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ABSTRACT

This report summarizes the data about minority group scientists and engineers obtained as part of a national survey of scientific and engineering personnel in 1972. Information pertaining to minority group college students enrolled in engineering is also discussed briefly. Data presented on overall distribution patterns indicate that persons of Oriental descent have the highest concentration of scientists and engineers. The distribution of all scientists and engineers among regions of the country are seen to correspond to the distribution of the total population. The age distributions of minority group engineers are found to reflect past lack of opportunities for entry into the field, the median age for all minorities being five years less than the white median age of 42. Age distributions of scientists show less differences. The levels of educational attainment among the different racial groups of scientists and engineers vary, with those of Oriental descent indicating more education than either members of other minorities or whites. The key relationship between field of study and professional identity relationship is considered to be the level of degree earned rather than the racial characteristics of the workers. (Author/AM)

SCIENCE RESOURCES STUDIES HIGHLIGHTS

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Racial Minorities in the Scientist and Engineer Population

Introduction

In recent years, in the face of a generally unfavorable market situation for many scientific and engineering specialties, scientists and engineers who are women or members of racial or certain ethnic minority groups have been sought by employers more often than in the past as a result of affirmative action and equal employment opportunity programs.[1] Associated with these demands have been requests for data about the availability of these workers. This report summarizes the data about minority group scientists and engineers obtained as part of a national survey of scientific and engineering personnel in 1972.[2] Information pertaining to minority group college students enrolled in engineering is also discussed briefly.

A basic problem associated with data on minority-group scientists and engineers is similar to that attendant to the collection of any kind of information about populations through the use of sample surveys—reliability of the estimates. Because the sample of scientists and engineers was based on the total population in occupational categories and not by racial groups, the reliability of the data concerning small minorities is considerably less than that of larger populations. The technical notes at the end of this report provide some examples of the relevant data and their reliability as applied to minority-group scientists and engineers. Particular caution should be exercised in analyzing data cells with small numbers.

The data (excluding information on minority-group college students) in this report are based upon a sample of the scientists and engineers who were in the labor force during both 1970 and 1972. Therefore, it does not represent the total number in the 1972 labor force for it does not count those who entered or re-entered the labor force between the Aprils of 1970 and 1972. Data derived from the National Sample Survey on the 1974 characteristics of racial minorities in science and engineering will be available in late 1975.

[1] See Wilburn, Adolph Y. "Careers in Science and Engineering for Black Americans." *Science*, Vol. 184, June 14, 1974.

[2] Based on estimates developed from the 1972 Postcensal Survey of Professional, Technical and Scientific Manpower. See National Science Foundation / *Science Resources Studies Highlights*. "The 1972 Scientist and Engineer Population Redefined." (NSF 75-305) (Washington, D.C. 20550) April 11, 1975.

Overall Distribution

Within the 1972 scientist and engineer (S/E) populations (as identified in the postcensal survey),[3] racial minority-group members represented about 4 percent, or 53,000 of the 1.3 million total scientists and engineers.[4] Of these minority-group members, about 29,000 were engineers and the remainder scientists. Racially, 60 percent were of Oriental descent,[5] 30 percent were black, and the remainder were members of other nonwhite races.[6] In terms of the relationships to the respective total populations, persons of Oriental descent had the highest concentration of scientists and

[3] *Ibid.*

[4] Numbers exclude those who entered the labor force between April 1970 and 1972 as scientists and engineers. See Introduction.

[5] Japanese, Chinese, Filipino and Korean, according to Bureau of the Census definition.

[6] E.g., American Indian, Hawaiian, etc. See U.S. Bureau of the Census, *1970 Census of Population, Vol. 1, Characteristics of the Population*, U.S. Summary (Washington, D.C. 20402: Supt. of Documents, U.S. Government Printing Office, 1973).

Table 1.—Total population, 1970, and scientists and engineers, 1972, by racial group

Total population, scientists and engineers	Total	White	Minorities[1] Total	Black	Oriental
		Millions			
Total population	203.2	177.7	25.5	22.6	1.4
		Thousands			
Total scientists and engineers	1 336.4	1 283.0	53.5	16.2	32.1
Scientists	496.1	471.3	24.8	9.7	12.8
Engineers	840.3	811.7	28.6	6.5	19.3
	Number of scientists and engineers per 10,000 population concentration[2]				
Total scientists and engineers	65.8	72.2	21.0	7.2	223.8
Scientists	24.4	26.5	9.8	4.3	88.6
Engineers	41.3	45.7	11.2	2.9	134.2
	Number of scientists and engineers relative to total concentration				
Total scientists and engineers	1.00	1.10	.32	.11	3.40
Scientists	1.00	1.09	.40	.18	3.63
Engineers	1.00	1.10	.27	.07	3.24

[1] Includes other minorities not shown separately.

