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ABSTRACT

Doctorate holders who received their degrees in science or other fields between 1930 and 1972 and who held jobs in the sciences and engineering (S/E) were surveyed. Findings include the following: employment of doctorates in S/E activities continued to grow between 1979 and 1981 at the same rate since 1975, about 5 percent per year, reaching a total of 314,000 in 1981; this growth in job opportunities was about equal to the growth in available supply; declines in S/E utilization rate (i.e., the number employed in S/E activities per 100 Ph.D. scientists and engineers in the labor force) were particularly notable in the mathematical and social sciences over the 1973-1981 period; S/E job opportunities for Ph.D. computer, life, and environmental scientists and engineers remained strong; although representing only 3 percent of the total, computer sciences outpaced all other doctoral S/E employment between 1979 and 1981, growing at an average annual rate of 16 percent; job opportunities continued to shift from educational institutions and government to business/industry; although 55 percent of all doctoral S/E employment was at educational institutions, the demand in academia continued to increase at a below-average rate; and minorities and women continued to increase their share of the doctoral population. (SW)

SCIENCE RESOURCES STUDIES -- HIGHLIGHTS

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GROWTH IN EMPLOYMENT OF SCIENCE AND ENGINEERING DOCTORATES CONTINUES, LED BY COMPUTER SCIENTISTS

Prepared in the Demographic Studies Group, Division of Science Resources Studies

SCIENCE RESOURCES STUDIES HIGHLIGHTS

NATIONAL SCIENCE FOUNDATION WASHINGTON, D.C. 20550 NOVEMBER 30, 1982 NSF 82-328

Growth in Employment of Science and Engineering Doctorates Continues, Led by Computer Scientists

Surveys of doctorate-holding scientists and engineers[1] have been conducted biennially for the National Science Foundation (NSF) and other Federal Government agencies by the National Research Council of the National Academy of Sciences since 1973. The science and engineering (S/E) population surveyed consisted of individuals in the United States who held S/E doctorates or who had received doctorates in non-S/E fields but were employed in S/E positions. The 1973 survey included individuals who had received their doctorates in the 42-year period between January 1, 1930, and June 30, 1972. Subsequent surveys in this biennial series continued to take account of a 42-year period by dropping the two oldest cohort years and adding the two most recent.

Highlights

• Employment of doctorates in science and engineering (S/E) activities continued to grow between 1979 and 1981 at the same rate since 1975, about 5 percent per year, reaching a total of 314,000 in 1981.

• This growth in S/E job opportunities was about equal to the growth in available supply. Although practically all (99 percent) Ph.D. scientists and engineers are employed, a small but increasing share of those employed have been working outside S/E fields (6 percent in 1973 and 9 percent in 1981). Declines in the S/E utilization rate (i.e., the number employed in S/E activities per 100 Ph.D. scientists and engineers in the labor force) were particularly notable in the mathematical and social sciences over the 1973-81 period. During this time, the S/E utilization rate for mathematical sciences dropped 5 percentage points, to the 90-percent range, while that for social sciences dropped 4 percentage points to the 80-percent range. S/E job opportunities, however, for Ph.D. computer, life, and environmental scientists and engineers—as measured by this rate—continue to remain strong. In all fields the most often cited reason for working outside science and engineering was "more attractive career options"; less than one in ten cited the unavailability of an S/E position.

• Although representing only 3 percent of the total, computer sciences outpaced all other doctoral S/E employment between 1979 and 1981, growing at an average annual rate of 16 percent. Psychology and engineering reported slightly above-average growth rates (6 percent for each), while the physical and mathematical sciences grew considerably below the average (3 percent and 0 percent, respectively).

• Job opportunities continued to shift from educational institutions and government to business/industry. S/E employment in the industrial sector increased 18 percent between 1979 and 1981, representing an average annual growth rate of 9 percent, up from a comparable rate of 7 percent for 1973-77 and almost 8 percent for 1977-79. In contrast, as noted earlier, total doctoral S/E employment increased 9 percent between 1979 and 1981, representing an average annual rate of growth of 5 percent—the same as 1977-79 and down from 6 percent between 1973 and 1977. Thus the shift into business/industry observed between 1979 and 1981 represents an acceleration of longer term changes.

