences and engineering at the graduate level can help them complete their work within a reasonable period of time. Studies to determine appropriate financial support for blacks might show these needs to be considerably different from the general case. We cannot afford to waste the abilities of individuals who have shown that they can profit from graduate education by allowing them to drop out for financial reasons. Similar efforts must be made to get able students who failed to enter graduate school for financial reasons to reconsider. Many black students of high ability leave undergraduate school in debt, both to parents and to commercial sources. In order to meet these obligations, they are forced to market their baccalaureate skills. Grants from conventional support programs for graduate students often are not enough to attract these students.

Table 5. Highest degree expected—demographic and background characteristics of American graduate students, percentage distribution in 1971. [Source: A. E. Bayer, *The American Graduate Student* (American Council on Education, Washington, D.C., 1972)]

Degree	White	Black	Oriental	Other	Total
Ph.D.	91.8	1.9	4.5	1.8	100
Ed.D., D.A., other	91.3	6.3	1.6	0.8	100
First professional	97.0	2.0	0.8	0.2	100
Nonprofessional (subdoctoral)	95.9	1.8	1.2	1.1	100
All degrees	92.5	2.7	3.2	1.6	100

Science instruction should be improved in those institutions in which most black students enroll. Efforts should be made to bring more black students into those institutions in which the United States has made its largest investment in facilities, research, and training programs. Career opportunities for blacks should also be sought and encouraged at these institutions of scientific excellence. Finally, organizations like the National Science Foundation and the National Research Council need to plan and support new institutional arrangements to help ethnic and racial minorities learn science, since existing institutions, particularly those at primary and secondary levels, do not appear to be adequate.

Summary

Racial and ethnic minorities (blacks, Chicanos, Native Americans, and Puerto Ricans) comprise 16 percent of the U.S. population, 7 percent of the enrollment in higher education, 5 percent of the yearly baccalaureate output from college, 3 percent of the graduate school enrollment, and 1 percent of the annual output of doctorates. Yet, projections of future scientific and technical manpower needs do not consider questions of race or ethnic origin. For example, those who now project a future oversupply of scientific and technical manpower at the Ph.D. level have made use of "monochromatic" assumptions. They estimate the future demand from a projection of present trends without considering the current high demand for women and minority-group scientists and engineers.

It is understood that this "demand" cannot create jobs that do not exist. But it should have some positive effect on the questions of supply. It is common to hear employers say, "I would hire more minority-group scientists and engineers if vacancies existed and if there were a supply of such people." Activities should be directed toward getting government policies established to encourage increased participation of minorities in scientific and technical careers. Efforts should be made to get the Office of Management and Budget, the Equal Employment Opportunity Commission, the Department of Health, Education, and Welfare, the National Science Foundation, and the Department of Labor to recognize these issues, interpret them correctly, and shape programs, policies, and projects around them.

The immediate goal need not be to attain for minority groups qualitative and quantitiative parity with nonminority groups in the sciences and engineering. The first task might be to make sure that ethnic minorities understand enough about the nature of the various aspects of scientific and technical education and employment to enable those among them with interest and ability to also understand that they have access to scientific and technical occupations.

In designing effective programs to promote equality of employment opportunity in the sciences and engineering for members of minority groups, one must ensure that appropriate opportunities for learning science and

engineering are available. This, in most cases, would mean innovative compensatory programs, which have higher per pupil instructional and support costs for minority students than do current programs for nonminority students. Such programs might also have to be longer, with more learning opportunities provided for minority students within the educational system itself.

The major thrust of a national effort should be to make the development, conservation, and effective utilization of minority citizens' scientific and engineering talents an integral part of a comprehensive national manpower policy. Such an effort should be viewed within the context of federal programs to aid the disadvantaged and broaden the base of opportunity for education and training. Minority scientific and technical personnel comprise a critical and scarce national resource that can and should be nurtured and strengthened by sound policies, programs, and projects.

References and Notes

1. In fiscal 1970, over 4000 scientists, over 9300 engineers, and over 3100 physicians and surgeons were admitted into the United States as immigrants. The 9300 engineers represent over 20 percent of the total number of recipients of baccalaureates in engineering from U.S. institutions. Totals for the period 1954 to 1970 were 67,400 scientists and engineers and 19,106 physicians and surgeons from foreign countries [National Science Foundation annual report, *Scientists, Engineers and Physicians from Abroad* (National Science Foundation, Washington, D.C., 1971)].
2. The production of scientists and engineers by U.S. institutions has increased during the post-Sputnik era. According to the National Science Foundation, between 1960 and 1970 annual production of baccalaureate degrees in the sciences and engineering increased by more than a factor of 2, master's degrees by a factor of 2.5, and doctorates by a factor of 2.9 [National Science Foundation, *Scientific Human Resources: Profiles and Issues* (NSF 72-304, National Science Foundation, Washington, D.C., 1972), p. 1].
3. For a consideration of the representation of women and ethnic minorities on advisory boards, see Committee on the Utilization of Young Scientists and Engineers in Advisory Services to Government, *The Science Committee* (National Academy of Sciences–National Research Council, Washington, D.C., 1972).
4. From an internal National Science Foundation memorandum.
5. A 1963 follow-up study of recipients of science and engineering baccalaureates showed that only 35 percent of them entered the work force directly with that degree [L. M. Sharp, *Education and Employment: The Early Careers of College Graduates* (Johns Hopkins Press, Baltimore, 1970)].
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NEWS AND COMMENT

The Sloan-Kettering Affair (II): An Uneasy Resolution

William T. Summerlin spent the night of Monday, 25 March, in New York on a cot in his laboratory at the Memorial Sloan-Kettering Cancer Center. It had become his habit to spend Monday and Thursday nights in the lab. He needed the time, he has said, to complete grant applications and get other paper work done.

That night Summerlin slept poorly, as he often had for several months. On the morning of the 26th, he got up at 4 a.m., shaved, and went upstairs to the animal room to check on his mice. Later that morning he would take some of them with him to a meeting with his boss and erstwhile mentor, immunologist Robert A. Good, president of the Sloan-Kettering Institute for Cancer Research.* It would be his downfall (*Science*, 10 May).

For 3 years, Summerlin and Good had been exuberant over experiments conducted when the two were in Minneapolis at the University of Minnesota—experiments that indicated that skin and other organs, when maintained for a time in tissue culture, lose their normal ability to provoke an immune response. If their observations proved true, it theoretically meant that one could transplant organs between genetically mismatched individuals

* The Memorial Sloan-Kettering Cancer Center is a composite of two related institutions, Memorial Hospital and the Sloan-Kettering Institute for Cancer Research.