[2] Calculations based on unrounded numbers.

Note: Detail may not add to totals because of rounding.

Source: National Science Foundation and Bureau of the Census.

(Prepared in the Manpower Utilization Studies Group, Division of Science Resources Studies)

engineers. There were 134 Oriental engineers and 89 Oriental scientists per 10,000 total population of Oriental descent, versus 3 black engineers and 4 black scientists per 10,000 total black population. The ratio for whites, on the other hand, was 46 engineers and 27 scientists per 10,000 population (table 1).

Geographic Distribution

The distribution of all scientists and engineers among regions of the country generally corresponds to the distribution of total population. There was no more than about a 6-percentage-point difference in the share of engineers and about a 4-percentage-point difference in the share of scientists with respect to population shares in 1970. Minority-group scientists and engineers, however, were distributed differently than both total scientists and engineers and the respective minority populations.

Table 2 details three measures of S E concentration by race and groups of States. The first panel (A) distributes total populations, scientists and engineers, by race and region. (The component States of each region are shown in the technical notes). From these data, it can be seen that scientists and engineers have been considerably more mobile than other members of their respective races. Whereas more than one-half of the black population lived in the Southern States, only about one-third of the black engineers and scientists lived in these States. More striking is the comparison of Oriental population in the Western States to the respective scientists and engineers. These States housed about three-quarters of the population of Oriental descent, about one-half of the group's engineers and about one-third of its scientists.

The ratios in the second panel (B) relate the distributions of scientists and engineers to population by race and region (both in panel A). The 1.1 ratio of all engineers in the Northeast region is obtained from the 27.5 percent of all engineers residing in these States compared with 24 percent of the total population. These

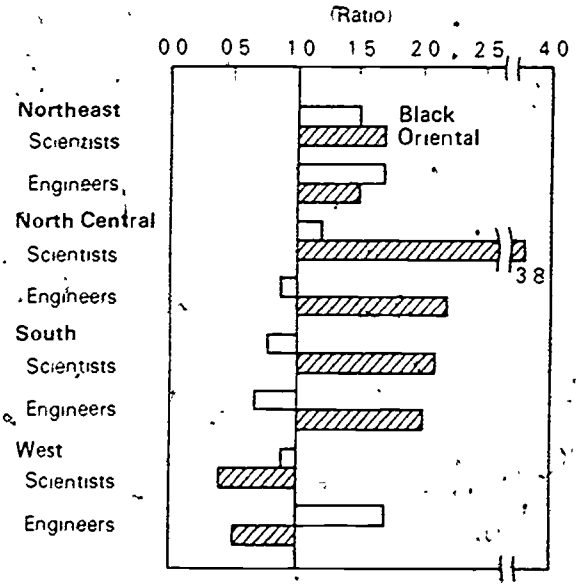
Table 2.—Total population, and persons in the 1970 experienced civilian labor force identified as scientists and engineers, by racial group and geographic region: 1972

Total population scientists and engineers	Total United States (in thousands)	Region			
		Total	Northeast	North-central	South	West
		Panel A. Percent distribution				
Total population						
All groups	203,212	100	24	28	31	17
Black	22,580	100	19	20	53	7
Oriental	1,369	100	12	8	7	73
Scientists						
All groups	469	100	27	24	29	20
Black	10	100	31	21	39	8
Oriental	13	100	22	26	14	38
Engineers						
All groups	840	100	27	24	25	23
Black	7	100	36	16	30	18
Oriental	19	100	20	15	12	53
		Panel B. Distribution of scientists and engineers relative to distribution of respective population[2]				
Scientists						
All groups	(X)	1.0	1.1	0.9	0.9	1.2
Black	(X)	1.0	1.6	1.0	.7	1.1
Oriental	(X)	1.0	1.9	3.3	1.9	.5
Engineers						
All groups	(X)	1.0	1.1	0.9	.8	1.4
Black	(X)	1.0	1.9	.8	.6	2.4
Oriental	(X)	1.0	1.7	1.9	1.6	.7
		Panel C. Racial concentration within regions adjusted for concentration of total scientists and engineers[4]				
Scientists						
Black	(X)	1.0	1.5	1.2	.8	.9
Oriental	(X)	1.0	1.7	3.8	2.1	.4
Engineers						
Black	(X)	1.0	1.7	.9	.7	1.7
Oriental	(X)	1.0	1.5	2.2	2.0	.5