• Although 55 percent of all doctoral S/E employment is in educational institutions, the demand in academia continues to increase at a rate below average. This sector increased 8 percent between 1979 and 1981, representing an average annual growth rate of less than 4 percent per year, continuing the 1977-79 level, and down from 6 percent per year between 1973 and 1977. As a consequence, the share of employment in academia declined from 59 percent to 55 percent of the total between 1973 and 1981. Demographic considerations such as the shrinking pool of the college-age population point to continuing employment difficulties for S/E doctorates in the academic sector.

• These sectoral shifts have produced changes in the distribution of doctoral work activity. Research and development, and its management, continue to be the primary work activity of about half of all Ph.D.'s working in science and engineering. Those who cited teaching as their primary work activity, however, declined from 37 percent of this group in 1973 to 31 percent in 1981, reflecting the slower than average growth of the academic sector noted earlier. This decline was offset by proportional increases largely in sales/professional services and, to a lesser extent, in development.

• Minorities and women continue to increase their share of the doctoral S/E population. The number of minority Ph.D. scientists and engineers rose from 5 percent to 10 percent of the total Ph.D. S/E population between 1973 and 1981. Although the number of blacks more than doubled during those years, blacks still represented only 1 percent of the total by 1981. The number of women Ph.D. scientists and engineers also more than doubled between 1973 and 1981 with their share of the total rising from 9 percent to 13 percent.

[1] These surveys were expanded to include doctorate-holders in the humanities in 1977, 1979, and 1981

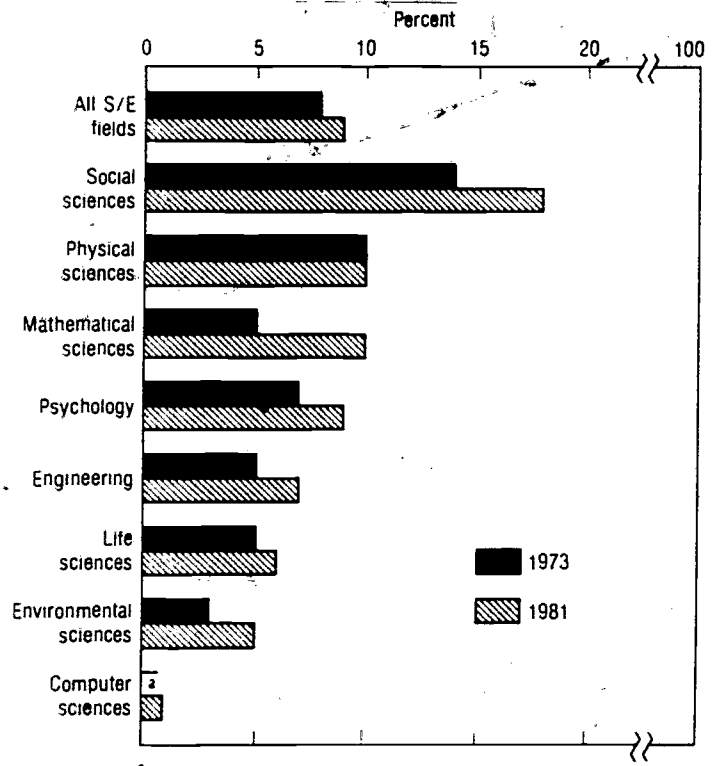
Labor Force Status

Conditions in the labor market remained generally favorable for U.S. doctoral scientists and engineers in 1981. While the number within the labor force (i.e., supply) rose almost 10 percent between 1979 and 1981, employment opportunities kept pace.[2] As a result, fewer than 1 percent of those in the doctoral S/E labor force were unemployed in 1981, unchanged from the level recorded since this series of surveys began in 1973. Because of their high levels of skill and training, Ph.D. scientists and engineers experience relatively low levels of unemployment. Thus, while unemployment rates are a commonly accepted indicator of labor market conditions, they are a less important gauge of these conditions for doctoral scientists and engineers. Employment outside S/E fields, however, can indicate underutilization for doctoral scientists and engineers. Although practically all Ph.D. scientists and engineers who wish to work are employed (99 percent), 9 percent in 1981 were working in jobs outside science and engineering. Only a small fraction of those so employed, however, cited the unavailability of an S/E job as their reason for non-S/E employment. The most often cited reason was "more attractive career options" which may or may not connote truly "voluntary" choices.