For component States see technical notes.
Sample calculations for black engineers in the Northeast
Panel B (from Panel A) black engineers (36.2) ÷ black population (19.2) = 1.89

(X) Not applicable
[4] Panel C (From Panel B) black engineers (1.89) ÷ all engineers (1.14) = 1.66
Source: National Science Foundation and Bureau of the Census

Comparisons of adjusted racial concentrations, by region of black and Oriental scientists and engineers: 1972
[U.S. concentration = 1.0]



SOURCE National Science Foundation and Bureau of the Census

ratios show the regions of the country with the extremes of scientists and engineers per population. For example, on the high end of the scales for black scientists and engineers were the Western States (1.1 and 2.4, respectively), and Northeastern States (1.6 and 1.9, respectively), on the low end were the Southern States. These ratios also show that the region at the high end of each scale had more than twice as many black scientists or engineers per black population as the Southern States.

The ratios in the third panel (C) compare the ratios of black and Oriental scientists and engineers per the respective populations to the ratios of all scientists and engineers per population. The 1.7 ratio of black engineers in the Northeast results from the relative distributions (shown in panel B) indicating that black engineers were proportionately 1.9 times as populous as black population, whereas all engineers were proportionately only 1.1 times as populous as total population in these States. (See footnotes in table 2 and methodology in technical notes.)

Panel C indicates the probabilities of encountering black and Oriental scientists and engineers considering the respective populations and the numbers of scientists or engineers in each region. Thus, at the high end of the scale in the Western States there are 1.7 times the number of black engineers that one would expect if the national rate of black engineers to black population were applied, after adjusting for the number of engineers of all races in those States. At the other end of the scale for black engineers in the Southern States, the same measure yields only 69 percent of the national norm.

Age Characteristics

The age distributions of minority group engineers appear to reflect past lack of opportunities for entry to the field, the median age for all minorities being five years less than for whites. Blacks are even younger—seven years less than the white median age of 42. A more vivid comparison can be drawn from the proportions of engineers by race 45 years old and over. Of the white engineers, 40 percent were in this age bracket, while only 26 percent of the blacks and 19 percent of the Oriental engineers were in this age group (table 3). On the other hand, the age distributions of scientists showed less differences—with scientists, as a whole, being younger than engineers, since the bulk of the growth of the science occupations occurred when enrollment opportunities for minority groups were beginning to open in colleges. Also, there has been less tendency to upgrade older workers without degrees in the science occupations than in engineering.

Educational Characteristics

The levels of educational attainment among the different racial groups of scientists and engineers vary. In general, the scientists and engineers of Oriental descent have more education than either members of other minorities or whites. Over 70 percent of the Oriental scientists had graduate degrees as opposed to 54 percent of all scientists. Almost one-half the Oriental engineers

Table 3.—Scientists and engineers by racial group and age: 1972

Age	Total	White	All minorities Total[1]	Black	Oriental
Scientists, total (in thousands)	496	471	25	10	13
	Percent distribution				
Total	100	100	100	100	100
Less than 35 years	43	43	37	38	33
35-44 years	29	29	40	36	47
45 and over	27	28	22	26	19
Median age	37	37	38	38	39
Engineers, total (in thousands)	840	812	29	7	19
	Percent distribution				
Total	100	100	100	100	100
Less than 35 years	31	30	44	51	40
35-44 years	30	30	37	23	41
45 and over	39	40	19	26	19
Median age	41	42	37	35	37

[1] Includes other minorities not shown separately.
See table A-1 in technical notes for distribution by field and race.
Note: Percents may not add to 100 because of rounding.
Source: National Science Foundation

Table 4.—Scientists and engineers by highest degree held and racial group: 1972

Highest degree held	Total	All minorities		
		White	Total	Black	Oriental
Scientists, total (thousands)	496	471	25	10	13
	Percent distribution				
Total	100	100	100	100	100
None	2	2	0	0	0
Bachelor's	43	44	39	55	29
Master's	25	25	29	31	27
Doctorate	29	27	31	13	44
Engineers, total (thousands)	840	812	29	7	19
	Percent distribution				
Total	100	100	100	100	100
None	9	10	3	3	3
Associate	2	2	2	3	2
Bachelor	67	67	54	73	49
Master's	17	17	28	18	31
Doctorate	4	4	13	3	14
Education index					
Scientists	181	180	191	157	214
Engineers	114	112	148	119	153

[1] Includes other minorities not shown separately
[2] See table A-1 in technical notes for distribution by field and race
[3] Includes associate degrees (representing 0.1 percent of total and white scientists), and 1 to 4 years of college but no degree
[4] Includes other degrees not separately shown
[5] Includes no college and 1 to 4 years of college but no degree
[6] Values assigned to degrees: less than bachelor's, 0; bachelor's, 1; master's, 2; doctorate, 3; each value is multiplied by percent of total with degree
Note: Detail may not add to totals because of rounding
Source: National Science Foundation

have graduate degrees while only 21 percent of the total engineering work force had these degrees. Black scientists have had on the average less education than members of all other groups, but black engineers averaged more education than their white counterparts (table 4) for there exists a relatively large share of white scientists and engineers without college degrees in comparison to the minority groups. Proportionately, three times as many whites as minorities without college degrees were in the engineering labor force, and six times as many in the science labor force. This probably stems from the lack of minority group technicians in the past, since such jobs have in many instances provided opportunities for upgrading to professional positions.

Field of Study/Professional Identity Relationships

Minority-group scientists and engineers exhibited about the same degree of attachment to the disciplines in which they majored as did all scientists and engineers. The key relationship between fields of highest degree and professional identity was the level of degree rather than the racial characteristic of these workers. In general, a doctorate degree in a field of study resulted in a stronger identity attachment to the same field, while bachelor's and master's degrees were associated with greater degrees of mobility.

Both total and minority-group engineers had higher degree field-professional identification relationships than all scientists[7]. Table 5 summarizes the coincidence of field of professional identification with field of degree for the total population and minority-group members by level of degree and identity field. The only differences between Orientals and blacks resulted from a greater proportion of the former with doctorate degrees and thus a greater identity attachment to the same field as their studies.

The Education Process for Black Engineering Students

While blacks accounted for about 12 percent of the college-age population, they comprised 8 percent of total college enrollment and 2.6 percent of under-

[7] Computer specialists and operations research analysts are excluded from these calculations of total scientists because few workers indicated majors in these relatively new disciplines

Table 5.—Scientists and engineers, total and minority groups, by educational attainment and field of study: 1972

Highest degree held	Percent with same field of study as identity						
	Engineers	Computer specialists	Mathematical specialists[1]	Total scientists[2]	Life scientists	Physical scientists	Social scientists[3]
Total	85	6	72	79	80	78	82
No degree[4]	90	9	40	67	80	64	100
Bachelor's	87	1	51	76	86	77	70
Master's	81	19	82	79	75	78	81
Doctorate	87	16	86	85	85	81	92
Minority groups, total	89	5	76	75	75	71	82
No degree[4]	93	0	0	0	—	—	—
Bachelor's	90	2	72	74	81	72	79
Master's	87	10	83	75	69	73	79
Doctorate	92	0	79	78	90	72	93

[1] Includes statisticians
[2] Excludes computer specialists, mathematical specialists, and operations research analysts; includes life, physical, and social scientists
[3] Includes psychologists
[4] Includes associate degrees and persons with some college but no degree
Source: National Science Foundation

graduate engineering enrollments in 1973 (table 6). Recent trends, however, indicate that blacks have been growing as a proportion of engineering students while stabilizing as a share of total college enrollment. Of engineering enrollments, blacks have more than doubled their representation in four years, growing from a 1.1 percent share in 1969. Enrollments of blacks in the first year of the engineering curriculum have grown more dramatically from 1.4 percent to 3.8 percent in the same period. While both total and first-year engineering enrollments dropped by 21 percent and 31 percent, respectively, in the 1969-73 period, black enrollments increased by 78 percent and 88 percent. Although these percents are generated by relatively small numbers of black students—2,900 in 1969 and 5,200 in 1973—the trends are pronounced.