The trend in these non-S/E utilization rates suggests that there may be increasing amounts of underutilization, particularly in fields where demand may be relatively weak. The percents of non-S/E employment across fields display a general upward drift over the 1973-81 period, and show marked increases—4 to 5 percentage points—in the mathematical and social sciences (chart 1).

[2] The labor force includes those employed in any job and those seeking employment

Chart 1. Percent of doctoral science/engineering (S/E) labor force working outside science/engineering by field: 1973 and 1981



[a] Less than 0.5 percent
SOURCE: National Science Foundation

The non-S/E utilization rates for women doctoral scientists and engineers continued to increase less than those for men. Moreover, whereas the rate for men increased in every major S/E field between 1973 and 1981, it declined substantially for women in the physical sciences and engineering and to a lesser extent in the environmental and life sciences.

Employment by Sector

Between 1973 and 1979, total employment of doctorates in science and engineering grew at 6 percent per year and employment in the business/industry sector grew at 7 percent. Between 1979 and 1981, however, the average annual growth rate of total S/E employment fell slightly—to 5 percent per year—while the rate for business/industry climbed to 9 percent. As a consequence of this relatively rapid industrial growth the share of Ph.D.'s in S/E employment in this sector rose from 24 percent to 28 percent between 1973 and 1981.

About 90 percent of the 1979-81 growth of Ph.D. scientists and engineers in the industrial sector took place among those working primarily in R&D[3] activities, even though only 48 percent of all S/E industrial doctorates are engaged primarily in research and development. This concentration reflects, in part, a 10-percent increase in real terms in industrial R&D expenditures. Correspondingly, growth in industrial R&D spending reflects, in part, a change in corporate strategy which places greater emphasis on research and development as a source of future growth and new market opportunities. Also, the policies of the Federal Government influence industry's expenditures through tax incentives and establishment of regulations and minimum standards in areas such as environmental pollution, food and drug production, and public safety.[4]

While employment in the industrial sector was growing faster than average and at an accelerating rate during the seventies, the reverse was taking place in the educational institutions. Between 1973 and 1979 employment in academia showed an annual growth rate of 5 percent; between 1979 and 1981 the annual rate fell to under 4 percent.[5] As a result, the share of academic employment declined from 37 percent to 31 percent of the total between 1973 and 1981. Slower growth in this sector resulted in part from the current and projected future declines in enrollment growth.[6]

Despite the decline in doctoral S/E employment in academia, selected work activities show marked strength. For example, research showed stronger than average growth between 1973 and 1979 and grew at almost double the average rate of all employment in academic work activities between 1979 and 1981.

[3] Excludes the management of research and development

[4] See National Science Foundation, *National Patterns of Science and Technology Resources, 1981* (NSF 81-311) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office), p. 10

[5] The same declining trend is found in Ph.D. academic S/E employment data supplied by the educational institutions themselves. The average annual rate of growth for 1976-78 was 3.8 percent, that for 1978-81, 1.8 percent. See National Science Foundation, *Academic Science: Scientists and Engineers, January 1981* (Detailed Statistical Tables) (NSF 82-305) (Washington, D.C.), tables B-9 and B-10, p. 10