In addition, black students are attending predominantly white engineering schools in increasing numbers. For example, in 1969 nearly 60 percent of the black engineering students—U.S. citizens only—were enrolled in six predominantly black institutions.[8] Within these schools they represented 80 percent of engineering enrollments, most of the remainder being foreign students. Between 1969 and 1973, however, these schools experienced declines in total engineering enrollments as well as black enrollees, while in other (predominantly white) schools, black enrollments almost tripled from about 1,250 in 1969 to 3,650 in 1973. As a result, by 1973 these six schools accounted for only 30 percent of black engineering students.

[8] Howard University, North Carolina Agricultural and Technical University, Prairie View Agricultural-Mechanical University, Southern University, Tennessee State University, and Tuskegee Institute. Another predominantly black school with an engineering curriculum is the Hampton Institute which is not considered here as it has a very small engineering enrollment with fewer black students enrolled than a number of large predominantly white schools. Only two predominantly white schools reported as many black students as the smallest of the six predominantly black schools in the 1973-74 academic year.

Table 6.—Undergraduate enrollments in engineering compared with total college enrollments: 1973

(Numbers in thousands)

Racial ethnic group	Engineering enrollments		Total college enrollments	
	Number	Percent	Number	Percent
Total	202.4	100.0	8 179.0	100.0
Black	5.2	2.6	684.0	8.4
Spanish origin	2.5	1.2	290.0	3.5
Oriental	3.0	1.5	NA	NA
American Indian	2	1	NA	NA
White and other races	191.5	94.6	NA	NA

Note: NA, not available.

Sources: Engineering enrollment: *Engineering and Technician Enrollments, Fall 1973*, Engineering Manpower Commission of Engineers Joint Council, New York, 1974.

Total college enrollment: U.S. Bureau of the Census, *Current Population Reports*, Series P-20, No. 272, Social and Economic Characteristics of Students, October 1973, U.S. Government Printing Office, Washington, D.C., 1974.

Trends of black engineering student enrollment in predominantly white schools have shown a diffusion among schools between 1969 and 1973. In 1969 almost one-half these black students were enrolled in 10 schools, while in 1973 less than one-third were in the 10 schools with the largest numbers of black students.[9]

Similar trend data for members of other minority groups are not available. However, enrollments of blacks and members of other minority groups in engineering in the 1973-74 school year were available and can be compared with the racial characteristics of all college students, as shown in table 6.

[9] There is evidence of some underreporting of black enrollment in 1969 and the trend data are not strictly comparable. It is likely, however, that if complete data were available, the results would not significantly differ from those discussed above.

Technical Notes

Race

The data on racial minorities are based on responses in the 1970 Census of Population. The "other races" category includes all races not included in the specific categories shown.

Geographic Data

States within regions of the United States

Northeast: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania

North Central: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraksa, Kansas

Southern: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas

Western: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska, Hawaii

Methodology for estimating relative concentration within regions (table 2)

(1)

$$C = \frac{E_{r,i} \div P_{r,i}}{E_{u,t} \div P_{u,t}}$$

(2)

$$C_{r,i} = C_{ri} \div \frac{E_{r,t}}{P_{r,t}}$$

C = Concentration ratio among regions by race
E = Engineers (or scientists)
P = Population
r = Region
i = Race
t = Total
u = United States
C = Relative concentration of engineers (scientists) by race within region

Table A-1—Persons in the 1970 experienced civilian labor force identified as scientists, total and racial groups, by field, age, and educational attainment, 1972

(In thousands)