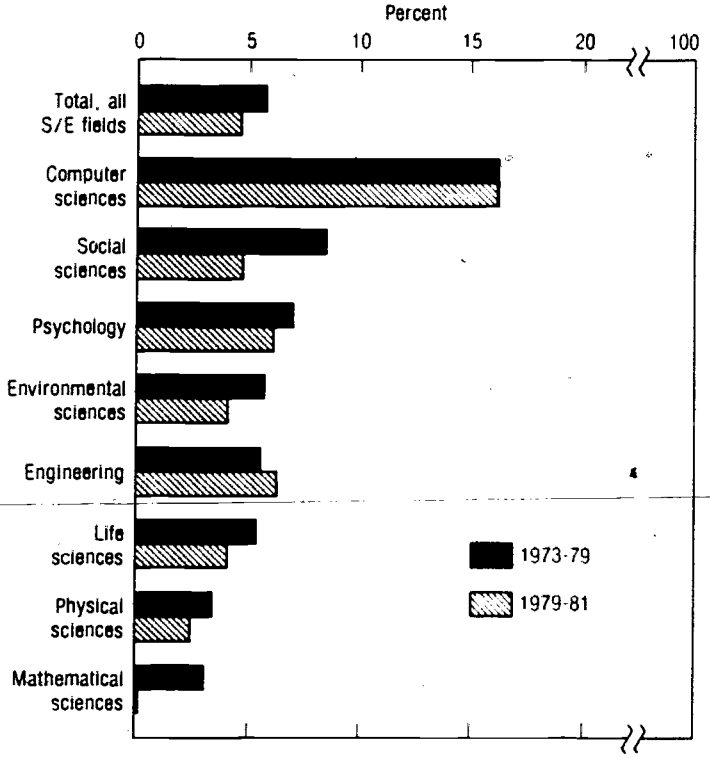
[6] National Science Foundation, *Academic Science: 1972-81, R&D Funds, Scientists and Engineers, Graduate Enrollment and Support* (NSF 81-326) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office), p. 11

S/E Employment Fields

For all sectors combined, a great deal of variation appeared in the S/E employment growth rates among S/E fields. Except for the mathematical and social sciences, however, the growth rate within each field was about the same for the 1979-81 period as it has been over the previous six years (chart 2). The differences in growth rates among fields indicate a consistent pattern of shifts in S/E employment away from the physical and mathematical sciences toward engineering and the computer sciences, primarily reflecting the shifting demands of both industry and academia noted earlier. In the most recent period, 1979-81, employment of computer scientists grew at a rate more than three times the average; employment of engineers grew almost one and one-half times the average. Computer scientists, however, comprise less than 3 percent of all doctoral scientists and engineers.

Only employment of computer and social scientists increased at rates in excess of the average in academia. The average annual growth rate for computer scientists was 10 percent over the 1973-79 period and 12 percent between 1979 and 1981. Among social scientists, the comparable growth rates were 7 percent and 5 percent. The growth among computer scientists is not surprising and reflects both the rapidly increasing number of students majoring in the computer sciences and the increases in the number of nonmajors receiving some training in computer fields. The growth among social scientists seems to result from an upgrading of educational qualifications for social science employment in educational institutions. Employment of social scientists at less than the doctoral level in academia remained fairly stable during the late seventies. Thus, it appears that educational institutions are replacing those social scientists without the Ph.D. with those who hold doctorates. The relatively slow growth among engineers (3 percent per year between 1979 and 1981) reflects the inability of educational institutions to attract Ph.D. engineers. Engineering colleges reported that 10 percent of their full-time faculty positions were vacant in the fall of 1980.[1]

Chart 2. Average annual rate of growth of science/engineering (S/E)-employed Ph.D.'s by field: 1973-79 and 1979-81



SOURCE: National Science Foundation

Women and Minorities

The number of female Ph.D. scientists and engineers continued to increase at an average annual rate of 10 percent between 1979 and 1981 (table 1). This increase is twice that of men. The female share of the Ph.D. S/E population rose

[1] National Science Foundation, "Engineering Colleges Report 10% of Faculty Positions Vacant in Fall 1980," *Science Resources Studies Highlights* (NSF 81-322) (Washington, D.C., November 2, 1981).

Table 1. Selected characteristics of doctoral scientists and engineers in the United States: 1973, 1979, and 1981

Characteristic	1973	1979	1981	Average annual rate of growth[1] (percent) 1973-79	1979-81
Total population	239,000	332,000	364,000	5.7	4.6
Male	218,000	294,000	318,000	5.1	4.0
Female	21,000	38,000	46,000	10.5	9.9
White	217,000	293,000	323,000	5.2	4.9
Black	2,000	4,000	5,000	8.7	11.5
American Indian	[2]	1,000	2,000	14.2	55.3
Asian	10,000	22,000	28,000	14.5	13.3
No report	10,000	12,000	6,000	—	—
Total science/engineering employment	206,000	287,000	314,000	5.7	4.6
Physical sciences	44,000	54,000	57,000	3.5	2.5
Mathematical sciences	12,000	14,000	14,000	3.1	0.1
Computer sciences	3,000	7,000	9,000	16.2	16.4
Environmental sciences	10,000	14,000	15,000	5.8	4.3
Engineering	34,000	47,000	53,000	5.5	6.2
Life sciences	56,000	76,000	82,000	5.3	4.1
Psychology	23,000	35,000	39,000	7.0	6.1
Social sciences	24,000	40,000	44,000	8.5	4.7
Business/industry	49,000	75,000	89,000	7.2	8.7
Educational institutions	122,000	160,000	173,000	4.7	3.7
Nonprofit organizations	7,000	11,000	11,000	7.1	-0.3
Federal Government[3]	19,000	25,000	26,000	4.2	2.7
Other[4]	9,000	16,000	16,000	10.3	1.3
No report	[2]	[2]	[2]	—	—

[1] Derived from unrounded data
[2] Less than 500
[3] Includes the military and commissioned corps
[4] Includes other government and all other sectors

SOURCE: National Science Foundation

from 9 percent in 1973 to 13 percent in 1981. Females, however, continue to earn less than males. The median annual salary of Ph.D. women scientists and engineers was 76 percent that of men in 1981. This difference results, in part, from the employment distribution in the various fields. For example, four-fifths of women doctoral scientists and engineers work in the life and social sciences, and psychology—three of the four lowest paying S/E fields. When standardized for field distribution, the salary gap lessens by 5 percentage points.

Female salaries differed little from those of males among young cohorts. For example, the 1979 and 1980 female doctoral S/E recipients earned 88 percent the salaries of males and achieved virtual parity in the mathematical and environmental sciences and psychology. Compared with salary differences for the total group, however, the smaller differentials for the inexperienced cohorts suggest that the salary gap widens with years of experience (table 2).

Although starting from a much smaller base than women, minority Ph.D. scientists and engineers also experienced rapid growth between 1973 and 1979 and accelerated the pace between 1979 and 1981 to roughly 15 percent per year. Their share of the total S/E doctoral population increased from 5 percent to 10 percent between 1973 and 1981. The number of blacks more than doubled and the number of Asians tripled. The black share of Ph.D. scientists and engineers, however, increased only slightly, from 0.9 percent in 1973 to 1.3 percent in 1981, while the Asian share increased from 4 percent to almost 8 percent in 1981.

Salaries of black Ph.D. scientists and engineers were slightly over 90 percent those of whites. Asians earned a median annual salary that was roughly the same as that of whites.

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Detailed statistical tables on this subject will be available in early 1983.

Table 2. Median annual salaries, Ph. D. scientists and engineers: 1981

Field	All science/engineering doctoral recipients			Female salaries as a percent of male	1979 and 1980 science/engineering doctoral recipients			Female salaries as a percent of male
	Both sexes	Male	Female		Both sexes	Male	Female	
Total, all science/engineering fields	$34,700	$35,600	$27,000	76	$25,300	$25,900	$22,800	88
Physical sciences	36,200	36,500	29,400	81	28,700	28,800	27,600	96
Mathematical sciences	31,300	31,900	26,800	84	22,100	21,800	22,600	104
Computer sciences	34,400	34,700	28,700	83	29,400	30,100	25,900	86
Environmental sciences	36,500	36,900	29,200	79	25,300	25,300	24,700	98
Engineering	40,200	40,300	32,000	79	31,900	32,000	28,600	89
Life sciences	33,200	34,300	27,100	79	23,100	23,500	22,100	94
Psychology	30,700	32,400	26,200	81	22,700	22,800	22,400	98
Social sciences	30,800	31,700	25,900	82	23,200	23,400	21,600	92

SOURCE: National Science Foundation

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