Scientists, racial group, age and highest degree held	Total	Mathematical specialists[1]	Computer specialists	Operations research analysts	Life scientists	Physical scientists	Social scientists[2]
Total	496.2	31.1	100.3	11.8	77.2	179.8	95.9
Under 35 years	213.5	14.7	57.4	5.9	29.6	65.4	40.7
35-54 years	236.6	13.6	41.3	5.2	38.7	92.8	45.1
55 years and over	46.0	2.9	1.7	.7	8.9	21.6	10.2
No degree[4]	11.2	5	5.4	(5)	5	3.9	5
Bachelor's degree	215.9	10.4	71.0	5.6	30.7	76.0	22.3
Master's degree	126.4	10.7	21.6	4.7	17.8	36.5	35.0
Doctorate degree	142.7	9.6	2.3	1.5	28.2	63.4	38.1
White, total	471.3	28.5	97.0	11.2	73.6	169.3	91.8
Under 35 years	204.2	13.2	55.6	5.8	28.3	61.5	39.3
35-54 years	222.8	12.3	39.7	4.8	36.6	86.9	42.7
55 years and over	44.2	2.6	1.6	.6	8.7	20.9	9.8
No degree[4]	11.0	(5)	5.3	(5)	5	3.9	5
Bachelor's degree	206.2	9.4	69.0	5.3	29.9	71.9	20.8
Master's degree	119.1	9.9	20.3	4.5	16.1	34.7	33.6
Doctorate degree	135.0	8.9	2.3	1.0	27.1	58.8	36.9
Black, total	9.7	1.4	1.4	(5)	1.3	3.0	2.4
Under 35 years	3.7	.6	.8	0	(5)	1.3	.6
35-54 years	5.3	.6	.5	(5)	.8	1.6	1.6
55 years and over	.7	(5)	(5)	0	(5)	(5)	(5)
No degree[4]	(5)	(5)	0	0	0	0	0
Bachelor's degree	5.4	.7	1.0	(5)	(5)	2.0	1.0
Master's degree	3.0	.5	(5)	(5)	.7	.5	.9
Doctorate degree	1.3	(5)	0	0	(5)	.5	.5
Oriental, total	12.8	1.0	1.3	(5)	1.9	6.9	1.4
Under 35 years	4.2	(5)	(5)	(5)	.6	2.3	.5
35-54 years	7.7	.6	.9	(5)	1.2	4.1	.8
55 and over	.8	0	0	(5)	(5)	.6	(5)
No degree[4]	(5)	(5)	0	0	0	0	0
Bachelor's degree	3.7	(5)	.7	0	(5)	2.0	.5
Master's degree	3.4	(5)	.6	(5)	.8	1.2	(5)
Doctorate degree	5.6	.5	(5)	(5)	.8	3.7	.6

[1] Includes statisticians
[2] Includes psychologists
[3] Includes other nonwhite races not shown separately
[4] Includes associate degree holders and some college, but no degree
[5] Less than 500
[6] Less than 50
Note: Detail may not add to totals because of rounding
Source: National Science Foundation

Standard Errors

The table below has some examples of the standard errors of totals for the various field groups among the scientist and engineer population. Each standard error indicates the range in which the estimate is likely to fall 68 percent of the time; double this range—two standard errors—encompasses a 95-percent probability of the estimate being within the boundaries of the numbers. For example, the total number of black engineers is estimated at 6,500 and the standard error for this number of engineers is approximately 665 (interpolating between the errors for 5,000 and 10,000). Thus, there is a 68-percent chance that the total number of black engineers will fall between 5,835 and 7,165, and a 95-percent chance that the total will be between 5,170 and 7,830.

Table A-2.—Approximate standard errors of totals for scientists and engineers

Size of estimate	Mathematical specialists	Computer specialists	Life scientists	Physical scientists	Social scientists	Engineers
500	150	180	140	160	170	210
1,000	210	250	200	230	240	270
2,000	300	330	280	315	310	350
5,000	450	560	442	510	520	590
10,000	580	760	610	720	700	840
20,000	620	1,010	790	980	890	1,160

[1] Includes statisticians.
[2] Includes operations research analysts.
[3] Includes psychologists.

Estimated Sample

The table below compares the numbers of minority group scientists and engineers actually responding to the sample survey and the associated weighted estimates of the numbers of each group in the total population.

Table A-3.—Comparisons of sample to estimated totals of minority scientists and engineers

Field	Sample size				Total population estimate			
	All minorities	Black	Oriental	Other	All minorities	Black	Oriental	Other
Total scientists and engineers	862	281	496	85	53,482	16,239	32,087	5,156
Total scientists	499	205	248	46	24,847	9,746	12,755	2,346
Mathematical specialists[1]	60	32	24	4	2,597	1,353	992	252
Computer specialists	61	30	22	9	3,332	1,387	1,291	654
Operations research analysts	11	5	6	—	656	282	374	—
Life scientists	91	35	45	11	3,594	1,313	1,856	425
Physical scientists	186	53	120	13	10,547	2,985	6,887	675
Social scientists	90	50	31	9	4,121	2,426	1,359	340
Engineers	363	76	248	39	28,635	6,493	19,332	2,810

[1] Includes statisticians.
[2] Includes psychologists.